Prepared for
Commander, U.S. Pacific Fleet, Executive Agent

In accordance with
The National Environmental Policy Act and
Executive Order 12114

MARIANA ISLANDS RANGE COMPLEX

ENVIRONMENTAL IMPACT STATEMENT/

OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

Volume 3 of 3

May 2010

Final

Please contact the following person with comments and questions:

Mariana Islands Range Complex EIS/OEIS
Project Manager, Code EV21
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96869-3134
Phone: 808-472-1402
E-mail: marianas.tap.eis@navy.mil

This page intentionally left blank.

Acronyms and Abbreviations

μg/L	micrograms per liter
μm	micrometers
$\mu g/m^3$	micrograms per cubic meter
μPa^2-s	squared micropascal-second
μPa	micropascal
A-	Alert Area
A-A	Air-to-Air
A-G	Air-to-Ground
A-S	Air-to-Surface
AFB	Air Force Base
AAFB	Andersen Air Force Base
AAMEX	Air-to-Air Missile Exercise
AAV	Amphibious Assault Vehicle
AAW	Anti-Air Warfare
ABR	Auditory Brainstem Response
ACHP	Advisory Council on Historic Preservation
ACM	Air Combat Maneuvers
ADAR	Air Deployed Active Receiver
ADC	Acoustic Device Countermeasure
ADV	SEAL Delivery Vehicle
AEER	Advanced Extended Echo Ranging
AEP	Auditory Evoked Potentials
AESA	Airborne Electronically Scanned Array
AFAST	Atlantic Fleet Active Sonar Training
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFI	Air Force Instruction
AGE	Aerospace Ground Equipment
AGL	Above Ground Level
AICUZ	Air Installations Compatible Use Zones
AIM	Air Intercept Missile
AK	Alaska
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AMSP	Advanced Multi-Static Processing Program
AMW	Amphibious Warfare
ANNUALEX	Annual Exercise
AOR	area of responsibility
APCD	Air Pollution Control District
APZ	Accident Potential Zones
AQCR	Air Quality Control Region
AR	Army Reserves
AR-Marianas	Army Reserves Marianas
Army	U.S. Army
ARPA	Archaeological Resources Protection Act
ARS	Advance Ranging Source
ARTCC	Air Route Traffic Control Center
AS	Assault Support
ASDS	Advanced SEAL Delivery System
ASL	Above Sea Level
ASTA	Andersen South Training Area
ASTM	American Society for Testing and Materials
ASUW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
AT	Anti-Terrorism
AT/FP	Anti-Terrorism/Force Protection
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
atm	atmosphere (pressure)
ATOC	Acoustic Thermometry of Ocean Climate
ATSDR	Agency for Toxic Substances and Disease Registry
AUPM	Above & Underground Storage Tanks and Pesticide Management
AUTEC	Atlantic Undersea Test and Evaluation Center
AV-8B	Vertical/Short Takeoff and Landing Strike Aircraft
AW	Air Warfare
B-1	Strategic Bomber
B-2	Stealth Bomber
B-52	Strategic Bomber
BA	Biological Assessment
BAMS	Broad Area Maritime Surveillance
BASH	Bird Aircraft Strike Hazard
BDA	Battle-Damage Assessment
BDU	Bomb Dummy Unit
BH	Breacher House
BMDTF	Ballistic Missile Defense Task Force
BMP	Best Management Practices
BO	Biological Opinion
BOMBEX	Bombing Exercise
BQM	Aerial Target Drone Designation
BRAC	Base Realignment and Closure
BSP	Bureau of Statistics and Plans
BSS	Beaufort Sea State
BZO	Battle Sight Zero
°C	degrees Centigrade
C2	Command and Control
C-4	Composition 4
C-130	Military Transport Aircraft
CA	California
CAA	Clean Air Act
CAL	Confined Area Landing
CAN	Center for Naval Analysis
CAS	Close Air Support
CASS	Comprehensive Acoustic System Simulation
CASS-GRAB	Comprehensive Acoustic System Simulation Gaussian Ray Bundle
CATM	Combat Arms and Training Maintenance
CATMEX	Captive Air Training Missile Exercise
cc	cubic centimeter(s)
CCD	Carbonate Compensation Depth
CCF	Combined Control Facility
CDF	Cumulative Distribution Function
CDS	Container Delivery System
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CG	Cruiser
CHAFFEX/FLAREX	Chaff/Flare Exercise
CHESS	Chase Encirclement Stress Studies
CI	Confidence Interval
CIP	Capital Improvements Program
CITES	Convention on International Trade In Endangered Species
CIWS	Close-in Weapons System
cm	centimeters
CMC	Northern Mariana Islands Commonwealth Code

CMP	Coastal Management Plan
CNEL	Community Noise Equivalent Level
CNO	Chief of Naval Operations
CNRM	Commander, Navy Region Marianas
CNMI	Commonwealth of the Northern Mariana Islands
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COMNAVREG	Commander, Navy Region Marianas
COMNAVMAR	Commander, United States Naval Forces Marianas
COMPACFLT	Commander, Pacific Fleet
COMPTUEX	Composite Training Unit Exercise
COMSUBPAC	Commander, Submarine Forces Pacific
CONEX	Container Express (Shipping Container)
CONUS	Continental United States
CPF	Commander, U.S. Pacific Fleet
CPRW	Commander, Patrol and Reconnaissance Wing
CPX	Command Post Exercise
CQC	Close Quarters Combat
CR	Control Regulation
CRE FMP	Coral Reef Ecosystem Fishery Management Plan
CRG	Contingency Response Group
CRM	Coastal Resources Management
CRRC	Combat Rubber Raiding Craft
CRU	Cruiser
CSAR	Combat Search and Rescue
CSG	Carrier Strike Group
CSS	Commander, Submarine Squadron
CT	Computerized Tomography
CTF	Cable Termination Facility
CUC	Commonwealth Utilities Corporation
CV	Coefficients of Variation
CVN	Aircraft Carrier, Nuclear
CW	Continuous Wave
CWA	Clean Water Act
CY	Calendar Year
CZ	Clear Zones
CZMA	Coastal Zone Management Act
DARPA	Defense Advanced Research Programs Agency
DAWR	Division of Aquatic and Wildlife Resources
dB	Decibel
dBA	A-Weighted Sound Level
DBDBV	Digital Bathymetry Data Base Variable
DDG	Guided Missile Destroyer
DDT	Dichlorodiphenyltrichloroethane
DES	Destroyer
DESRON	Destroyer Squadron
DEQ	Department of Environmental Quality
DFW	CNMI Division of Fish and Wildlife
DICASS	Directional Command Activated Sonobuoy System
DLCD	Department of Land Conservation and Development
DNL	Day-Night Average A-Weighted Sound Level
DNT	Dinitrotoluene
DoD	Department of Defense
DoD REP	DoD Representative Guam, Commonwealth of Northern Mariana Islands, Federated States of Micronesia and Republic of Palau
DoN	Department of Navy
DPW	Department of Public Works
DTR	Demolition Training Range
DZ	Drop Zone
EA-6	Electronic Attack Aircraft
EA-18	Electronic Warfare Aircraft
EA	Electronic Attack
EA	Environmental Assessment
EAC	Early Action Compact
EC	Electronic Combat
EC OPS	Chaff and Electronic Combat
ECSWTR	East Coast Shallow-Water Training Range
EDS	Emergency Detonation Site
EER	Extended Echo Ranging
EEZ	Exclusive Economic Zone
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EFSEC	Energy Facility Site Evaluation Council
EGTTR	Eglin Gulf Test and Training Range
EIS	Environmental Impact Statement
EL	Sound Energy Flux Density Level
EMATT	Expendable Mobile ASW Training Target
EMR	Electromagnetic Radiation
EMUA	Exclusive Military Use Area
ENP	Eastern North Pacific
ENSO	El Niño/Southern Oscillation
EO	Executive Order
EOD	Explosive Ordnance Disposal
EODMU	Explosive Ordnance Disposal Mobile Unit
EPA	Environmental Protection Agency
EPAct	Energy Policy Act
EPCRA	Emergency Planning and Community Right to Know Act
ER	Extended Range
ES	Electronic Support
ESA	Endangered Species Act
ESG	Expeditionary Strike Group
ESGEX	Expeditionary Strike Group Exercise
ESQD	Explosive Safety Quantity Distance
ET	Electronically Timed
ETP	Eastern Tropical Pacific
EW	Electronic Warfare
EX	Exercise
EXTORP	Exercise Torpedo
°F	degrees Fahrenheit
FA-18	Flight/Attack Strike Fighter
FAA	Federal Aviation Administration
FAC	Forward Air Control
FACSFAC	Fleet Area Control and Surveillance Facility
FAD	Fish Aggregating Devices
FARP	Fuel and Armament Replenishment Point
FAST	Floating At-Sea Target
FAST	Fleet Anti-Terrorism Security Team
FCLP	Field Carrier Landing Practice
FDM	Farallon de Medinilla
FDNF	Forward Deployed Naval Forces
FEA	Final Environmental Assessment
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FFG	Frigate
FHA	Federal Housing Administration
FICUN	Federal Interagency Committee On Urban Noise
FIP	Federal Implementation Plan
FIREX	Fire Support
FIRP	Flood Insurance Rate Map
FISC	Fleet and Industrial Supply Center
FHA	Federal Housing Administration
FL	Flight Level
FM	Frequency Modulated

FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FP	Force Protection
FP	fibropapillomatosis
FR	Federal Register
FRP	Facility Response Plan
FRTP	Fleet Response Training Plan
FSAR	Finegayan Small Arms Ranges
FSM	Federated States of Micronesia
ft	feet
ft^2	square feet
FTX	Field Training Exercise
FUTR	Fixed Underwater Tracking Range
FY	Fiscal Year
FY04 NDAA	National Defense Authorization Act For Fiscal Year 2004
g	gram
GBU	Guided Bomb Unit
GCA	Guam Code Annotated
GCA	Ground Controlled Approach
GCE	Ground Combat Element
GCMP	Guam Coastal Management Plan
GDEM	Generalized Digital Environmental Model
GDP	Gross Domestic Product
GEPA	Guam Environmental Protection Agency
GHG	greenhouse gas
GIAA	Guam International Airport Authority
GIAT	Guam International Air Terminal
GJMMP	Guam Joint Military Master Plan
GLUP	Guam Land Use Plan
GNWR	Guam National Wildlife Refuge
GovGuam	Government of Guam
GRAB	Gaussian Ray Bundle
GUANG	Guam Air National Guard
GUARNG	Guam Army National Guard
GUNEX	Gunnery Exercise
GVB	Guam Visitors Bureau
HABS	Historic American Building Survey
HADR	Humanitarian and Disaster Relief
HAER	Historic American Engineering Record
HAPC	Habitat Areas of Particular Concern
HARM	High Speed Anti-radiation Missile
HC	Helicopter Coordinator
HC(A)	Helicopter Coordinator (Airborne)
HCN	Hydrogen Cyanide
HE	High Explosive
HELO	Helicopter
HFA	High-Frequency Active
HFBL	High-Frequency Bottom Loss
HFM3	High Frequency Marine Mammal Monitoring Sonar System
HH	Helicopter Designation (Typically Search/Rescue/Medical Evacuation))
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HMX	High Melting Explosive
HPA	Hypothalamic-pituitary-adrenal
HPO	Historic Preservation Officer
hr	hour
HRST	Helicopter Rope Suspension Training
HSC	Helicopter Sea Combat
HSWA	Hazardous and Solid Waste Act
HUD	Department of Housing and Urban Development
Hz	hertz
IAH	Inner Apra Harbor
IBB	International Broadcasting Bureau
ICAP	Improved Capability
ICMP	Integrated Comprehensive Monitoring Program
ICRMP	Integrated Cultural Resource Management Plan
ICWC	International Whaling Commission
IED	Improvised Explosive Device
IEER	Improved Extended Echo Ranging
IFR	Instrument Flight Rules
IHA	Incidental Harassment Authorization
III MEF	Third Marine Expeditionary Force
in.	inch
in^3	cubic inch
INRMP	Integrated Natural Resource Management Plan
IOC	Initial Operating Capability
IP	Implementation Plan
IR	infrared
ISR	Intelligence, Surveillance, and Reconnaissance
ISR/Strike	Intelligence, Surveillance, and Reconnaissance/Strike
IUCN	The World Conservation Union
IWC	International Whaling Commission
JDAM	Joint Direct Attack Munition
JFCOM	Joint Forces Command
JGPO	Joint Guam Program Office
JLOTS	Joint Logistics over the shore
JNTC	Joint National Training Capability
JSOW	Joint Stand-Off Weapon
JTFEX	Joint Task Force Exercise
JUCAS	Joint Unmanned Combat Air System
KD	Known Distance
KE	Kinetic Energy
kg	kilogram
kHz	kilohertz
km	kilometer
km^2	square kilometer
kts	knots
LAV	Light Armored Vehicle
lb	pound
LBA	Lease Back Area
LCAC	Landing Craft Air Cushion
LCE	Logistics Combat Element
LCS	Littoral Combat Ship
LCU	Landing Craft Utility
LFA	Low-Frequency Active
LFBL	Low-Frequency Bottom Loss
L_{eq}	Equivalent Sound Level
LHA	Amphibious Assault Ship
LHD	Amphibious Assault Ship
L_{max}	Maximum Sound Level
LGB	Laser Guided Bomb
LGTR	Laser Guided Training Round
LMRS	Long-Term Mine Reconnaissance System
ln	natural log
LOA	Letter of Agreement
LOA	Letter of Authorization
LPD	Amphibious Transport Dock
LSD	Amphibious Assault Ship
LT	Limited Training
LZ	Landing Zone
m	meters
m^2	square meters
m^3	cubic meters
M-4	Assault Rifle
M-16	Assault Rifle

M-203	40 mm Grenade Launcher
M-240G	Medium Machine Gun
M-249 SAW	Light Machine Gun, Squad Automatic Weapon
MAGTF	Marine Air Ground Task Force
MARPOL 73/78	Marine Pollution Convention '73, modified in '78
MAW	Marine Air Wing
MBTA	Migratory Bird Treaty Act
MCM	Mine Countermeasure
MCMEX	Mine Exercise
MEDEVAC	Medical Evacuation
MEF	Marine Expeditionary Force
MEMC	Military Expended Material Constituent
METOC	Meteorological and Oceanographic Operations
MEU	Marine Expeditionary Unit
MFA	Mid-Frequency Active
MFAS	Medium-Frequency Active Sonar
MG	Machine Gun
mgd	million gallons per day
mg/L	milligrams per liter
MH	Helicopter Designation (Typically Multi-mission)
MHWM	Mean High Water Mark
mi.	miles
mi^2	square miles
MI	Maritime Interdiction
MILCON	Military Construction
min	minutes
MINEX	Mine Laying Exercise
MIO	Maritime Interception Operation
MIRC	Mariana Islands Range Complex
MISSILEX	Missile Exercise
MISTCS	The Mariana Islands Sea Turtle and Cetacean Survey
MIW	Mine Warfare
MLA	Military Lease Area
mm	millimeters
MMA	Multi-mission Maritime Aircraft
MMHSRA	Marine Mammal Health and Stranding Response Act
MMHSRP	Marine Mammal Health and Stranding Response Program
MMPA	Marine Mammal Protection Act
MMR	Military Munitions Rule
MOA	Military Operations Area
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MOUT	Military Operations in Urban Terrain
MPA	Maritime Patrol Aircraft
MPRSA	Marine Protection, Research, and Sanctuaries Act
MRA	Marine Resources Assessment
MRUUV	Mission Reconfigurable Unmanned Undersea Vehicle
MSA	Munitions Storage Area
MSE	Multiple Successive Explosions
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MSS	Mobile Security Squadron
MTH	Marianas Training Handbook
MVA	Marianas Visitors Authority
MWR	Morale, Welfare, and Recreation
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NAS	Naval Air Station
NAS	National Academies of Science
NATO	North Atlantic Treaty Organization
NAVBASE	Naval Base
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NAVMAG	Naval Magazine
NAVSTA	Naval Station
NAWQC	National Ambient Water Quality Criteria
NCA	National Command Authority
NCRD	No Cultural Resource Damage
NCTAMS	Naval Communications Area Master Station
NCTS	Naval Computers and Telecommunications Station
NDAA	National Defense Authorization Act
NDE	National Defense Exemption
NEC	North Equatorial Current
NECC	Navy Expeditionary Combat Command
NEO	Noncombatant Evacuation Operations
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NITTRSS	Navy Integrated Training and Test Range Strategic Study
NLNA	Northern Land Navigation Area
nm	nautical mile
nm^2	square nautical mile
NMFS	National Marine Fisheries Service
NMMTB	National Marine Mammal Tissue Bank
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NPAL	North Pacific Acoustic Laboratory
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NRFCC	National Recreational Fisheries Coordination Council
NRHP	National Register of Historic Places
NRIS	National Register Information System
NRL	Naval Research Laboratory
NS	Naval Station
NSCT	Naval Special Clearance Team
NSFS	Naval Surface Fire Support
NSR	New Source Review
NSW	Naval Special Warfare
NSWG	Naval Special Warfare Group
NSWU	Naval Special Warfare Unit
NT	No Training
NUWC	Naval Undersea Warfare Center
NVG	Night Vision Goggle
NWD	No Wildlife Disturbance
NWF	Northwest Field
NWR	National Wildlife Refuge

NZ	Noise Zones
O_3	Ozone
OAH	Outer Apra Harbor
OAMCM	Organic Airborne Mine Countermeasure
OCE	Officer-In-Charge of the Exercise
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OLF	Outlying Landing Field
OP	Orote Point
OPA	Oil Pollution Act
OPAREA	Operating Area
OPCQC	Orote Point Close Quarters Combat
OPFOR	Opposition Forces
OPKDR	Orote Point Known Distance Range
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Chief of Naval Operations Instruction
OPS	Operations
OR	Oregon
ORMA	Ocean Resources Management Act
OSS	Operations Support Squadron
OTB	Over-the-Beach
OTH	Over the Horizon
Pa	Pascal
PA	Programmatic Agreement
Pa•s	Pascal•seconds
PACAF	Pacific Air Forces
PACFIRE	Pre-action Calibration Firing
PACOM	U.S. Pacific Command
PAG	Port Authority of Guam
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyl
PETN	Pentaerythritol Tetranitrate
pH	Hydrogen Ion Concentration
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PL	Public Law
$PM_{2.5}$	Particulate Matter 2.5 Microns in Diameter
PM_{10}	Particulate Matter 10 Microns in Diameter
PMAR	Primary Mission Area
POL	Petroleum, Oils, and Lubricants
POW	Prisoner of War
PPA	Pollution Prevention Act
ppb	parts per billion
PPF	Polaris Point Field
ppm	parts per million
PRI	Primary Training Area
psf	pounds per square foot
psi	pounds per square inch
psi-ms	pounds per square inch - milliseconds
PTP	Pre-deployment Training Phase
PTS	Permanent Threshold Shift
PUTR	Portable Underwater Tracking Range
PWC	Public Works Center
PWSS	Public Water Supply Systems
QDR	Quadrennial Defense Review
R-	Restricted Area
R&S	Reconnaissance and Surveillance
RAICUZ	Range Air Installations Compatible Use Zones
RCA	Range Condition Assessment
RCB	Reserve Craft Beach
RCD	Required Capabilities Document
RCMP	Range Complex Management Plan
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test, and Evaluation
RDX	Royal Demolition Explosive
re 1 µPa-m	referenced to 1 micropascal at 1 meter
RED HORSE	Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer
REXTORP	Recoverable Exercise Torpedo
RFRCP	Recreational Fisheries Resources Conservation Plan
RHA	Rivers and Harbors Act
RHIB	Rigid Hull Inflatable Boat
RICRMP	Regional Integrated Cultural Resources Management Plan
RIMPAC	Rim of the Pacific
RL	Received Level
rms	root mean square
RNM	Rotorcraft Noise Model
ROD	Record of Decision
ROWPU	Reverse Osmosis Water Purification Unit
RSIP	Regional Shore Infrastructure Plan
RSO	Range Safety Officer
S-A	Surface-to-Air
S-S	Surface-to-Surface
S&R	Surveillance and Reconnaissance
SACEX	Supporting Arms Coordination Exercise
SAM	Surface-to-Air Missile
SAMEX	Surface-to Air Missile Exercise
SAR	Search and Rescue
SARS	Severe Acute Respiratory Syndrome
SAW	Squad Automatic Weapon
SBU	Special Boat Unit
SCD	Silicate Compensation Depth
SCUBA	Self-Contained Underwater Breathing Apparatus
SD	Standard Deviation
SDV	SEAL Delivery Vehicle
SDWA	Safe Drinking Water Act
SDZ	Surface Danger Zone
SEAD	Suppression of Enemy Air Defense
SEAL	Sea, Air, and Land Forces
sec	second
SEC	Secondary Training Areas
§	Section
SEIS	Supplemental Environmental Impact Statement
SEL	Sound Exposure Level
SEPA	State Environmental Policy Act
SFCP	Shore Fire Control Parties
SFS	Security Forces Squadron
SH	Helicopter Designation (Typically Anti-Submarine)
SHAREM	Ship ASW Readiness and Evaluation Measuring
SHPO	State Historic Preservation Officer
SINKEX	Sinking Exercise
SIP	State Implementation Plan
SLAM-ER	Stand-off Land Attack Missile - Extended Range
SLC	Submarine Learning Center
SLNA	Southern Land Navigation Area
SM	Standard Missile
SMA	Shoreline Management Act
SNS	Sympathetic Nervous System
SO_2	Sulfur Dioxide
SOCAL	Southern California
SOC	Special Operations Capable
SOCEX	Special Operations Capable Exercise

SOF	Special Operations Forces
SONAR	Sound Navigation and Ranging
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control, and Countermeasure
SPIE	Special Purpose Insertion and Extraction
SPL	Sound Pressure Level
SPMAGTF	Special Purpose Marine Air Ground Task Force
SPORTS	Sonar Positional Reporting System
sqrt	Square Root
SRBOC	Super Rapid Bloom Off-board Chaff
SRF	Ship Repair Facility
SRP	Scientific Research Program
SSBN	Ship, Submersible, Ballistic, Nuclear (Submarine)
SSC	SPAWAR Systems Center
SSG	Surface Strike Group
SSGN	Guided Missile Submarine
SSN	Fast Attack Submarine
SSN	Nuclear Submarine
STD	Standard
STOM	Ship to Objective Maneuver
STW	Strike Warfare
SUA	Special Use Airspace
SURC	Small Unit River Craft
SURTASS	Surveillance Towed-Array Sensor System
SUS	Signal Underwater Sound
SUW	Surface Warfare
SVP	Sound Velocity Profile
SWFSC	Southwest Fisheries Science Center
SWPPP	Storm Water Pollution Prevention Plans
T&E	Threatened and Endangered Species
TACP	Tactical Air Control Party
TALD	Tactical Air-Launched Decoy
TAP	Tactical Training Theater Assessment And Planning
TDU	Target Drone Unit
TGEX	Task Group Exercise
TM	Tympanic Membrane
TMDL	Total Maximum Daily Loads
TNT	Trinitrotoluene
TORPEX	Torpedo Exercise
TP	Training Projectile
TRACKEX	Tracking Exercise
TRUEX	Training in Urban Environment Exercise
TS	Threshold Shift
TSCA	Toxic Substances Control Act
TSPI	Time, Space, Position, Information
TSV	Training Support Vessel
TTS	Temporary Threshold Shift
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UCRMP	Updated Cultural Resources Management Plan
UDP	Unit Deployment Program
UJTL	Universal Joint Task List
ULT	Unit-level Training
UME	Unusual Mortality Event
UN	United Nations
UNDET	Underwater Detonations
U.S.	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USC	United States Code
USCG	United States Coast Guard
USCINCPAC REP	Commander In Chief, U.S. Pacific Command Representative
USCINCPAC REP GUAM/CNMI	Commander In Chief, U.S. Pacific Command Representative Guam and the Commonwealth of the Northern Mariana Islands
USDA	United States Department of Agriculture
USDA WS	United States Department of Agriculture Wildlife Services
USEPA	United States Environmental Protection Agency
USFF	United States Fleet Forces
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USGS – BRD	United States Geological Survey Biological Resources Division
USMC	United States Marine Corps
USNS	U.S.Naval Ship
USPACOM	United States Pacific Command
USWEX	Undersea Warfare Exercise
USWTR	Undersea Warfare Training Range
UTR	Underwater Tracking Range
UUV	Unmanned Underwater Vehicle
UXO	Unexploded Ordnance
V&VE	coastal flood hazard zones
VAST-IMPASS	Virtual At-Sea Training Integrated Maritime Portable Acoustic Scoring and Simulator
VBSS	Visit, Board, Search, and Seizure
VFR	Visual Flight Rules
VoA-IBB	Voice of America - International Broadcasting Bureau
VOC	Volatile Organic Compounds
VTNF	Variable Timed, Non-Fragmentation
VTOL	Vertical Takeoff and Landing
VTUAV	Vertical Take-off and Land UAV
W-	Warning Area
WestPac	Western Pacific
WISS	Weapons Impact Scoring System
WPRFMC	Western Pacific Regional Fisheries Management Council
WS	Wildlife Service
WWII	World War Two
ZOI	Zone of Influence

Volume III

This page intentionally left blank.

APPENDIX A

COOPERATING AGENCY REQUESTS

AND

ACCEPTANCE LETTERS

This page intentionally left blank.

COOPERATING AGENCY REQUESTS

1. Dr. William T. Hogarth
Assistant Administrator
National Oceanic and Atmospheric Administration (NOAA) Fisheries
1315 East West Highway
Silver Spring, MD 20910

2. Mr. Dirk Kempthorne
Secretary of the Interior
Department of the Interior
1849 C Street, NW
Washington, DC 20240

3. Mr. Mike Johanns
Secretary of Agriculture
U.S. Department of Agriculture
Animal and Plant Health Inspection Services
Wildlife Services
1400 Independence Avenue, S.W.
Washington, DC 20250

4. Marion C. Blakey
Administrator, Federal Aviation Administration
800 Independence Ave., SW
Washington, DC 20591

5. Commander, 196th Infantry Brigade
Headquarters Bldg 525
Fort Shafter, HI 96858-5300

6. Commander, Marine Corps Bases Pacific
Marine Corps Bases Hawaii
P.O. Box 64119
Camp H.M. Smith, HI 96861-4119

7. Mr. Kevin Billings
Deputy Assistant Secretary
(Environment, Safety and Occupational Health)
HQ SAF/IEE
1665 Air Force Pentagon
Washington, DC 20330-1665

8. Commander, U.S. Coast Guard Sector Guam
PSC 455 Box 176
FPO AP 96540-1056

9. Commanding General
U.S. Army Reserve
9th Regional Readiness Command
1557 Pass Street
Fort Shafter Flats
Honolulu, Hawaii 96819

10. Adjutant General
Guam National Guard
430 Army Drive Bld 300, Rm 113
Barrigada, Guam 96913-4421

11. Mr. Paul C. Hubbell
Deputy Assistant Deputy Commandant for Installations and Logistics (Facilities)
Headquarters, U.S. Marine Corps
2 Navy Annex
Washington, DC 20380-1775

This page intentionally left blank.

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456E/7U158221
9 Aug 2007

Dr. William T. Hogarth
Assistant Administrator
National Oceanic and Atmospheric
Administration (NOAA) Fisheries
1315 East West Highway
Silver Spring, MD 20910

Dear Dr. Hogarth:

In accordance with the National Environmental Policy Act (NEPA) and Executive Order 12114, the Department of the Navy (Navy), as executive agent for the Department of Defense (DoD), is preparing an Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS) to evaluate potential environmental effects of using the Mariana Islands Range Complex (MIRC) to achieve and maintain military readiness and to support and conduct current, emerging, and future training activities and research, development, test, and evaluation (RDT&E) events.

In order to adequately evaluate the potential environmental effects of the Proposed Action, Navy and the National Marine Fisheries Service would need to work together on acoustic effects to marine species protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act. To assist in this effort and in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, Navy requests NMFS serve as a cooperating agency for the development of the MIRC EIS/OEIS.

The MIRC consists of multiple ranges and training areas of land, sea space (nearshore and offshore), undersea space, and air space under different controlling authorities in the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and surrounding waters. The Proposed Action for the MIRC EIS/OEIS is to:

- Maintain baseline operations at current levels;

- Increase training operations from current levels as necessary to support Military Service training requirements;

- Implement new and enhanced range complex capabilities;

- Increase and accommodate planned RDT&E events.

The Proposed Action will further our statutory obligations under Title 10 of the United States Code to provide combat capable forces ready to deploy worldwide.

The No Action Alternative is the continuation of training activities and major range events in the MIRC at current levels. Two action alternatives are proposed to accomplish the Proposed Action. Alternative 1 consists of an increase in the number of training activities, from levels described in the No Action Alternative, along with upgrades to ranges and training areas. Alternative 2 consists of all elements of Alternative 1 with an additional increase in the number and types of training operations and implementation of range enhancements including a fixed underwater training range.

The EIS/OEIS will address measurably foreseeable activities in the particular geographical areas affected by the No Action Alternative and action alternatives. This EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where MIRC activities occur. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include: air quality; airspace; biological resources, including threatened and endangered species; cultural resources; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; and water resources.

As executive agent for the lead agency, DoD, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes but is not limited to the following:

- Gathering all necessary background information and preparing the EIS/OEIS and all necessary permit applications associated with acoustic issues on the underwater ranges.

- Working with NMFS personnel to determine the method of estimating potential effects to protected marine species, including threatened and endangered species.

- Determining the scope of the EIS/OEIS, including the alternatives evaluated.

- Circulating the appropriate NEPA documentation to the general public and any other interested parties.

- Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.

- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As a cooperating agency, the Navy requests NMFS support the Navy in the following manner:

- Provide timely comments after the Agency Information Meeting (which will be held at the onset of the EIS/OEIS process) and on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 21 calendar days.

- Respond to Navy requests for information. Timely NMFS input will be critical to ensure a successful NEPA process.

- Coordinate, to the maximum extent practicable, any public comment periods that is necessary in the MMPA permitting process with the Navy's NEPA public comment periods.

- Participate, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS related issues.

- Adhere to the overall project schedule as agreed upon by the Navy and NMFS.

- Provide a formal, written response to this request.

The Navy views this agreement as important to the successful completion of the NEPA process for the Mariana Island Range Complex EIS/OEIS. It is Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. NMFS assistance will be invaluable in this endeavor.

My point of contact for this action is Ms. Karen M. Foskey, (703) 602-2859, email:Karen.Foskey@navy.mil.

Sincerely,

WILLIAM G. MATTHEIS
Acting Director, Environmental
Readiness Division (OPNAV N45)

Copy to:
DASN (Environment)
OAGC (I&E)
PACOM (J44)
US Naval Forces Marianas
CPF (N01CE, N7)
COMNAVFACENGCOM, Marianas

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0260
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Mr. Dirk Kempthorne
Secretary of the Interior
Department of the Interior
1849 C Street, NW
Washington, DC 20240

Dear Mr. Dirk Kempthorne:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas

and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD and the Department of the Interior need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the Department of the Interior be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

3500
Ser N00/ 0260
September 6, 2007

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0254
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Mr. Mike Johanns
Secretary of Agriculture
U.S. Department of Agriculture
Animal and Plant Health Inspection Services
Wildlife Services
1400 Independence Avenue, S.W.
Washington, DC 20250

Dear Mr. Mike Johanns:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in

DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in alternative 1 with the addition of new types of operations on existing ranges and training areas and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD and the U.S. Department of Agriculture need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the U.S. Department of Agriculture be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in

3500
Ser N00/ 0254
September 6, 2007

February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0257
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Marion C. Blakey
Administrator, Federal Aviation Administration
800 Independence Ave., SW
Washington, DC 20591

Dear Marion C. Blakey:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD and the Federal Aviation Administration need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the Federal Aviation Administration be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

3500
Ser N00/ 0257
September 6, 2007

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by e-mail at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0259
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Commander, 196th Infantry Brigade
Headquarters Bldg 525
Fort Shafter, HI 96858-5300

Dear Colonel Tom Guthrie:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD components need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Naval Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the HQ 196th Infantry Brigade be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

3500
Ser N00/ 0259
September 6, 2007

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0252
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Commander, Marine Corps Bases Pacific
Marine Corps Bases Hawaii
P.O. Box 64119
Camp H.M. Smith, HI 96861-4119

Attention: Director, Marine Corps Installations MidPac

Dear Colonel Burton:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas

and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD components need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the Marine Corps be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

3500
Ser N00/ 0252
September 6, 2007

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0255
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Mr. Kevin Billings
Deputy Assistant Secretary (Environment, Safety and Occupational Health)
HQ SAF/IEE
1665 Air Force Pentagon
Washington, DC 20330-1665

Dear Mr. Billings:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas

and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD components need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the U.S. Air Force be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0256
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Commander, U.S. Coast Guard Sector Guam
PSC 455 Box 176
FPO AP 96540-1056

Dear Captain Marhoffer:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD and the U.S. Coast Guard need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the Coast Guard Sector Guam be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

3500
Ser N00/ 0256
September 6, 2007

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0253
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Commanding General
U.S. Army Reserve
9th Regional Readiness Command
1557 Pass Street
Fort Shafter Flats
Honolulu, Hawaii 96819

Dear Brigadier General Alexander Kozolv:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas

and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD components need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the U.S. Army Reserve be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in

3500
Ser N00/ 0253
September 6, 2007

February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. French
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
U.S. DEFENSE REPRESENTATIVE GUAM/ COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS/
FEDERATED STATES OF MICRONESIA/ REPUBLIC OF PALAU
PSC 455 BOX 152
FPO AP 96540-1000

IN REPLY REFER TO:

3500
Ser N00/ 0258
September 6, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Adjutant General
Guam National Guard
430 Army Drive Bld 300, Rm 113
Barrigada, Guam 96913-4421

Dear Major General Goldhorn:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT – COOPERATING AGENCY

The U.S. Department of Defense (DoD) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of Northern Mariana Islands (CNMI). The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, will act as Executive Agent for DoD in completing this EIS. DoD requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Forces Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; Rota; and Air Traffic Control Assigned Airspace.

Two action alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in DoD Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD and the Guam National Guard need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD's desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD is requesting that the Joint Force Headquarters - Guam be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6 DoD as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.
3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.
2. Participate in the scoping process.
3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

3500
Ser N00/ 0258
September 6, 2007

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Neil Sheehan, COMPACFLT N01CE13, at (808) 474-7836, or by email at neil.a.sheehan.ctr@navy.mil.

Sincerely,

W. D. FRENCH
Rear Admiral, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment)
Office of Assistant General Council (Installations & Environment)
Commander, Navy Installations Command
Commander, Pacific Fleet N01CE
Commander, Pacific Fleet N7 (Mr. Long)
Naval Facilities Engineering Command, Pacific (Environmental)
Naval Facilities Engineering Command, Marianas (Environmental)

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Mr. Paul C. Hubbell
Deputy Assistant Deputy Commandant for
Installations and Logistics (Facilities)
Headquarters, U.S. Marine Corps
2 Navy Annex
Washington, DC 20380-1775

Dear Mr. Hubbell:

SUBJECT: MARIANA ISLANDS RANGE COMPLEX ENVIRONMENTAL IMPACT STATEMENT- COOPERATING AGENCY

The U.S. Department of Defense Representative Guam and the Commonwealth of the Northern Mariana Islands (DoD Rep) has initiated an Environmental Impact Statement (EIS) to address the potential environmental impacts of proposed military training, research, development, and testing within the Marina Islands Range Complex (MIRC). As an update to the 1999 EIS for Military Training in the Marianas, the MIRC EIS will analyze military training activities throughout Guam and the Commonwealth of the Northern Marianas Islands (CNMI) on existing DOD facilities and does not include the requirements for proposed deployment of forces to Guam. The Commander, U.S. Pacific Fleet (COMPACFLT), on behalf of the Department of the Navy, is acting as Executive Agent for DoD Rep in completing this EIS. DoD Rep requests your participation in this EIS as a cooperating agency pursuant to the National Environmental Policy Act and associated regulations.

DoD Rep will study the environmental effects of increasing usage and enhancing the capability of the MIRC to achieve and maintain military readiness across all Service components, and to conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations. The No-Action Alternative is the continuation of the current volume and types of training, RDT&E activities, and base operations that was approved in the 1999 EIS for Military Training in the

Marianas. This includes all multi-Service training activities and operations on military ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Commander, U.S. Naval Force Marianas, and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; and Air Traffic Control Assigned Airspace.

Two action Alternatives are proposed. Alternative 1 includes the activities described in the No-Action Alternative with the addition of an increase in current training operations on existing ranges and training areas to support military units located either permanently or temporarily in the DoD Rep Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new types of operations on existing ranges and training areas and adjacent air and ocean areas. A complete description of the alternatives will be provided in the Description of Proposed Action and Alternatives, which is currently being completed.

In order to adequately evaluate the potential environmental effects of this proposed action, DoD components need to work together in assessing potential impacts to training activities and operations within the joint MIRC study area. It is DoD’s desire to formalize this relationship as outlined in CEQ guidelines (40 CFR Part 1501.6).

As defined in 40 CFR 1501.6, DoD Rep is the lead agency for the MIRC EIS. The MIRC EIS is funded through the Navy's Tactical Training Theater Assessment and Planning (TAP) program. COMPACFLT will process the MIRC EIS in accordance with other TAP documents to ensure consistency. The Chief of Navy Operations and the Assistant Secretary of the Navy (Installations and Environment) will provide concurrence prior to public release of the draft and final documents. DoD Rep is requesting that the Marine Corps be a cooperating agency as defined in 40 CFR 1501.6.

Per 40 CFR 1501.6, DoD Rep as the lead agency shall:

1. Request the participation of each cooperating agency in the NEPA process at the earliest possible time.

2. Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.

3. Meet with a cooperating agency at the latter's request.

Each cooperating agency shall:

1. Participate in the NEPA process at the earliest possible time.

2. Participate in the scoping process.

3. Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.

4. Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.

5. Use their own funds.

DoD views this agreement as important to the successful completion of the NEPA process for the MIRC EIS. DoD's goal is to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in February 2009 with the Final EIS released in October 2009, and the Record of Decision for this EIS published in December 2009. Your assistance will be invaluable in that endeavor.

We appreciate your consideration of our request and look forward to your response. Should you have any questions or need additional information, please contact Mr. Edward Lynch, COMPACFLT N01CE19, at (808) 471-1714, edward.j.lynch.ctr@navy.mil.

Sincerely,

J. P. RIOS
Captain, U.S. Navy

Copy to:
Assistant Secretary of the Navy (Installations & Environment)
Deputy Assistant Secretary of the Navy (Installations & Environment

Office of Assistant General Council (Installations & Environment)
Commander, Naval Installations Command
Commander, Pacific Fleet N7 (Mr. Long)
Commander, Navy Region Marianas
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas (EV)

This page intentionally left blank

ACCEPTANCE LETTERS

Dr. William T. Hogarth
Assistant Administrator
National Oceanic and Atmospheric
Administration (NOAA) Fisheries
1315 East West Highway
Silver Spring, MD 20910

Mr. James Cason
Associate Deputy Secretary of the Interior
Department of the Interior
1849 C Street, NW
Washington, DC 20240

Mr. Paul C Hubbell
Deputy Assistant Deputy Commandant
Installations and Logistics (Facilities)
Headquarters, USMC
2 Navy Annex
Washington, DC 20380-1775

Edith V. Parish
Acting Director
Systems Operations Airspace and Aeronautical Information Management
Air Traffic Organization
Federal Aviation Administration
800 Independence Avenue, SW.
Washington, DC 20591

HQ PACAF/A7N
Colonel William M. Corson
Director, Installations and Mission Support
25 E Street, Suite D-306
Hickam AFB, HI 96853-5412

This page intentionally left blank

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910
THE DIRECTOR

SEP 17 2007

Mr. William G. Mattheis
Acting Director, Environmental Readiness Division
Department of the Navy
2000 Navy Pentagon
Washington, DC 20350-2000

Dear Mr. Mattheis:

Thank you for your letter requesting that NOAA's National Marine Fisheries Service (NMFS) be a cooperating agency in the preparation of an Environmental Impact Statement (EIS) to evaluate potential environmental effects of using the Department of the Navy's Mariana Islands Range Complex to achieve and maintain military readiness and to support and conduct training activities and research, development, test, and evaluation events.

We support the Navy's decision to prepare an EIS on these activities and agree to be a cooperating agency, due, in part, to our responsibilities under section 101(a)(5)(A) of the Marine Mammal Protection Act and section 7 of the Endangered Species Act. As agreed upon with Navy staff, NMFS staff will provide comments on draft EISs to the Navy within 28 days of receipt of the document. Otherwise, NMFS will make every effort to support the Navy in the specific ways described in your letter.

If you need any additional information, please contact Ms. Jolie Harrison at (301) 713-2289, ext. 166.

Sincerely,

William T. Hogarth, Ph.D.

This Page Intentionally Left Blank

THE ASSOCIATE DEPUTY SECRETARY OF THE INTERIOR
WASHINGTON

NOV 0 1 2007

Rear Admiral W.D. French, U.S.N.
Department of the Navy
U.S. Defense Representative
PSC 455 Box 152
FPO AP 96540-1000

Dear Admiral French:

Thank you for your September 6, 2007, letter to Secretary Kempthorne requesting the Department of the Interior to become a cooperating agency in the development of an Environmental Impact Statement to address the potential environmental impacts of proposed military training, research and development, and testing within the Mariana Islands Range Complex. We are pleased to accept your request.

The Office of Insular Affairs will be the Department's representative on this effort. Please contact Ms. Faride Komisar at (202) 208-6971, or by email at <faride_komisar@ios.doi.gov> should you have any questions or need additional information.

The Department of the Interior appreciates this opportunity to serve as a cooperating agency and we look forward to working closely with the U.S. Department of Defense during the EIS process.

Sincerely,

James E. Cason

James E. Cason

This Page Intentionally Left Blank

DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
2 NAVY ANNEX
WASHINGTON, DC 20380-1775

Nova —
09
EV

IN REPLY REFER TO:
5090
LF
05 FEB 2008

J.P. Rios, Capt (USN)
Deputy Fleet Civil Engineer
Commander, Pacific Fleet (N01CE1)
250 Makalapa Drive
Pearl Harbor, HI 96860-3131

Dear Captain Rios:

This letter is in response to your 12 December 2007 letter requesting Marine Corps participation as a cooperating agency in the Mariana Islands Range Complex Environmental Impact Statement. The Marine Corps supports this effort and agrees to be a cooperating agency. We stand by ready to support as necessary, in addition to the staff level personnel already supplying support and data to the Commander, U.S. Pacific Fleet.

My point of contact for this matter is Ms. Mary Hassell. She can be contacted at DSN 695-8240, (703) 695-8232, ext. 3346, or email: mary.hassell@usmc.mil.

Sincerely,

Paul C. Hubbell
Deputy Assistant/Deputy Commandant
Installations and Logistics
(Facilities)

Copy to:
ASN (I&E)
DASN (E)
OAGC (I&E)
CNIC
CDR NAVREG MARIANAS
NAVFAC PAC (EV)
NAVFAC MAR (EV)

This Page Intentionally Left Blank

U.S. Department
of Transportation
**Federal Aviation
Administration**

System Operations Airspace and
Aeronautical Information Management
800 Independence Ave., SW.
Washington, DC 20591

OCT 9 2007

RECEIVED 19 OCT. 07

Rear Admiral William D. French
U.S. Defense Representative
Guam/Commonwealth of the
Northern Mariana Islands/
Federated States of Micronesia/
Republic of Palau
PSC 455 Box 152
FPO AP 96540-1000

Dear Admiral French:

Thank you for your letter of September 6, 2007 requesting Federal Aviation Administration participation in the environmental impact statement process associated with the proposed military training, research and development, and testing within the Mariana Islands Range Complex (MIRC).

We are pleased to participate as a cooperating agency, in accordance with the National Environmental Policy Act of 1969, as Amended, and the implementing regulations. Since the proposal contemplates activities associated with Special Use Airspace (SUA), the FAA will cooperate following the guidelines described in the Memorandum of Understanding between the FAA and the Department of Defense Concerning SUA Environmental Actions, dated October 4, 2005.

The FAA Western Service Area will be the primary focal point for environmental matters related to this proposal. I have forwarded a copy of this letter and your letter to the System Support Group Manager, Mr. Clark Desing. You can contact him directly at (425) 917-6700.

We look forward to working with the Navy on the environmental process for the proposed MIRC military training activities throughout Guam and the Commonwealth of Northern Mariana Islands.

Sincerely,

Edith V. Parish
Acting Director, System Operations Airspace & Aeronautical Information Management
Air Traffic Organization

cc with attachment: FAA Western Service Area

This Page Intentionally Left Blank

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

MEMORANDUM FOR COMPACFLT (Attn: N01CE, Mr. Larry Foster)

FROM: HQ PACAF/A7N
25 E Street, Suite D-306
Hickam AFB, HI 96853-5412

SUBJECT: Air Force Cooperating Agency Offer of Assistance for Military Training in the Marianas Environmental Impact Statement

1. The Air Force requests to participate as a formal cooperating agency in preparation of an update to the environmental impact statement (EIS) for the Military Training in the Marianas as prescribed in the President's Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) Regulations, 40 CFR §1501.6, Cooperating Agencies. For training purposes, the Air Force has interest in the airspace that overlays Farallon de Medinilla (FDM), which will be assessed in the subject EIS.

2. As a cooperating agency, the Air Force understands it will be expected to participate in various portions of the EIS development. As a cooperating agency, the Air Force asks to:

- Participate in the scoping process;
- Assume responsibility, upon request by your organization, for developing information and preparing analyses on issues for which it has special expertise; and
- Make Air Force staff available for interdisciplinary reviews.

3. The Air Force asks that it be provided appropriate, related information in a timely fashion to ensure unnecessary delays are avoided. In turn, the Air Force commits to respond in a prompt manner. Should you or your staff have further questions regarding this memo, our point of contact is Lt Col Christopher Sharp at (808) 448-0470, christopher.sharp@hickam.af.mil.

WILLIAM M. CORSON, Colonel, USAF
Director, Installations and Mission Support

cc:
HQ USAF/A7CPB
HQ PACAF/A7N

This Page Intentionally Left Blank

APPENDIX B

NOTICE OF INTENT
AND
NOTICE OF AVAILABILITY

This page intentionally left blank.

Number Of Respondents: 229.

Responses Per Respondent: Approximately 2.

Annual Responses: 453.

Average Burden Per Response: 1 hour (reporting); 3.7 hours (recordkeeping).

Annual Burden Hours: 1,300.

Needs and Uses: DoD needs this information to evaluate whether the purposes of the DoD Pilot Mentor-Protege program have been met. These reports provide data for several reports to Congress required by Section 822 of the National Defense Authorization Act for FY1998 and Section 811 of the National Defense Authorization Act for FY2000.

Affected Public: Business or other for-profit; not-for-profit institutions.

Frequency: Semiannually (mentor); annually (protege).

Respondent's Obligation: Required to obtain or retain benefits.

OMB Desk Officer: Ms. Hillary Jaffe.

Written comments and recommendations on the proposed information collection should be sent to Ms. Jaffe at the Office of Management and Budget, Desk Officer for DoD, Room 10236, New Executive Office Building, Washington, DC 20503.

You may also submit comments, identified by docket number and title, by the following method:

• Federal eRulemaking Portal: *http://www.regulations.gov.* Follow the instructions for submitting comments.

Instructions: All submissions received must include the agency name, docket number and title for this **Federal Register** document. The general policy for comments and other submissions from members of the public is to make these submissions available for public viewing on the Internet at *http://www.regulations.gov* as they are received without change, including any personal identifiers or contact information.

DOD Clearance Officer: Ms. Patricia Toppings.

Written requests for copies of the information collection proposal should be sent to Ms. Toppings at WHS/ESD/Information Management Division, 1777 North Kent Street, RPN, Suite 11000, Arlington, VA 22209–2133

Dated: May 21, 2007.

Patricia L. Toppings,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

[FR Doc. 07–2712 Filed 5–31–07; 8:45 am]

BILLING CODE 5001–06–M

DEPARTMENT OF DEFENSE

Office of the Secretary

[No. DoD–2007–DARS–0053]

Submission for OMB Review; Comment Request

ACTION: Notice.

The Department of Defense has submitted to OMB for clearance, the following proposal for collection of information under the provisions of the Paperwork Reduction Act (44 U.S.C. Chapter 35).

DATES: Consideration will be given to all comments received by July 2, 2007.

Title, Form, and OMB Number: Foreign Acquisition—Defense Federal Acquisition Regulation Supplement Part 225 and Related Clauses at 252.225; DD Form 2139; OMB Control Number 0704–0229.

Type of Request: Revision.

Number of Respondents: 20,485.

Responses Per Respondent: Approximately 8.

Annual Responses: 154,924.

Average Burden Per Response: 31 hours.

Annual Burden Hours: 48,480 (48,385 reporting hours; 95 recordkeeping hours).

Needs and Uses: DoD needs this information to ensure compliance with restrictions on the acquisition of foreign products imposed by statute or policy to protect the industrial base; to ensure compliance with U.S. trade agreements and memoranda of understanding that promote reciprocal trade with U.S. allies; and to prepare reports for submission to the Department of Commerce on the Balance of Payments Program.

Affected Public: Business or other for-profit; not-for-profit institutions.

Frequency: On occasion.

Respondent's Obligation: Required to obtain or retain benefits.

OMB Desk Officer: Ms Hillary Jaffe.

Written comments and recommendations on the proposed information collection should be sent to Ms. Jaffe at the Office of Management and Budget, Desk Officer for DoD, Room 10236, New Executive Office Building, Washington, DC 20503.

You may also submit comments, identified by docket number and title, by the following method:

• Federal eRulemaking Portal: *http://www.regulations.gov.* Follow the instructions for submitting comments.

Instructions: All submissions received must include the agency name, docket number and title for this **Federal Register** document. The general policy for comments and other submissions from members of the public is to make these submissions available for public viewing on the Internet at *http://www.regulations.gov* as they are received without change, including any personal identifiers or contact information.

DOD Clearance Officer: Ms. Patricia Toppings.

Written requests for copies of the information collection proposal should be sent to Ms. Toppings at WHS/ESD/Information Management Division, 1777 North Kent Street, RPN, Suite 11000, Arlington, VA 22209–2133.

Dated: May 21, 2007.

Patricia L. Toppings,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

[FR Doc. 07–2713 Filed 5–31–07; 8:45 am]

BILLING CODE 5001–06–M

DEPARTMENT OF DEFENSE

Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau; Notice of Intent To Prepare an Environmental Impact Statement/Overseas Environmental Impact Statement for the Mariana Islands Range Complex and To Announce Public Scoping Meetings

AGENCY: Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau.

ACTION: Notice.

SUMMARY: Pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, as implemented by the Council on Environmental Quality Regulations (40 CFR parts 1500–1508), and Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions), the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau (DoD REP) announces its intent to prepare an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental impacts associated with conducting military readiness activities in the Mariana Islands Range Complex (MIRC). The DoD REP proposes to support current and emerging training operations and research, development, testing, and evaluation (RDT&E) activities in the MIRC by: (1) Maintaining baseline

operations at current levels; (2) increasing training operations from current levels as necessary to support Military Service training requirements; (3) increasing and accommodating potential RDT&E operations; and (4) implementing new and enhanced range complex capabilities.

Dates and Addresses: Public scoping meetings will be held on Guam, Saipan, and Tinian to receive oral and/or written comments on environmental concerns that should be addressed in the EIS. The public scoping meetings will be held at the following dates, times, and locations:

1. Monday, June 18, 2007, 5 p.m.–8 p.m., Guam Hilton, 202 Hilton Road, Tumon Bay, Guam.
2. Wednesday, June 20, 2007, 5 p.m.–8 p.m., Hyatt Regency Saipan, Garapan Village (Across from American Memorial Park), Garapan, Saipan, CNMI.
3. Thursday, June 21, 2007, 5 p.m.–8 p.m., Dynasty Hotel, One Broadway, San Jose Village, Tinian, CNMI.

Details of the meetings will be announced in local newspapers. Additional information concerning the scoping meetings will be available on the EIS/OEIS Web page located at: *http://www.MarianasRangeComplexEis.com*.

FOR FURTHER INFORMATION CONTACT: LT Donnell Evans, U.S. Naval Forces Marianas Public Affairs Officer, *ATTN:* Code N00PA, PSC 455 Box 152, FPO AP 96540–1000, Building 3190, Sumay Drive, Santa Rita, Guam 96915; phone (671) 339–2115; e-mail at: *donnell.evans@guam.navy.mil*.

SUPPLEMENTARY INFORMATION: The Commander Naval Forces Marianas (COMNAVMAR) as the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau is the Executive Agent for the Commander United States Pacific Command (USPACOM) on all matters of MIRC management and sustainment. COMNAVMAR coordinates Joint Service planning and use of MIRC ranges and training areas. COMNAVMAR's role is to provide resources, range complex management, and training support to U.S. military forces in the Western Pacific (WESTPAC) Theater.

COMNAVMAR's mission in the MIRC is to support Army, Navy, Marine Corps, Air Force, U.S. Coast Guard, Army Reserves, and Guam National Guard tactical training by maintaining and operating facilities and range infrastructure and by providing services and material. The MIRC consists of multiple ranges and training areas of land, sea space (nearshore and offshore), undersea space, and air space under different controlling authorities in the Territory of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and surrounding waters.

The mission of USPACOM is to provide interoperable, trained, and combat-ready military forces to support the National Security Strategy of the United States in the WESTPAC Theater. United States military forces from all Services use the MIRC as a training venue to prepare for contingency warfare.

The MIRC is the westernmost military training complex in U.S. territory. The MIRC has range and training area assets in Guam and the Northern Mariana Islands archipelago. Guam is located roughly three quarters the distance from Hawaii to the Philippines, 1,600 miles east of Manila and 1,550 miles southeast of Tokyo. The southern extent of CNMI is located 40 miles north of Guam (Rota Island) and extends 330 miles to the northwest. The CNMI capital, Saipan, is 3,300 miles west of Honolulu and 1,470 miles south-southeast of Tokyo. The location of the MIRC allows for training of U.S. military forces in WESTPAC, without having to return to Hawaii or the continental United States.

The purpose of the Proposed Action is to: Achieve and maintain military readiness using the MIRC to conduct and support current, emerging, and future military training and RDT&E operations on existing DoD lands and ranges and adjacent air and ocean areas; and, upgrade and modernize range complex capabilities to enhance and sustain military training and RDT&E operations and to expand the Services warfare missions.

The Proposed Action stems from the need to: (1) Maintain current levels of military readiness by training in the MIRC; (2) accommodate future increases in operational training tempo on existing ranges and adjacent air and ocean areas in the MIRC and support the rapid deployment of military units and strike groups; (3) achieve and sustain readiness so that the Military Services can quickly surge required combat power in the event of a national crisis or contingency operation consistent with Service training requirements; (4) support the acquisition, testing, training, and fielding of advanced platforms and weapons systems into Service force structure; and, (5) maintain the long-term viability of the MIRC while protecting human health and the environment, enhancing the quality of training, communications, and safety within the range complex.

The EIS/OEIS will consider two action alternatives to accomplish these objectives, in addition to the No-Action Alternative. The No-Action Alternative is the continuation of training operations, RDT&E activities and on-going base operations. This includes all multi-Service training activities and operations on Navy and Non-Navy ranges and training areas including: Andersen Air Force Base (Main Base, Northwest Field, Andersen South, and Tarague Beach); Naval Station Guam and its off-shore areas; Farallon de Medinilla; Tinian; Saipan; and Air Traffic Control Assigned Airspace (ATCAA). Alternative 1 includes the activities described in the No-Action Alternative with the addition of increased training operations as a result of upgrades and modernization of existing ranges and training areas, and of operations on existing ranges that are required to support the relocation of military units to the DoD REP Area of Responsibility (AOR). Alternative 2 would include all the operations described in Alternative 1 with the addition of new operations on existing ranges and training areas and adjacent air and ocean areas with upgraded and modernized capabilities. In addition, Alternative 2 would incorporate the increased operations resulting from increased operational tempo and training event frequency to optimize training throughput in support of current and future contingencies.

Previously, the Navy's Joint Guam Program Office (JGPO) published a Notice of Intent to prepare an EIS/OEIS for the Relocation of U.S. Marine Corps Forces to Guam (**Federal Register**, 72 FR 10186, March 7, 2007). JGPO's proposed EIS/OEIS will examine potential impact from activities associated with the Marine Corps units' relocation from Okinawa, Japan to Guam, including operations, infrastructure changes and training. Since the proposed MIRC EIS/OEIS will cover all DoD training on existing DoD land and operating areas in and around Guam and CNMI, there will be some overlap between the two proposed EIS/OEISs. Therefore, preparation of these documents will be closely coordinated to ensure consistency.

Environmental issues that will be addressed in the EIS/OEIS include but are not limited to: Airspace; biological resources (including marine mammals and threatened and endangered species); cultural resources; health and safety; and noise. The analysis will include an evaluation of direct and indirect impacts, and will account for cumulative impacts.

The DoD REP is initiating the scoping process to identify community concerns and issues that must be addressed in the EIS/OEIS. Federal agencies, Government of Guam and CNMI agencies, the public, and other interested stakeholders are encouraged to provide oral and written comments to the Navy to identify specific issues or topics of concern for consideration in the EIS/OEIS. The DoD REP will hold three public scoping meetings. Each meeting will consist of an informal information session, staffed by Navy representatives. Members of the public can contribute oral or written comments at the scoping meetings or subsequent to the meetings by mail, fax, or e-mail. All comments, oral and written, will receive the same consideration during EIS/OEIS preparation. Written comments on the scope of the EIS/OEIS must be postmarked by July 16, 2007, and should be mailed to: MIRC TAP EIS, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134, *Attention:* EV2. Comments can be faxed to 808–474–5419 or e-mailed to *marianas.tap.eis@navy.mil.*

Dated: May 24, 2007.

L.R. Almand,

Office of the Judge Advocate General, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. E7–10629 Filed 5–31–07; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF DEFENSE

Office of the Secretary

Revised Non-Foreign Overseas Per Diem Rates

AGENCY: DoD, Per Diem, Travel and Transportation Allowance Committee.

ACTION: Notice of revised non-foreign overseas per diem rates.

SUMMARY: The Per Diem, Travel and Transportation Allowance Committee is publishing Civilian Personnel Per Diem Bulletin Number 253. This bulletin lists revisions in the per diem rates prescribed for U.S. Government employees for official travel in Alaska, Hawaii, Puerto Rico, the Northern Mariana Islands and Possessions of the United States. AEA changes announced in Bulletin Number 194 remain in effect. Bulletin Number 253 is being published in the **Federal Register** to assure that travelers are paid per diem at the most current rates.

DATES: *Effective Date:* June 1, 2007.

SUPPLEMENTARY INFORMATION: This document gives notice of revisions in per diem rates prescribed by the Per Diem Travel and Transportation Allowance Committee for non-foreign areas outside the continental United States. It supersedes Civilian Personnel Per Diem Bulletin Number 252. Distribution of Civilian Personnel Per Diem Bulletins by mail was discontinued. Per Diem Bulletins published periodically in the **Federal Register** now constitute the only notification of revisions in per diem rates to agencies and establishments outside the Department of Defense. For more information or questions about per diem rates, please contact your local travel office. The text of the Bulletin follows:

Dated: May 24, 2007.

C.R. Choate,

Alternate OSD Federal Register Liaison Officer, DoD.

BILLING CODE 5001–06–M

Total Burden Cost (operating/maintenance): None.

Dated: January 23, 2009.

Lois Nembhard,

Acting Director, AmeriCorps State and National.

[FR Doc. E9–1972 Filed 1–29–09; 8:45 am]

BILLING CODE 6050–$$–P

CORPORATION FOR NATIONAL AND COMMUNITY SERVICE

Information Collection; Submission for OMB Review, Comment Request

AGENCY: Corporation for National and Community Service.

ACTION: Notice.

SUMMARY: The Corporation for National and Community Service (hereinafter the ''Corporation''), has submitted a public information collection request (ICR) entitled ''AmeriCorps Member Application Form'' to the Office of Management and Budget (OMB) for review and approval in accordance with the Paperwork Reduction Act of 1995, Public Law 104–13 (44 U.S.C. Chapter 35). Copies of this ICR, with applicable supporting documentation, may be obtained by calling the Corporation for National and Community Service, Ms. Amy Borgstrom at (202) 606–6930. Individuals who use a telecommunications device for the deaf (TTY-TDD) may call (202) 565–2799 between 8:30 a.m. and 5 p.m. eastern time, Monday through Friday.

ADDRESSES: Comments may be submitted, identified by the title of the information collection activity, to the Office of Information and Regulatory Affairs, Attn: Ms. Sharon Mar, OMB Desk Officer for the Corporation for National and Community Service, by any of the following two methods within 30 days from the date of publication in this **Federal Register**:

(1) *By fax to:* (202) 395–6974, Attention: Ms. Sharon Mar, OMB Desk Officer for the Corporation for National and Community Service; and

(2) *Electronically by e-mail to: smar@omb.eop.gov.*

SUPPLEMENTARY INFORMATION: The OMB is particularly interested in comments which:

- Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of the Corporation, including whether the information will have practical utility;
- Evaluate the accuracy of the agency's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used;
- Propose ways to enhance the quality, utility, and clarity of the information to be collected; and
- Propose ways to minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology, *e.g.*, permitting electronic submissions of responses.

Comments:

A 60-day public comment Notice was published in the **Federal Register** on Wednesday, October 15, 2008. This comment period ended December 15, 2008. Two sets of public comments were received from Corporation grantees. The Corporation gave full consideration to those comments and, for the most part, incorporated their suggested changes in the information collection form.

Description: This Member Application Form will be used by applicants who are interested in serving as AmeriCorps members. The information requested in the application form makes it possible for programs to select members to serve. Programs also use this form as an example that they customize to develop their own recruitment materials. The Corporation also seeks to continue using the current Application Form until the revised Application Form is approved by OMB. The current form is due to expire on January 31, 2009.

Type of Review: Renewal.

Agency: Corporation for National and Community Service.

Title: AmeriCorps Member Application Form.

OMB Number: 3045–0054.

Agency Number: None.

Affected Public: Applicants to serve in AmeriCorps.

Total Respondents: 225,000 applicants.

Frequency: Annually.

Average Time per Response: 1.5 hours to apply.

Estimated Total Burden Hours: 281,250 hours.

Total Burden Cost (capital/startup): None.

Total Burden Cost (operating/maintenance): None.

Dated: January 26, 2009.

Kristin McSwain,

Chief of Program Operations, Corporation for National and Community Service.

[FR Doc. E9–1973 Filed 1–29–09; 8:45 am]

BILLING CODE 6050–$$–P

CORPORATION FOR NATIONAL AND COMMUNITY SERVICE

Sunshine Act Notice

The Board of Directors of the Corporation for National and Community Service gives notice of the following meeting:

DATE AND TIME: Wednesday, February 4, 2009, 10 a.m.–11:30 a.m.

PLACE: Corporation for National and Community Service; 8th Floor; 1201 New York Avenue, NW., Washington, DC 20525.

STATUS: Open.

MATTERS TO BE CONSIDERED:

I. Chair's Opening Remarks and Swearing in of New Member.
II. Consideration of Prior Meeting's Minutes.
III. CEO Report.
IV. Committee Reports.
V. Public Testimony on the Impact of the Economy on National Service Grantees.
VI. Honoring Departing Board Member.
VII. Public Comment.

ACCOMMODATIONS: Anyone who needs an interpreter or other accommodation should notify the Corporation's contact person by 5:00 p.m. Monday, February 4, 2009.

CONTACT PERSON FOR MORE INFORMATION: Lisa Guccione, Senior Policy Advisor, Office of the CEO, Corporation for National and Community Service, 10th Floor, Room 10207, 1201 New York Avenue, NW., Washington, DC 20525. Phone (202) 606–6637. Fax (202) 606–3460. TDD: (202) 606–3472. E-mail: *lguccione@cns.gov.*

Dated: January 27, 2009.

Frank R. Trinity,

General Counsel.

[FR Doc. E9–2115 Filed 1–28–09; 11:15 am]

BILLING CODE 6050–$$–P

DEPARTMENT OF DEFENSE

Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau; Notice of Public Hearings for the Mariana Islands Range Complex Draft Environmental Impact Statement/Overseas Environmental Impact Statement

AGENCY: Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act (NEPA); the Council of Environmental Quality (CEQ) Regulations for implementing the procedural provisions of NEPA (Title 40 Code of Federal Regulations [CFR] Parts 1500–1508); and Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions, on behalf of the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau (DoD REP), the U.S. Navy (Navy) has prepared and filed with the U.S. Environmental Protection Agency a Draft Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS) for the Mariana Islands Range Complex (MIRC) for public release on January 30, 2009.

The National Marine Fisheries Service (NMFS), the U.S. Department of the Interior, Office of Insular Affairs, the Federal Aviation Administration, the United States Marine Corps, and the United States Air Force (USAF) are cooperating agencies in the preparation of this EIS/OEIS.

The Draft EIS/OEIS evaluates the potential environmental impacts associated with the military readiness training; research, development, testing, and evaluation (RDT&E) activities; and associated range capabilities enhancements within the existing MIRC. A Notice of Intent for this Draft EIS/OEIS was published in the **Federal Register** on June 1, 2007 (72 FR 30557).

The Navy will conduct five public hearings to receive oral and written comments on the Draft EIS/OEIS. Federal agencies, state agencies, and local agencies and interested individuals are invited to be present or represented at the public hearings. This notice announces the dates and locations of the public hearings for this Draft EIS/OEIS.

DATES AND ADDRESSES: An open house session will start before the scheduled public hearing at each of the locations listed below and will allow individuals to review the information presented in the MIRC Draft EIS/OEIS. DoD REP, Navy and USAF representatives will be available during the open house sessions to clarify information related to the Draft EIS/OEIS. All meetings will include an open house session from 5 p.m. to 9 p.m. and a formal presentation and public comment period from 7 p.m. to 9 p.m. Public hearings will be held on the following dates and at the following locations:

1. Thursday, February 19, 2009, at the Jesus & Eugenia Leon Guerrero School of Business and Public Administration Building, The Anthony Leon Guerrero Multi-Purpose Room 129, University of Guam, Mangilao, Guam;

2. Friday, February 20, 2009, at the Southern High School Cafeteria, #1 Jose Perez Leon Guerrero Drive, Santa Rita, Guam;

3. Monday, February 23, 2009, at the Multi-Purpose Center in Susupe, Saipan;

4. Tuesday, February 24, 2009, at the Tinian Elementary School Cafeteria, San Jose Village, Tinian;

5. Thursday, February 26, 2009, at the Sinapolo Elementary School Cafeteria, Sinapolo, Rota.

FOR FURTHER INFORMATION CONTACT: Mariana Islands Range Complex EIS, 258 Makalapa Drive, Suite 100, Attn: EV2, Pearl Harbor, HI 96860–3134; e-mail at: *marianas.tap.eis@navy.mil.*

SUPPLEMENTARY INFORMATION: The MIRC Study Area is located in the Western Pacific (WESTPAC) and consists of three primary components: ocean surface and undersea areas; special use airspace (SUA); and training land areas. For the purposes of this EIS/OEIS, the MIRC and the Study Area are the same geographical areas consisting of land areas and offshore areas off the coast of Guam and the Commonwealth of Northern Mariana Islands (CNMI). The ocean surface and undersea areas of the MIRC extend from the international waters south of Guam to north of Pagan, CNMI, and from the Pacific Ocean east of the Mariana Islands to the middle of the Philippine Sea to the west, encompassing 501,873 square nautical miles of open ocean and littorals (coastal areas).

The MIRC Study Area does not include the sovereign territory (including waters out to 12 nautical miles) of the Federated States of Micronesia. Portions of the Marianas Trench Marine National Monument, which was established in January 2009 by Presidential Proclamation under the authority of the Antiquities Act (16 U.S.C. 431), lie within the Study Area. The range complex includes land ranges and training area/facilities on Guam, Rota, Tinian, Saipan, and Farallon de Medinilla (FDM), encompassing 64 square nautical miles of land. SUA consists of Warning Area 517 (W–517), restricted airspace over FDM (R–7201), and Air Traffic Control Assigned Airspace encompassing 63,000 square nautical miles of airspace.

The MIRC is used to support tactical training by the U.S. Military Services (Services), including Army, Navy, Marine Corps, Air Force, Coast Guard, Army Reserves, and Guam National Guard, in the WESTPAC Theater. The proposed action does not involve extensive changes to MIRC facilities, operations, training, or RDT&E capacities. Rather, the proposed action would result in relatively small-scale but critical enhancements to the MIRC that are necessary if the Services are to maintain a state of military readiness commensurate with their national defense mission. The recommended range enhancements, as well as current and future training and testing operations, that have the potential to impact the environment, are the primary focus of the EIS/OEIS.

The purpose for the Proposed Action is to achieve and maintain military readiness using the MIRC to support and conduct current, emerging, and future training and RDT&E activities while enhancing training resources through investment in the ranges.

The need for the Proposed Action is to enable the Services to meet their statutory responsibility to organize, train, equip, and maintain combat-ready forces and to successfully fulfill their current and future global mission of winning wars, deterring aggression, and maintaining freedom of the seas. Activities involving RDT&E are an integral part of this readiness mandate. In this regard, the MIRC furthers the Services' execution of their Congressionally-mandated roles and responsibilities under Title 10 U.S.C. 5062.

To implement this Congressional mandate, the Services need to: (1) Maintain mandated levels of military readiness training in the MIRC; (2) accommodate future increases in training tempo on existing ranges and adjacent air and ocean areas in the MIRC and support the rapid employment of military units or strike groups; (3) achieve and sustain readiness so that the Services can quickly surge required combat power in the event of a national crisis or contingency operation consistent with Service training requirements and airspace requirements for the deployment of future live fire ranges; (4) support the acquisition, testing, training, and fielding of advanced platforms and weapons systems into Service force structure; and, (5) maintain the long-term viability of the MIRC while protecting human health and the environment and enhancing the quality of training, communications and safety within the range complex.

Alternatives in this EIS/OEIS were evaluated to ensure they met the purpose and need, giving due consideration to range complex attributes such as the capability to support current and emerging training and RDT&E requirements; the capability to support realistic, essential training at the level and frequency sufficient to support the Tactical Training Theater Assessment and Planning Program (TAP); and the capability to support training requirements while following Service Personnel Tempo of Operations guidelines.

The three alternatives analyzed in this EIS/OEIS are: the No Action Alternative—Current training activities; Alternative 1—Increase training, modernization and upgrades; and Alternative 2—Increase major at-sea exercises and training.

The No Action Alternative will continue training and RDT&E activities of the same types, and at the same levels of training intensity as currently conducted, without change in the nature or scope of military activities in the EIS/OEIS study area.

Alternative 1, the Preferred Alternative, is a proposal designed to meet the Services' current and near-term operational training requirements. This is the Preferred Alternative, because it would meet all near-term training requirements by increasing training activities, as a result of upgrades and modernization of existing training areas, and increasing the number of exercises. This alternative also includes increased activities due to meeting new training and capability requirements for personnel and platforms.

Implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, and new activities related to additional major at-sea exercises.

The decision to be made by the DoD REP is to determine which of the alternatives analyzed in the EIS/OEIS best meets the needs of the Services given that all reasonably foreseeable environmental impacts have been considered.

The Draft EIS/OEIS addresses potential environmental impacts on multiple resources, including but not limited to: water resources; air quality; marine mammals; sea turtles; fish and essential fish habitat; seabirds and shorebirds; cultural resources; regional economy; and public health and safety. The Draft EIS/OEIS identifies aspects of the proposed action that could act as stressors to these resources. The stressors considered for analysis of potential environmental consequences include but are not limited to: Vessel movements; aircraft overflights; non-explosive practice munitions; sonar; and underwater detonations and high explosive ordnance.

No significant impacts are identified for any resource area in any geographic location within the MIRC Study Area that cannot be mitigated, with the exception of exposure of marine mammals to underwater sound. The Navy has requested from NMFS a Letter of Authorization in accordance with the Marine Mammal Protection Act to authorize the incidental take of marine mammals that may result from the implementation of the activities analyzed in the MIRC Draft EIS/OEIS. In accordance with section 7 of the Endangered Species Act, the Navy is consulting with NMFS and U.S. Fish and Wildlife Service for potential impacts to federally listed species.

The MIRC Draft EIS/OEIS has been distributed to Federal, State, and local agencies, elected officials, and other interested individuals and organizations. In addition, copies of the Draft EIS/OEIS are available for public review at the following libraries: University of Guam Robert F. Kennedy Memorial Library, Government Documents Tan Siu Lin Building, UOG Station, Mangilao, GU 96923; Nieves M. Flores Memorial Library, 254 Martyr Street, Hagätña, GU 96910; Rota Public Library, P.O. Box 879, Rota, MP 96951; Joeten-Kiyu Public Library, P.O. Box 501092, Saipan, MP 96950; and Northern Marianas College Public Library, P.O. Box 459, Tinian, MP 96952.

The Draft EIS/OEIS is also available for electronic public viewing or download at *http://www.MarianasRangeComplexEIS.com.* A paper copy of the Executive Summary or a single CD with the Draft EIS/OEIS will be made available upon written request by contacting Mariana Islands Range Complex EIS, 258 Makalapa Drive, Suite 100, Attn: EV2, Pearl Harbor, HI 96860–3134; e-mail at: *marianas.tap.eis@navy.mil.*

Written comments can be submitted during the open house sessions. Oral statements will be heard and transcribed by a stenographer during the hearing sessions; however, to ensure the accuracy of the record, all statements should be submitted in writing. All statements, both oral and written, will become part of the public record on the Draft EIS/OEIS and will be addressed in the Final EIS/OEIS. Equal weight will be given to both oral and written statements. In the interest of available time, and to ensure all who wish to give an oral statement have the opportunity to do so, each speaker's comments will be limited to three (3) minutes.

If a long statement is to be presented, it should be summarized at the public hearing with the full text submitted either in writing at the hearing; mailed to Mariana Islands Range Complex EIS, 258 Makalapa Drive, Suite 100, Attn: EV2, Pearl Harbor, HI 96860–3134; or e-mailed to *marianas.tap.eis@navy.mil.* In addition, comments may be submitted on-line at *http://www.MarianasRangeComplexEIS.com* during the comment period. All written comments must be postmarked by March 16, 2009, to ensure they become part of the official record. All timely comments will be addressed in the Final EIS/OEIS.

Dated: January 16, 2009.

A.M. Vallandingham,

Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. E9–2048 Filed 1–29–09; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF DEFENSE

Department of the Army

Availability for Non-Exclusive, Exclusive, or Partially Exclusive Licensing of U.S. Provisional Patent Application Concerning Treatment of the CNS for Status Epilepticus Due to Organophosphate Exposure

AGENCY: Department of the Army, DoD.

ACTION: Notice.

SUMMARY: Announcement is made of the availability for licensing of the invention set forth in U.S. Provisional Patent Application Serial No. 61/104,311 entitled ''* * * Treatment of the CNS for Status Epilepticus Due to Organophosphate Exposure,'' filed October 10, 2008. The United States Government, as represented by the Secretary of the Army, has rights in this invention.

ADDRESSES: Commander, U.S. Army Medical Research and Materiel Command, *ATTN:* Command Judge Advocate, MCMR–JA, 504 Scott Street, Fort Detrick, Frederick, MD 21702–5012.

FOR FURTHER INFORMATION CONTACT: For patent issues, Ms. Elizabeth Arwine, Patent Attorney, (301) 619–7808. For licensing issues, Dr. Paul Mele, Office of Research & Technology Assessment, (301) 619–6664, both at telefax (301) 619–5034.

SUPPLEMENTARY INFORMATION: The invention is a method of post exposure treatment for chemical warfare nerve agent or organophosphate induced seizure/status epilepticus and neuropathology. The method of treatment utilizes a specific blood-brain

APPENDIX C

AGENCY CORRESPONDENCE

This Page Intentionally Left Blank.

APPENDIX C

AGENCY COORESPONDENCE

1. Mr. P. Michael Payne, Division Chief
   Permits, Conservation, and Education Division
   Office of Protected Resources
   National Marine Fisheries Service (NMFS)
   National Oceanic and Atmospheric Administration
   Letter Dated: November 9, 2007

2. Mr. Patrick Leonard, Field Supervisor
   Pacific Islands Fish and Wildlife Office
   U.S. Fish and Wildlife Service
   Letter Dated: March 26, 2008

3. Ms. Angela Somma
   Chief, Endangered Species Division
   National Marine Fisheries Service (NMFS)
   National Oceanic and Atmospheric Administration
   Letter Dated: April 3, 2008

4. Ms. Angela Somma
   Chief, Endangered Species Division
   National Marine Fisheries Service (NMFS)
   National Oceanic and Atmospheric Administration
   Letter Dated: May 27, 2009

5. Mr. Alberto A. Lamorena V, Director
   Guam Bureau of Statistics and Plans
   Letter Dated: March 18, 2009

6. Dr. John B. Joyner
   Director
   Coastal Resources Management Office
   Letter Dated: March 18, 2009

7. Mr. James Lecky, Director
   Office of Protected Resources
   National Oceanic and Atmospheric Administration
   National Marine Fisheries Service (NMFS)
   Letter Dated: June 23, 2009

8. Mr. Patrick Leonard
   Field Office Supervisor
   U.S. Fish and Wildlife Service
   Pacific Islands Field Office
   Letter Dated: July 17, 2009

9. Mr. Alberto A. Lamorena V
   Director
   Guam Bureau of Statistics and Plans
   Letter Dated: July 23, 2009

10. Mr. William Robinson
    Regional Administrator
    Pacific Islands Regional Office
    National Marine Fisheries Service
    Letter Dated: October 1, 2009

11. Letter From: Patrick Leonard
    Field Supervisor
    United States Department of the Interior
    Fish and Wildlife Service
    Pacific Islands Fish and Wildlife Office
    Letter Dated: May 2, 2008

12. Letter From: Alberto A. Lamorena V, Director
    Bureau of Statistics and Plans
    Government of Guam
    Letter Dated: June 25, 2009 & March 16, 2009

13. Letter From: Loyal Mehrhoff
    United States Department of the Interior
    Fish and Wildlife Service
    Pacific Islands Fish and Wildlife Office
    Letter Dated: August 21. 2009

14. Letter From: William Robinson
    Regional Administrator
    U.S. Department of Commerce
    National Oceanic and Atmospheric Administration
    National Marines Fisheries Service
    Pacific Islands Regional Office
    Letter Dated: September 2, 2009

15. Letter From: Loyal Mehrhoff
    United States Department of the Interior
    Fish and Wildlife Service
    Pacific Islands Fish and Wildlife Office
    Letter Dated: February 22, 2010

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456/7U158324
November 9, 2007

Mr. P. Michael Payne
Division Chief
Permits, Conservation, and Education Division
Office of Protected Resources
National Marine Fisheries Service (NMFS)
National Oceanic and Atmospheric Administration
[redacted]

Dear Mr. Payne,

The Commander, U.S. Pacific Fleet (CPF), acting as executive agent for the Department of Defense is preparing an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to assess the potential environmental impacts associated with sustainable range usage and enhancements within the Mariana Islands Range Complex (MIRC).

The Proposed Action is to sustain, upgrade, modernize, and transform the ranges and training areas within the MIRC and will implement the US Pacific Command's strategic vision for the range complex. The purpose of the Proposed Action is to achieve and maintain military readiness using the MIRC to support current and future training requirements and Research, Development, Training and Evaluation (RDT&E) efforts within the DoD ranges and training areas. The area of the MIRC includes approximately 450,187 square nautical miles of ocean (enclosure 1).

Conduct of certain activities will likely result in acoustic exposure of marine mammals listed under the Marine Mammal Protection Act (MMPA) from Mid-Frequency Active Sonar (MFA) and impulsive sources, and likely requires a Letter of Authorization (LOA) from your office for those applicable activities. As such, the Navy will be submitting an LOA request to your office in the coming months for those applicable activities. It is expected that species for which an LOA is sought will include species listed under the Endangered Species Act (ESA).

Enclosures:

(1) Map of the MIRC study area
(2) Preliminary Draft Description of Proposed Action and Alternatives for the Mariana Island Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (August 2007)

Copy to (w/ enclosures):
Ms. Angela Somma,
Chief, Endangered Species Division, NMFS

Copy to (w/o enclosures):
OPNAV N43
CPF N01CE
CNMI

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND, PACIFIC
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HAWAII 96860-3134

5090.1G03
Ser EV22/ 237
26 MAR 2008

Mr. Patrick Leonard, Field Supervisor
Pacific Islands Fish and Wildlife Office
U.S. Fish and Wildlife Service

Dear Mr. Leonard:

SUBJECT: REQUEST FOR COMMENCEMENT OF SECTION 7, ENDANGERED SPECIES ACT, INFORMAL CONSULTATION REGARDING PROPOSED ACTIONS IN GUAM AND THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

As part of the National Environmental Policy Act process, the Department of the Navy is developing a series of documents and studies considering the possible impacts to species of plants and animals protected by the Endangered Species Act (ESA) which may result from the proposed establishment and operation of the Mariana Islands Range Complex (MIRC) and the relocation of U.S. Marine Corps forces to Guam. Over the past year, we have worked with members of your staff to develop a list of such species and discuss the range of potential impacts, possible design and operational modifications that may reduce adverse impacts, and other related topics, and we thank you for your assistance.

The purpose of this letter is to establish a date-of-record for commencement of informal ESA Section 7 consultation as directed by 50 CFR 402.12 (c). While informal consultation technically began months ago during our conversations and meetings, this letter provides a date-certain for documentation purposes for both of our agencies. This letter also confirms agreement of the attached species list that we created together and received on February 12, 2008.

Biological Assessments are in preparation for the two actions and drafts will be provided for your review when completed. We will continue to work closely at the staff level and appreciate your assistance on these very challenging projects.

Sincerely,

KAREN SUMIDA
Business Line Manager
Environmental
Acting

5090.1G03
Ser EV22/ 237
26 MAR 2008

Enclosure: Federally listed, candidate, and delisted species in the Territory of Guam and Commonwealth of the Northern Mariana Islands

Copy to:
Joint Guam Program Office (JGPO, Ms. Theresa Bernhard)
COMPACFLT (N01CE1, Mr. Larry Foster)
Guam Department of Agriculture (Mr. Paul Bassler)

Federally listed, candidate, and delisted species in the Territory of Guam and Commonwealth of the Northern Mariana Islands.

			Commonwealth of the Northern Mariana Islands														
Species	Protection Status[1]	Territory of Guam	Rota	Aguiguan	Tinian	Saipan	Farallon de Medinilla	Anatahan	Sarigan	Guguan	Alamagan	Pagan	Agrihan	Asuncion	Maug	Uracus	Citations
Mariana Fruit Bat (*Pteropus mariannus*)	T	< 100 (2007)[a]	> 800 (1983)	< 10 (1983)	< 25 (1983)	< 50 (1983)		< ? (2007)	200 (2000)	350 (2000)	200 (2000)	1,500 (2000)	1,000 (2000)	400 (1983)	< 25 (1983)		Wiles et al. 1989, Cruz et al. 2000a-e, C. Kessler, pers. comm. 2007
Little Mariana Fruit Bat (*Pteropus tokudae*)	E	PEX															USFWS 2004
Sheath-tailed Bat (*Emballonura semicaudata*)	C	EX	EX	< 500 (2003)	EX	EX											Esselstyn et al. 2004
Nightingale Reed-warbler (*Acrocephalus luscinia*)	E	EX		PEX	EX	4,200 (1997)					173 (2000)	PEX					USFWS 1998a, Cruz et al. 2000c
Mariana Swiftlet (*Aerodramus bartschi*)	E	> 800 (2006)	EX	> 400 (2002)	EX	5,000 (2005)											Esselstyn et al. 2002, Cruz et al. 2007; A. Brooke pers. comm. 2006
Mariana Crow (*Corvus kubaryi*)	E	10 (2007)	80 pairs (2007)														J. Quitigua pers comm. 2007 Berry et al. 2007
Mariana Common Moorhen (*Gallinula chloropus*)	E	90 (2001)	2 (2001)		41 (2001)	154 (2001)						PEX					Takano and Haig 2004
Guam Micronesian Kingfisher (*Halcyon cinnamomina*)	E	CAP [95][b]															Bahner and Bier 2007
Micronesian Megapode (*Megapodius laperouse*)	E	EX	EX	< 80 (2002)	< 10 (1997)	< 25 (1997)	PEX	PEX	360 (2000)	305 (2000)	< 30 (1992)	134 (2000)	395 (2000)	< 25 (1992)	< 150 (1992)	PEX	USFWS 1998b, Cruz et al. 2000a-e
Guam Rail (*Gallirallus owstoni*)	E	CAP [?]	XP 60-80														P. Wenninger pers. comm. 2007, S. Medina pers. comm. 2007
Guam Bridled White-eye (*Zosterops conspicillatus*)	E	PE															USFWS 2004
Rota Bridled White-eye (*Zosterops rotensis*)	E		1,000 (1999)														Amidon 2000
Tinian Monarch (*Monarcha takatsukasae*)	D				56,000 (1996)												Lusk et al. 2000
Green Sea Turtle (*Chelonia mydas*)	T	NEST	NEST		NEST	NEST						UNK					Berger et al. 2005
Hawksbill Turtle (*Eretmochelys imbricate*)	E	NEST	UNK			UNK											Berger et al. 2005
Mariana Wandering Butterfly (*Vagrans egestina*)	C	PEX?	1 Pop. (1995)														Schreiner and Nafus 1996

Species	Protection Status[1]	Territory of Guam	Commonwealth of the Northern Mariana Islands														Citations
			Rota	Aguiguan	Tinian	Saipan	Farallon de Medinilla	Anatahan	Sarigan	Guguan	Alamagan	Pagan	Agrihan	Asuncion	Maug	Uracus	
Mariana Eight Spot Butterfly (*Hypolimnus oticula*)	C	10 Pop. (1995)				PEX?											Schreiner and Nafus 1996
Humped Tree Snail (*Partula gibba*)	C	> 600 (2006)	<1,600 (1996)	PEX?	PEX?	UNK		PEX?	>100k (2006)		UNK (1994)	UNK (1994)					B. Smith pers. comm. 2006, Bauman 1996, Kurozumi 1994
Langford's Tree Snail (*Partula langfordi*)	C			PEX?													B. Smith pers. comm. 2006
Guam Tree Snail (*Partula radiolata*)	C	22 Pop (2004)															B. Smith pers comm. 2004
Fragile Tree Snail (*Samoana fragilis*)	C	4 Pop (2006)	1 Pop (1996)														B. Smith pers. comm. 2006, Bauman 1996
Nesogenes rotensis (No Common Name)	E		< 600 (2005)														USFWS 2006
Osmoxylon mariannense (No Common Name)	E		10 (2002)														USFWS 2006
Serianthes nelsonii (Hayun Lagu (Guam), Tronkon guafi (Rota))	E	1 (1992)	121 (1992)														Wiles et al. 1995, A. Brooke pers. comm. 2007

[1] **Federal Listing Status:** T = Threatened, E = Endangered, C = Candidate, and D = Delisted, Undergoing 5 Year Post-Delisting Monitoring
[2] **Population Status:** PEX = Presumed Extinct, UNK = Status Uncertain, CAP = Extirpated in the Wild, Captive Population Established, XP = Non-essential Experimental Population, and NEST = Nesting beaches
[a] Date of population estimate
[b] Population estimate

Migratory Bird Treaty Act, locally listed, IUCN, and other species of concern in the Territory of Guam and Commonwealth of the Northern Mariana Islands.

Species	Protection Status[1]	Territory of Guam	Commonwealth of the Northern Mariana Islands													
			Rota	Aguiguan	Tinian	Saipan	Farallon de Medinilla	Anatahan	Sarigan	Guguan	Alamagan	Pagan	Agrihan	Asuncion	Maug	Uracus
Wedge-tailed Shearwater (*Puffinus pacificus*)	M					X										
White-tailed Tropicbird (*Phaethon lepturus*)	M		X	X	X	X	X	U	X	X	X	X	X	X	X	
Red-tailed Tropicbird (*Phaethon rubricauda*)	M		X	X	X	X	X		X	X		X	X	X	X	X
Masked Booby (*Sula dactylatra*)	M					X	X	U		X					X	X
Brown Booby (*Sula leucogaster*)	M		X	X	X	X	X	U	X	X	X	X	X	X	X	X
Red-footed Booby (*Sula sula*)	M		X				X			X		X		X	X	
Great Frigatebird (Fregata minor)	M						X									
Little Tern (*Sterna albifrons*)	M					X										
Black-naped Tern (*Sterna sumatrana*)	M					U										
Spectacled Tern (*Sterna lunata*)	M					U		U	X	X						
Bridled Tern (*Sterna anaethetus*)	M						X									
Sooty Tern (*Sterna fuscata*)	M					X				X				X		X
Brown Noddy (*Anous stolidus*)	M	X	X	X	X	X	X	U	X	X	X	X	X	X	X	X
Black Noddy (*Anous minutus*)	M			X	X		X			X		X	X		X	
White Tern (*Gygis alba*)	M	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Species	Protection Status[1]	Territory of Guam	Commonwealth of the Northern Mariana Islands: Rota	Aguiguan	Tinian	Saipan	Farallon de Medinilla	Anatahan	Sarigan	Guguan	Alamagan	Pagan	Agrihan	Asuncion	Maug	Uracus
Yellow Bittern (*Ixobrychus exilis*)	M	X	X	X	X	X										
Pacific Reef Heron (*Ardea sacra*)	M	X	X	X	X	X	U		U	U	U	X	U	X	U	
White-throated Ground Dove (*Gallicolumba xanthonura*)	G,I,S		X	X	X	X	U		X	X	X	X	X	X		
Mariana Fruit Dove (*Ptilinopus roseicapilla*)	G,I,S		X	X	X	X										
Micronesian Starling (*Aplonis opaca*)	G.I,S	X	X	X	X	X	X	U	X	X	X	X	X	X	X	
Collared Kingfisher (*Halcyon chloris*)	S		X	X	X	X			X		X	X	X	X	X	
Tinian Monarch (*Monarcha takatsukasae*)	C,I				X											
Rufous Fantail (*Rhipidura rufifrons*)	G,S		X	X	X	X										
Micronesian Honeyeater (*Myzomela rubrata*)	G,S		X	X	X	X		?	X	X	X	X	X	X	X	
Bridled White-eye (*Zosterops conspicillatus*)	G,I,S			X	X	X										
Golden White-eye (*Cleptornis marchei*)	I,S			X		X										
Micronesian Gecko (*Perochirus ateles*)	G,C	X	X	?	X	X										
Oceanic Gecko (*Gehyra oceanica*)	G	X	X	X	X	X				X	X	?		X		
Pacific Slender-toed Gecko (*Nactus pelagicus*)	G	X	X		X	?					X	U				
Snake-eyed Skink (*Cryptoblepharus poecilopleurus*)	G	X	X	X	X	X	?	?	X	X	X	U	X	X	X	
Tide-pool Skink (*Emoia atrocostata*)	G		X							X	X	U				

Species	Protection Status[1]	Territory of Guam	Commonwealth of the Northern Mariana Islands													
			Rota	Aguiguan	Tinian	Saipan	Farallon de Medinilla	Anatahan	Sarigan	Guguan	Alamagan	Pagan	Agrihan	Asuncion	Maug	Uracus
Azure-tailed Skink (*Emoia cyanura*)	G	U														
Slevin's Skink (*Emoia slevini*)	G	X	X		X				X		X	U		X		
Moth Skink (*Lipinia noctua*)	G	X	U													
No Common Name (*Succinea guamensis*)	S	X														
No Common Name (*Succinea piratarum*)	I,S	X														
No Common Name (*Succinea quadrasi*)	I,S	X														
Coconut Crab (*Birgus latero*)	S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Heritiera longipetiolata (Ufa-halomtano)	I,S	X	X		X	X										
Aglaia mariannensis	I	X	X	X	X	X		X	X	X	X	X	X	X		
Cyathea lunulata (Tsatsa)	G	X														
Lycopodium phlegmaria var. *logifolium* (Disciplina Fern)	C	X	X													

[1] **Protection Status:** M = Migratory Bird Treaty Act, I = IUCN Listed VU to CR, C = CNMI Listed, G = Guam Listed, S = Species of Concern (FWS, CNMI)
[2] **Population Status:** X = Present, U = Unknown

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0353
3 Apr 08

Ms. Angela Somma
Chief, Endangered Species Division
National Marine Fisheries Service (NMFS)
National Oceanic and Atmospheric Administration

Dear Ms. Somma:

SUBJECT: REQUEST FOR CONCURRENCE/REVISION ON SPECIES LIST, TECHNICAL ASSISTANCE FOR BIOLOGICAL ASSESSMENT PREPARATION

The Commander, U.S. Pacific Fleet (COMPACFLT), acting as executive agent for the Department of Defense (DoD) is preparing an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to assess the potential environmental impacts associated with sustainable range usage and enhancements within the Mariana Islands Range Complex (MIRC).

The Proposed Action is to sustain, upgrade, modernize, and transform the ranges and training areas within the MIRC and will implement the US Pacific Command's strategic vision for the range complex. The purpose of the proposed action is to achieve and maintain military readiness using the MIRC to support current and future training requirements and Research, Development, Training and Evaluation (RDT&E) efforts within the DoD ranges and training areas. The area of the MIRC includes approximately 450,187 square nautical miles of ocean (Enclosure 1).

A Biological Assessment (BA) will be prepared in support of the MIRC EIS/OEIS. Although the activities of the Proposed Action do not constitute a major construction activity as defined by the Endangered Species Act, the BA will be prepared in accordance with 50 CFR 402.12(f). This letter includes a list of threatened and endangered species determined to have potential occurrence within, or near, the action areas relevant to the Proposed Action (Enclosure 2). Critical habitat for some species has been defined, but none of the critical habitats include the Mariana Islands or Guam, and, therefore, critical habitat descriptions are not included here. Primary sources include various marine resource studies relevant to specific range areas.

Other action areas may have species under the mandate of the U.S. Fish and Wildlife Service (USFWS). A separate BA addressing the effects of the Proposed Action on terrestrial species will be submitted to the USFWS Pacific Islands Fish and Wildlife Office.

As per 50 CFR 402.12 (c), the Navy is requesting concurrence on **the** list of species, as well as possible revisions to the list NMFS deems relevant. If the BA is not commenced after 90 days from receipt of a species/critical habitat list, the Navy will verify the species list with NMFS (as per 50 FR 402.12 (e)).

We appreciate your continued support in helping us to meet our Section 7 responsibilities. My point of contact for this matter is **Ms.** Julie Rivers at (808) 472-1407 or julie.rivers@navy.mil

Sincerely,

J. P. RIOS
Captain, U.S. Navy
Deputy Fleet Civil Engineer
By direction

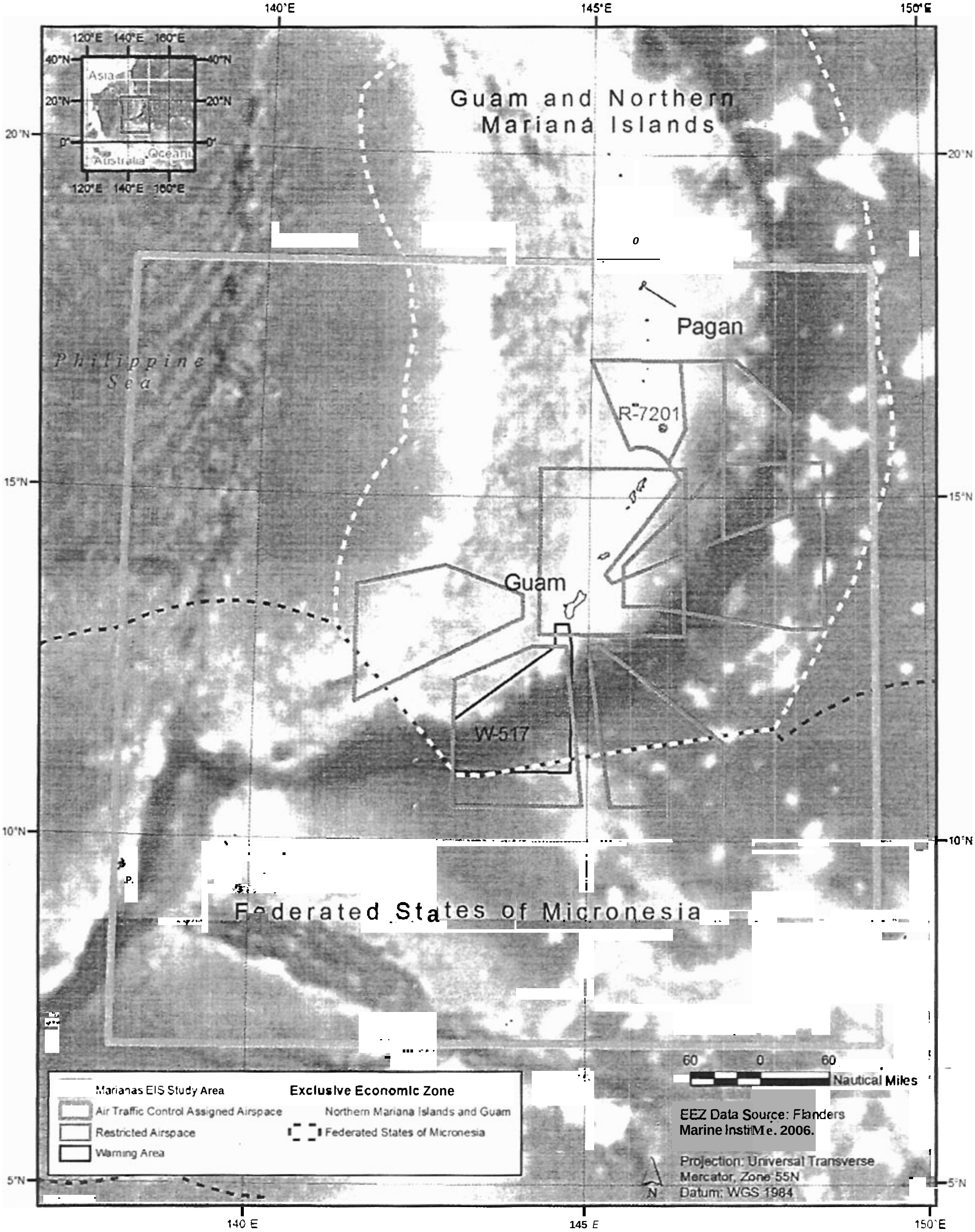
Enclosures:
(1) Map of the MIRC Study Area
(2) Marine Species Lists within the Mariana Islands

Copy to (w/ enclosures):
NMFS Pacific Islands Regional Office
USFWS Pacific Islands Fish and Wildlife Office

SUBJECT: REQUEST FOR CONCURRENCE/REVISION ON SPECIES LIST, TECHNICAL ASSISTANCE FOR BIOLOGICAL ASSESSMENT PREPARATION

Copy to (w/o enclosures):
OPNAV N45
Commander, Navy Region Marianas
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas (EV)

Enclosure (1)
Map MIRC Study Area



ENCLOSURE 2 – Marine Species Identified for Section 7 Consultation with NOAA Fisheries Service

Scientific Name	English Name(s)	Chamorro/ Carolinian Name(s)	Federal Listing Status	Pacific Basin Habitat(s) [1]	Mariana Islands Sighting Records [2]
Marine Mammals					
Megaptera novaeangliae	Humpback whale		Endangered	Antarctic pelagic, in summer: temperate to subtropical. In winter: tropical coastal	(1) Stories of sightings and killings of nine whales in one season were recorded in the southern Mariana Islands (Beane 1905). (2) Two whales were reported about 100 m off the reef margin at Uruno Point on February 25, 1978 (Eads, personal communication cited in GovGuam 2005). (3) Three were sighted off the west coast of Guam on February 13, 1991 (Eads 1991). (4) A group of three was photographed off Saipan in February 1991 (Darling and Mori 1991). **(5)** A mother and calf werg sighted off the east coast of Rota in late February 1991. (Stinson, personal communication cited in GovGuam 2005). (6) A group of six or more was photographed at the entrance to Apra Harbor in January 1996 (1996 Anonymous citation, as cited in GovGuam 2005). (7) One visual sighting of several animals in waters off the coast of Saipan and Tinian on February 18, 2007. Six acoustic detections from towed array and 2 sonobuoy detections In waters of Guam and CNMI between February 6 – April 13, 2007 (DoN 2007).
Balaenoptera borealis	Sei whale		Endangered	Oceanic, warm water breeding, cold water feeding grounds between 40 degs North and 20 degree isotherm.	(1) A single specimen was sighted west of Saipan (Masaki 1972). (2) Two tagged sei whales from the Northern Mariana Islands were later killed several hundred kilometers south of the western Aleutian Islands (Horwood 1987) (3) Sixteen total visual sightings; five acoustic detections from towed array and two sonobuoy detections in waters of Guam and CNMI between January 13 – April 13, 2007 (DoN 2007).

Scientific Name	English Name(s)	Chamorro/ Carolinian Name(s)	Federal Listing Status	Pacific Basin Habitat(s) [1]	Mariana Islands Sighting Records [2]
Physeter macrocephalus	Sperm whale		Endangered	Pelagic, offshore, deep water, temperate – tropical.	(1) Sightings throughout the year between 1761 and 1920, especially around the Marianas, Pohnpei, and Kosrae (Townsend 1935) (2) One 15-m albino sperm whale was found beached at Acho Bay, Inarajan, Guam on September 5,1962 (Bordallo 1962). (3) One stranding reported (Kami and Lujan 1976). (4) Eight sperm whales were sighted June 15, 2001, including a young calf with a trailing umbilical cord (as cited In GovGuam 2005). (5) Twenty-three total visual sightings; 60 acoustic detections from towed array and six detections from sonobuoy between January 13 – April 13, 2007 in waters of Guam and CNMI; (DoN 2007). [4]
Balaenoptea physalus	Fin whale		Endangered	In the northern hemisphere, most migrate seasonally from high Arctic feeding areas In summer to low latitude breeding and calving areas in winter.	Rare occurrences possible in the action area (NOAA Fisheries Biological Qpinion, Valiant Shield Training Exercises. 2007).
Balaenoptera musculus	Blue whale		Endangered	Mainly pelagic; generally prefers cold waters and open seas, but young are born In warmer waters of lower latitudes.	Rare occurrences possible in the actlon area (NOAA Fisheries Biological Opinion, Valiant Shield Training Exercises. 2007).
Sea Turtles					
Chelonia mydas	Green sea turtle	Haggan bed'di / Wong mool	Threatened	Oceanic beaches and coastal strand (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas.	Known to occur in / around Mariana Islands. Nest site locatlons on Andersen AFB (Explosive Ordnance Disposal Beach) and Guam NWR.
Dermochelys coriacea	Leatherback sea turtle	Hagan tasi / Wong raaw	Endangered	Oceanic beaches and coastal strand (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas.	Known to occur in / around Mariana Islands
Caretta caretta	Loggerhead sea turtle	Hagan tasi / Wong	Threatened	Oceanic beaches and coastal strand (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas.	Known to occur in / around Mariana Islands
Eretmochelys imbricata	Hawksbill sea turtle	Hagan karai / Wong maaw	Endangered	Oceanic beaches and coastal strand (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas.	Known to occur in / around Mariana islands. Dead individual recovered off Talofofo (Jeff's Pirate Cove), southeast coast of Guam. One visual sighting on the fourth survey leg (DoN 2007).

Scientific Name	English Name(s)	Chamorro/ Carolinian Name(s)	Federal Listing Status	Pacific Basin Habitat(s) [1]	Mariana Islands Sighting Records [2]
Lepidochelys olivacea	Olive Ridley sea turtle		Threatened	Oceanic beaches and coastal strand (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas.	One stuffed individual sighted in handicraft shop In Saipan in the 1970s (Kolinski, et al. 2001).
Fish Species					
Bolbometopon muricatum	Bumphead parrotfish		Species of Concern	Diurnal: barrier and fringing reefs 3 – 100 feet below surface. Nocturnal: shallow sandy lagoon flats Juveniles associated with seagrass beds Inside lagoons, adults associated with outer lagoons and seaward reefs. Spawning associated with lunar cycle near outer reef slope or near promontories, gutters, or channel mouths.	Nearly extirpated from Guam's reefs (NMFS 2007)
Cheilinus undulatus	Humphead wrasse		Species of Concern	Extremely patchy distribution with adults confined to steep outer reef slopes, channel slopes, and lagoon reefs In water 1- 100 meters deep.	Nearly extirpated from Guam's reefs (NMFS 2007)

1. Habitat sources from GovGuam DAWR (2005) and NOAA Fisheries Service factsheets for Bumphead parrotfish and Humphead wrasse (NMFS 2007).
2. Sighting records from GovGuam DAWR (2005) and Mariana islands Sea Turtle and Cetacean Survey Crulse Report (DoN 2007).

This Page Intentionally Left Blank

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO
5090
Ser N456K/9U158820
27 May 2009

Ms. Angela Somma
Division Chief Protected Resources
National Oceanic and Atmospheric Administration
National Marine Fisheries Services (NMFS)
B-SSMC3 Room 13821

Dear Ms. Somma:

The Commander, U.S. Pacific Fleet (CPF) is preparing an Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to assess the potential environmental impacts associated with sustainable range usage and enhancements within the Navy's Mariana Islands Training Complex (MIRC). Specifically, the proposed action is to sustain, upgrade, modernize, and transform the ranges and training areas within the MIRC and implement the US Pacific Command's strategic vision for the range complex. Through our cooperating agency agreement, the Navy and National Marine Fisheries Services (NMFS) are working together to develop these EISs/OEISs to release for public comment.

In a letter dated November 7, 2007, the Navy requested the NMFS' permit division initiate early consultation in anticipation of submitting a Marine Mammal Protection Act request for rulemaking and Letters of Authorization. In accordance with 50 CFR §401.12(f) the Navy is submitting its Biological Assessment (BA) [Enclosure 1] and is requesting formal consultation pursuant to Section 7(a)(2).

This BA assesses the potential effects of the proposed actions on species protected under the Endangered Species Act (ESA) that potentially occur within the MIRC.

In accordance with 50 CFR §401.14(c), the attached BA includes: (1) a description of the proposed action; (2) descriptions of the specific areas where the proposed action will occur (also called the Study Area); (3) descriptions of the listed species and critical habitat that may be affected by the actions; (4)

the potential effects on listed and proposed species or critical habitat; (5) an analysis of cumulative effects; and (6) measures proposed by the Navy to mitigate potential effects of the proposed action.

Additional technical information regarding the process by which the Navy determined the listed species distribution in these geographic areas is detailed in Enclosure 2. These reports are in a draft stage and would benefit from your staff's input, should any technical errors by identified. We are providing this report as additional relevant technical information for purposes of consultation under the ESA.

My staff point of contact for this matter is Dr. Kelly Brock, who can be reached at 703-604-5420 or via email at kelly.brock@navy.mil; Commander, U.S. Pacific Fleet's point of contact for this matter is Ms. Julie Rivers, who can be reached at (808) 472-1407 or julie.rivers@navy.mil.

Sincerely,

[signature] for

Ronald E. Tickle
Head, Operational Environmental
Readiness and Planning Branch
Environmental Readiness Division
(OPNAV N45)

Enclosures:
(1) Biological Assessment for the Mariana Islands Range Complex.
(2) Marine Resource Assessment Update for the Mariana Islands Operating Area (Draft Report August 2005 - CD Copy).

Copy to (w/o enclosures):
DASN(E)
OPNAV N43
CPF N01CE
CNMI

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0312
18 Mar 09

Mr. Alberto A. Lamorena V
Director
Guam Bureau of Statistics and Plans

Dear Mr. Lamorena:

SUBJECT: FEDERAL CONSISTENCY DETERMINATION FOR THE DEPARTMENT OF DEFENSE ACTIVITIES WITHIN THE MARIANA ISLANDS RANGE COMPLEX (MIRC)

In accordance with the Federal Coastal Zone Management Act, we request your review and concurrence on the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau (DoD Rep) consistency determination based on the assessment provided in the January 2009 MIRC draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) previously provided to you as well as the information contained herein.

As detailed in the draft EIS/OEIS separately provided to you, the proposed federal action is to achieve and maintain military readiness using the MIRC to support and conduct current, emerging, and future training and RDT&E activities, while enhancing training resources through investment in the MIRC. Although the majority of actions proposed to take place within the MIRC are outside the coastal zone or are either at sea in international waters or on Federally-owned lands and submerged lands on military installations and therefore outside of Guam's coastal zone, the DoD Rep is submitting this consistency determination.

As part of the National Environmental Policy Act (NEPA) process, the Navy acting for the DoD Rep, assessed reasonably foreseeable direct and indirect effects on Guam's defined coastal zone, Guam's resources and reviewed relevant management program enforceable policies. A completed Guam Coastal Management Program Assessment form is attached in support of this consistency determination. DoD Rep has determined that

SUBJECT: FEDERAL CONSISTENCY DETERMINATION FOR THE DEPARTMENT OF DEFENSE ACTIVITIES WITHIN THE MARIANA ISLANDS RANGE COMPLEX (MIRC)

based upon an evaluation in light of Guam's applicable enforcement policies there are no adverse direct or indirect (cumulative or secondary) effects on coastal uses or resources and the proposed action and its alternatives are consistent to the maximum extent practicable with the enforceable policies of Guam's CZM Program.

We appreciate your continued support. If you have any questions on this matter, please contact Mr. Edward J. Lynch, at (808) 471-1714 or by email at edward.j.lynch.ctr@navy.mil.

Sincerely,

J. R. RIOS
Captain, U.S. Navy
By direction

Enclosure: Guam Coastal Management Program Assessment Form

Copy to:
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas (EV - Mr. Robert Wescom)

GUAM COASTAL MANAGEMENT PROGRAM

ASSESSMENT FORMAT

DEVELOPMENT POLICIES (DP):

DP1. Shore Area Development

Intent: To insure environmental and aesthetic compatibility of shore area land uses.

Policy: Only those uses shall be located within the Seashore Reserve which:
enhance, are compatible with or do not generally detract from the surrounding coastal area's aesthetic and environmental quality and beach accessibility; or
can demonstrate dependence on such a location and the lack of feasible alternative sites.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. There would be no effect on Guam-owned shore area lands due to continuing military training conducted on Guam. Training will continue on federally-owned lands and submerged lands, which are not part of Guam's coastal zone.

DP2. Urban Development

Intent: To cluster high impact uses such that coherent community design, function, infrastructure support and environmental compatibility are assured.

Policy: Commercial, multi-family, industrial and resort-hotel zone uses and uses requiring high levels of support facilities shall be concentrated within urban districts as outlined on the Land Use Districting Map.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam and does not involve the development of commercial, multi-family, industrial and resort-hotel zone uses and uses requiring high levels of support facilities.

DP3. Rural Development

Intent: To provide a development pattern compatible with environmental and infrastructure support suitability and which can permit traditional lifestyle patterns to continue to the extent practicable.

Policy: Rural districts shall be designated in which only low density residential and agricultural uses will be acceptable. Minimum lot size for these uses should be one-half acre until adequate infrastructure including functional sewering is provided.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Rural or agricultural districts will not be affected.

DP4. Major Facility Siting

Intent: To include the national interest in analyzing the siting proposals for major utilities, fuel and transport facilities.

Policy: In evaluating the consistency of proposed major facilities with the goals, policies, and standards of the Comprehensive Development and Coastal Management Plans, the Territory shall recognize the national interest in the siting of such facilities including those associated with electric power production and transmission, petroleum refining and transmission, port and air installations, solid waste disposal, sewage treatment, and major reservoir sites.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. The proposed project does not involve construction or siting of major utilities, fuel, or transport facilities. Existing training areas and facilities may be enhanced in support of military training activities and associated construction or facility modification, if any, will be confined to federally-owned lands/submerged lands on Guam.

DP 5. Hazardous Areas

Intent: Development in hazardous areas will be governed by the degree of hazard and the land use regulations.

Policy: Identified hazardous lands, including flood plains, erosion-prone areas, air installations, crash and sound zones and major fault lines shall be developed only to the extent that such development does not pose unreasonable risks to the health, safety or welfare of the people of Guam, and complies with the land use regulations.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Existing training areas and facilities may be enhanced in support of military training activities and associated construction, if any, will be confined to federally-owned lands/submerged lands on Guam. Proposed training activities will also adhere to Department of Defense safety criteria, including those associated with the use and storage of munitions and explosives (quantity/distance criteria), design and maintenance/operation of training ranges, use of airfields (Air Installation Compatible Use Zones), exposure to electromagnetic radiation, and others.

DP 6. Housing

Intent: To promote efficient community design placed where the resources can support it.

Policy: The government shall encourage efficient design of residential areas, restrict such development in areas highly susceptible to natural and manmade hazards, and recognize the limitations of the island's resources to support historical patterns of residential development.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. The proposed project does not involve residential development. Housing for transient military trainees will be provided by the military using existing military housing, temporary housing (e.g. tents) at training venues, or available commercial temporary lodging facilities on Guam.

DP 7. Transportation

Intent: To provide transportation systems while protecting potentially impacted resources.

Policy: The Territory shall develop an efficient and safe transportation system, while limiting adverse environmental impacts on primary aquifers, beaches, estuaries and other coastal resources.

Discussion: The proposed project does not include the development of transportation systems. The proposed project would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. No new transportation systems are proposed. Existing transportation systems within military installations and on Guam will be used to access training venues. Transportation for transient military trainees to training venues will be provided by the military using existing military vehicles on Guam or commercially available rental vehicles.

DP 8. Erosion and Siltation

Intent: To control development where erosion and siltation damage is likely to occur.

Policy: Development shall be limited in areas of 15% or greater slope by requiring strict compliance with erosion, sedimentation, and land use districting guidelines, as well as other related land use standards for such areas.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Existing training areas and facilities may be enhanced in support of military training activities and associated construction, if any, will be confined to federally-owned lands/submerged lands on Guam. Training restrictions to prevent erosion, sedimentation, and siltation include controlling run on and runoff at training sites, military vehicles to stay on designated corridors with no off-roading allowed, avoiding creating areas of exposed dirt (e.g. vegetation clearing will be conducted in such a manner to leave roots intact), and others.

RESOURCES POLICIES (RP):

RP1. Air Quality

Intent: To control activities to insure good air quality.

Policy: All activities and uses shall comply with all local air pollution regulations and all appropriate Federal air quality standards in order to ensure the maintenance of Guam's relatively high air quality.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Training activities on land may result in temporary, intermittent, short-term emissions but do not include permanent, continuous emission sources that could impair local air quality.

RP2. Water Quality

Intent: To control activities that may degrade Guam's drinking, recreational, and ecologically sensitive waters.

Policy: Safe drinking water shall be assured and aquatic recreation sites shall be protected through the regulation of uses and discharges that pose a pollution threat to Guam's waters, particularly in estuaries, reef and aquifer areas.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Training restrictions to prevent degradation of drinking, recreational and ecologically sensitive waters include controlling run on and runoff at training sites, immediate cleanup of spills, no wash water or brine discharge into Fena Reservoir, nearby streams, and drainage ditches, and other control measures.

RP3. Fragile Areas

Intent: To protect significant cultural areas, and natural marine and terrestrial wildlife and plant habitats.

Policy: Development in the following types of fragile areas shall be regulated to protect their unique character.

- historical and archeological sites
- wildlife habitats
- pristine marine and terrestrial communities
- limestone forests
- mangrove stands and other wetlands

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Military installations on Guam implement Integrated Cultural Resources Management Plans and Integrated Natural Resources Management Plans in accordance with applicable federal regulations for the preservation and management of historical, archaeological, and natural resources within base boundaries. The Department of Defense has initiated consultation efforts with the US Fish and Wildlife Service and the National Marine Fisheries Service for the project's effects on wildlife and wildlife habitats, including marine mammals, under the Endangered Species Act. The Department of Defense is also coordinating with the State Historic Preservation Officer for a Programmatic Agreement for the preservation of Guam's cultural resources located within military installations, with particular emphasis on cultural resources located in or near training areas.

RP4. Living Marine Resources

Intent: To protect marine resources in Guam's waters.

Policy: All living resources within the territorial waters of Guam, particularly corals and fish, shall be protected from over harvesting and, in the case of marine mammals, from any taking whatsoever.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. The Navy is currently undertaking coral reef protection/enhancement projects as stewards of federally-owned submerged lands on Guam. In addition, the Navy implements reasonable and prudent measures to minimize impacts of incidental take of green sea turtles and hawksbill turtles during training activities at Sumay Cove as defined in the Biological Opinion and Conference Report for Military Training in the Marianas (Log No. 1-2-98-F-07, 4 January 1999) issued by the U.S. Fish and Wildlife Service (USFWS). The Navy has initiated the Endangered Species Act and Marine Mammal Protection Act compliance processes with the USFWS and the National Marine Fisheries Service (NMFS), respectively. The Navy will obtain the appropriate permits from NMFS and USFWS, and a letter of authorization for activities that take place at sea or in water.

RP5. Visual Quality

Intent: To protect the quality of Guam's natural scenic beauty

Policy: Preservation and enhancement of, and respect for the island's scenic resources shall be encouraged through increased enforcement of and compliance with sign, litter, zoning, subdivision, building and related land-use laws. Visually objectionable uses shall be located to the maximum extent practicable so as not to degrade significant views from scenic overlooks, highways and trails.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. All military training activities will be conducted within the boundaries of federal military installations and will have no impact on the aesthetic quality of Guam’s scenic views. Solid waste (litter) generated during training activities, which may impair visual quality, will be collected, consolidated and disposed on military landfills in accordance with base solid waste management plans.

RP6. Recreation Areas

Intent: To encourage environmentally compatible recreational development.

Policy: The Government of Guam shall encourage development of varied types of recreational facilities located and maintained so as to be compatible with the surrounding environment and land uses, adequately serve community centers and urban areas and protect beaches and such passive recreational areas as wildlife and marine conservation areas, scenic overlooks, parks and historical sites.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Recreational areas and facilities on federal military installations will continue to be maintained by the military. For those recreational areas and facilities where the public is allowed access, access may be temporarily curtailed during military training activities and restored upon completion of the training exercises.

RP7. Public Access

Intent: To ensure the right of public access.

Policy: The public's right of unrestricted access shall be ensured to all non-federally owned beach areas and all Territorial recreation areas, parks, scenic overlooks, designated conservation areas and their public lands; and agreements shall be encouraged with the owners of private and federal property for the provision of releasable access to and use of resources of public nature located on such land.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, which are restricted-access military installations. No non-federally owned beach areas, territorial recreation areas, parks, scenic overlooks, designated conservation areas or other public lands would be affected. For security and safety reasons, public access normally allowed (by permit) within military installations may be temporarily curtailed during military training activities and restored upon completion of the training exercise(s).

RP8. Agricultural Lands

Intent: To stop urban types of development on agricultural land.

Policy: Critical agricultural land shall be preserved and maintained for agricultural use.

Discussion The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Therefore urban development of agricultural lands would not occur.

FEDERAL CONSISTENCY
SUPPLEMENTAL INFORMATION FORM

Date: March 16, 2009

Project/Activity Title or Description: MARIANA ISLANDS RANGE COMPLEX

Location: MARIANA ISLANDS

Other applicable area(s) affected, if appropriate:
____

Est. Start Date:_____________________________Est. Duration: ______________________

APPLICANT

Name & Title: Department of Defense Representative Guam, Commonwealth of the Northern Marianas Islands, Federated States of Micronesia and Republic of Palau (DoD Rep)
Agency/Organization: ____
Address: ____
_______________________________________ Zip Code ___________________________

Telephone No. during business hours:

A/C (___) ____________________
A/C (___) ____________________
Fax (___) ____________________

E-mail Address: ____

AGENT

Name & Title: ____
Agency/Organization: ____
Address: ____
_______________________________________ Zip Code ___________________________

Telephone No. during business hours:

A/C (___) ____________________
A/C (___) ____________________
Fax (___) ____________________

E-mail Address: ____

CATEGORY OF APPLICATION (check one only)

(X) I Federal Agency Activity
( ) II Permit or License
( ) III Grants & Assistance

TYPE OF STATEMENT (check one only)

(X) Consistency
( ) General Consistency (Category I only)
( ) Negative Determination (Category I only)
( ) Non-Consistency (Category I only)

APPROVING FEDERAL AGENCY (Categories II & III only)

Agency: ______________________________________
____

Contact Person: __________________________________

Telephone No. during business hours:

A/C (___) ____________________
A/C (___) ____________________
Fax (___) ____________________

FEDERAL AUTHORITY FOR ACTIVITY

Title of Law: Title 10 – Armed Forces, United States Code
Section: Subtitle A – General Military Law, Part III – Training and Education

OTHER TERRITORIAL APPROVALS REQUIRED

Date of: ____

Agency	Type of Approval	Application	Status

GUAM COASTAL MANAGEMENT PROGRAM

ASSESSMENT FORMAT

DEVELOPMENT POLICIES (DP):

DP1. Shore Area Development

Intent: To insure environmental and aesthetic compatibility of shore area land uses.

Policy: Only those uses shall be located within the Seashore Reserve which:
enhance, are compatible with or do not generally detract from the surrounding coastal area's aesthetic and environmental quality and beach accessibility; or
can demonstrate dependence on such a location and the lack of feasible alternative sites.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. There would be no effect on Guam-owned shore area lands due to continuing military training conducted on Guam. Training will continue on federally-owned lands and submerged lands, which are not part of Guam's coastal zone.

DP2. Urban Development

Intent: To cluster high impact uses such that coherent community design, function, infrastructure support and environmental compatibility are assured.

Policy: Commercial, multi-family, industrial and resort-hotel zone uses and uses requiring high levels of support facilities shall be concentrated within urban districts as outlined on the Land Use Districting Map.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam and does not involve the development of commercial, multi-family, industrial and resort-hotel zone uses and uses requiring high levels of support facilities.

DP3. Rural Development

Intent: To provide a development pattern compatible with environmental and infrastructure support suitability and which can permit traditional lifestyle patterns to continue to the extent practicable.

Policy: Rural districts shall be designated in which only low density residential and agricultural uses will be acceptable. Minimum lot size for these uses should be one-half acre until adequate infrastructure including functional sewering is provided.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Rural or agricultural districts will not be affected.

DP4. Major Facility Siting

Intent: To include the national interest in analyzing the siting proposals for major utilities, fuel and transport facilities.

Policy: In evaluating the consistency of proposed major facilities with the goals, policies, and standards of the Comprehensive Development and Coastal Management Plans, the Territory shall recognize the national interest in the siting of such facilities including those associated with electric power production and transmission, petroleum refining and transmission, port and air installations, solid waste disposal, sewage treatment, and major reservoir sites.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. The proposed project does not involve construction or siting of major utilities, fuel, or transport facilities. Existing training areas and facilities may be enhanced in support of military training activities and associated construction or facility modification, if any, will be confined to federally-owned lands/submerged lands on Guam.

DP 5. Hazardous Areas

Intent: Development in hazardous areas will be governed by the degree of hazard and the land use regulations.

Policy: Identified hazardous lands, including flood plains, erosion-prone areas, air installations, crash and sound zones and major fault lines shall be developed only to the extent that such development does not pose unreasonable risks to the health, safety or welfare of the people of Guam, and complies with the land use regulations.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Existing training areas and facilities may be enhanced in support of military training activities and associated construction, if any, will be confined to federally-owned lands/submerged lands on Guam. Proposed training activities will also adhere to Department of Defense safety criteria, including those associated with the use and storage of munitions and explosives (quantity/distance criteria), design and maintenance/operation of training ranges, use of airfields (Air Installation Compatible Use Zones), exposure to electromagnetic radiation, and others.

DP 6. Housing

Intent: To promote efficient community design placed where the resources can support it.

Policy: The government shall encourage efficient design of residential areas, restrict such development in areas highly susceptible to natural and manmade hazards, and recognize the limitations of the island's resources to support historical patterns of residential development.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. The proposed project does not involve residential development. Housing for transient military trainees will be provided by the military using existing military housing, temporary housing (e.g. tents) at training venues, or available commercial temporary lodging facilities on Guam.

DP 7. Transportation

Intent: To provide transportation systems while protecting potentially impacted resources.

Policy: The Territory shall develop an efficient and safe transportation system, while limiting adverse environmental impacts on primary aquifers, beaches, estuaries and other coastal resources.

Discussion: The proposed project does not include the development of transportation systems. The proposed project would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. No new transportation systems are proposed. Existing transportation systems within military installations and on Guam will be used to access training venues. Transportation for transient military trainees to training venues will be provided by the military using existing military vehicles on Guam or commercially available rental vehicles.

DP 8. Erosion and Siltation

Intent: To control development where erosion and siltation damage is likely to occur.

Policy: Development shall be limited in areas of 15% or greater slope by requiring strict compliance with erosion, sedimentation, and land use districting guidelines, as well as other related land use standards for such areas.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Existing training areas and facilities may be enhanced in support of military training activities and associated construction, if any, will be confined to federally-owned lands/submerged lands on Guam. Training restrictions to prevent erosion, sedimentation, and siltation include controlling run on and runoff at training sites, military vehicles to stay on designated corridors with no off-roading allowed, avoiding creating areas of exposed dirt (e.g. vegetation clearing will be conducted in such a manner to leave roots intact), and others.

RESOURCES POLICIES (RP):

RP1. Air Quality

Intent: To control activities to insure good air quality.

Policy: All activities and uses shall comply with all local air pollution regulations and all appropriate Federal air quality standards in order to ensure the maintenance of Guam's relatively high air quality.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Training activities on land may result in temporary, intermittent, short-term emissions but do not include permanent, continuous emission sources that could impair local air quality.

RP2. Water Quality

Intent: To control activities that may degrade Guam's drinking, recreational, and ecologically sensitive waters.

Policy: Safe drinking water shall be assured and aquatic recreation sites shall be protected through the regulation of uses and discharges that pose a pollution threat to Guam's waters, particularly in estuaries, reef and aquifer areas.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Training restrictions to prevent degradation of drinking, recreational and ecologically sensitive waters include controlling run on and runoff at training sites, immediate cleanup of spills, no wash water or brine discharge into Fena Reservoir, nearby streams, and drainage ditches, and other control measures.

RP3. Fragile Areas

Intent: To protect significant cultural areas, and natural marine and terrestrial wildlife and plant habitats.

Policy: Development in the following types of fragile areas shall be regulated to protect their unique character.

- historical and archeological sites
- wildlife habitats
- pristine marine and terrestrial communities
- limestone forests
- mangrove stands and other wetlands

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Military installations on Guam implement Integrated Cultural Resources Management Plans and Integrated Natural Resources Management Plans in accordance with applicable federal regulations for the preservation and management of historical, archaeological, and natural resources within base boundaries. The Department of Defense has initiated consultation efforts with the US Fish and Wildlife Service and the National Marine Fisheries Service for the project's effects on wildlife and wildlife habitats, including marine mammals, under the Endangered Species Act. The Department of Defense is also coordinating with the State Historic Preservation Officer for a Programmatic Agreement for the preservation of Guam's cultural resources located within military installations, with particular emphasis on cultural resources located in or near training areas.

RP4. Living Marine Resources

Intent: To protect marine resources in Guam's waters.

Policy: All living resources within the territorial waters of Guam, particularly corals and fish, shall be protected from over harvesting and, in the case of marine mammals, from any taking whatsoever.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. The Navy is currently undertaking coral reef protection/enhancement projects as stewards of federally-owned submerged lands on Guam. In addition, the Navy implements reasonable and prudent measures to minimize impacts of incidental take of green sea turtles and hawksbill turtles during training activities at Sumay Cove as defined in the Biological Opinion and Conference Report for Military Training in the Marianas (Log No. 1-2-98-F-07, 4 January 1999) issued by the U.S. Fish and Wildlife Service (USFWS). The Navy has initiated the Endangered Species Act and Marine Mammal Protection Act compliance processes with the USFWS and the National Marine Fisheries Service (NMFS), respectively. The Navy will obtain the appropriate permits from NMFS and USFWS, and a letter of authorization for activities that take place at sea or in water.

RP5. Visual Quality

Intent: To protect the quality of Guam's natural scenic beauty

Policy: Preservation and enhancement of, and respect for the island's scenic resources shall be encouraged through increased enforcement of and compliance with sign, litter, zoning, subdivision, building and related land-use laws. Visually objectionable uses shall be located to the maximum extent practicable so as not to degrade significant views from scenic overlooks, highways and trails.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. All military training activities will be conducted within the boundaries of federal military installations and will have no impact on the aesthetic quality of Guam's scenic views. Solid waste (litter) generated during training activities, which may impair visual quality, will be collected, consolidated and disposed on military landfills in accordance with base solid waste management plans.

RP6. Recreation Areas

Intent: To encourage environmentally compatible recreational development.

Policy: The Government of Guam shall encourage development of varied types of recreational facilities located and maintained so as to be compatible with the surrounding environment and land uses, adequately serve community centers and urban areas and protect beaches and such passive recreational areas as wildlife and marine conservation areas, scenic overlooks, parks and historical sites.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Recreational areas and facilities on federal military installations will continue to be maintained by the military. For those recreational areas and facilities where the public is allowed access, access may be temporarily curtailed during military training activities and restored upon completion of the training exercises.

RP7. Public Access

Intent: To ensure the right of public access.

Policy: The public's right of unrestricted access shall be ensured to all non-federally owned beach areas and all Territorial recreation areas, parks, scenic overlooks, designated conservation areas and their public lands; and agreements shall be encouraged with the owners of private and federal property for the provision of releasable access to and use of resources of public nature located on such land.

Discussion: The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, which are restricted-access military installations. No non-federally owned beach areas, territorial recreation areas, parks, scenic overlooks, designated conservation areas or other public lands would be affected. For security and safety reasons, public access normally allowed (by permit) within military installations may be temporarily curtailed during military training activities and restored upon completion of the training exercise(s).

RP8. Agricultural Lands

Intent: To stop urban types of development on agricultural land.

Policy: Critical agricultural land shall be preserved and maintained for agricultural use.

Discussion The proposed project, military training activities, would continue to take place either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam. Therefore urban development of agricultural lands would not occur.

This Page Intentionally Left Blank

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0310
18 Mar 09

Dr. John B. Joyner
Director
Coastal Resources Management Office

Dear Dr. Joyner:

SUBJECT: COASTAL ZONE MANAGEMENT ACT (CZMA) NEGATIVE DETERMINATION NOTICE, MARIANA ISLANDS RANGE COMPLEX (MIRC) ENVIRONMENTAL IMPACT STATETEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATETEMENT (EIS/OEIS)

The Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau (DoD Rep) wishes to inform you of its negative determination under the CZMA for the subject proposed action. As detailed in the draft EIS/OEIS separately provided to you, the proposed federal action is to achieve and maintain military readiness using the MIRC to support and conduct current, emerging, and future training and RDT&E activities, while enhancing training resources through investment in the MIRC.

A federal consistency determination for this action is not required because the proposed action occurs on federal property, in waters for which the use is by law subject solely to the discretion of or which is held in trust by the Federal Government, or is not located within the coastal zone of the Commonwealth of the Northern Mariana Islands (CNMI) as defined by the CZMA. The proposed actions would not have reasonably foreseeable direct or indirect effects on any coastal use or resource of the coastal zone of the CNMI. Federally-leased lands of the CNMI include the island of Farallon de Medinilla (FDM), the Military Lease Area (MLA) on the island of Tinian, land at Tanapag Harbor on the island of Saipan, and the waters over federally controlled submerged lands in the CNMI, all of which form parts of the MIRC.

SUBJECT: COASTAL ZONE MANAGEMENT ACT (CZMA) NEGATIVE DETERMINATION NOTICE, MARIANA ISLANDS RANGE COMPLEX (MIRC) ENVIRONMENTAL IMPACT STATETEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATETEMENT (EIS/OEIS)

The lease of these public lands was enacted under the 1976 *Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America*, "made available to the United States by lease to enable it to carry out its defense responsibilities" for an initial period of 50 years with an option to renew the lease for another 50 years. For purposes of evaluating federal consistency of federal activities under the CZMA, these lands have been designated as excluded lands according to the Covenant. In addition, the waters over federally owned submerged lands of the Commonwealth have been designated as excluded lands of the Commonwealth under the CZMA.

A copy of this negative determination is being provided to you under 15 CFR 930.35(3), as the DoD Rep undertook a thorough consistency assessment before arriving at the negative determination. In addition to the draft EIS/OEIS previously submitted, the following is provided to you: 1) detailed description of the proposed project; 2) a description of the project's associated facilities; 3) a description of the combined, cumulative coastal effect of the project; and 4) data and additional information to support the DoD's negative determination.

The Navy welcomes your concurrence with the negative determination. If you have any questions on this matter, please contact Mr. Edward J. Lynch, at (808) 471-1714 or by email at edward.j.lynch.ctr@navy.mil.

Sincerely,

J. P. RIOS
Captain, U.S. Navy
By direction

SUBJECT: COASTAL ZONE MANAGEMENT ACT (CZMA) NEGATIVE DETERMINATION NOTICE, MARIANA ISLANDS RANGE COMPLEX (MIRC) ENVIRONMENTAL IMPACT STATETEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATETEMENT (EIS/OEIS)

Enclosures:
1. Detailed Description of the Proposed Project
2. Description of Associated Project Facilities
3. Description of the Combined, Cumulative Coastal Effect of the Project
4. Additional Information in Support of the DoD's Consistency Determination

Copy to:
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas (EV - Mr. Robert Wescom)

Detailed Description of the Proposed Project

The Military Services propose to implement actions within the Mariana Islands Range Complex (MIRC) to support current, emerging, and future training and research, development, test and evaluation (RDT&E) operations in the MIRC. Lands of the CNMI that are included in the MIRC include the island of Farallon de Medinilla (FDM), the northern two-thirds of the island of Tinian, 144 acres of Tanapag Harbor on Saipan, and non-Department of Defense (DoD) training facilities on Rota. FDM supports live and inert bombing, missile strikes and strafing. Training on Tinian is conducted on two parcels within the Military Lease Area (MLA): the Exclusive Military Use Area (EMUA) and the Leaseback Area (LBA). The MLA supports small unit level through large field exercises and expeditionary warfare operations. Rota provides non-DoD training facilities supporting special warfare training in coordination with local law enforcement on an as requested basis.

Potential actions specific to the CNMI for enhancing training in the MIRC include the following:

- Increased training activities of the types currently being conducted on FDM and Tinian
- Use of inert ordnance at FDM, with a portion of the island to remain available for live-fire
- Installation of Microwave and Data Link Backbone on Tinian
- Use of the commercial port facility at Rota for boat refueling and maintenance associated with forward staging and use of civilian owned properties on a case by case basis for staging Military Operations in Urban Terrain (MOUT) training by Naval Special Warfare (NSW) personnel

Current training operations on FDM, Tinian and Rota are as listed in Table 1.

Table 1

Military Training Activities Conducted at the CNMI		
Farallon de Medinilla	Tinian	Rota
Bombing Exercise (BOMBEX)	Surveillance and Reconnaissance (S&R)	NSW Training
Missile Exercise (MISSILEX)	Field Training Exercises (FTX)	MOUT
Direct Action	Ship to Objective Maneuver (STOM)	
Firing Exercise (FIREX)	Non-Combatant Evacuation Order (NEO)	
Hydrographic Surveys	Assault Support (AS)	
	Direct Action	
	Hydrographic Surveys	
	Combat Search & Rescue (CSAR)	
	Company Level Maneuver	
	Field Carrier Landing Practice (FCLP)	
	Breaching	
	MOUT	
	Amphibious landings	
	Night Vision Goggle (NVG) Training	

Descriptions of the above training events are as follows:

Military Operations in Urban Terrain (MOUT) - MOUT operations encompass advanced offensive close quarter battle techniques used on urban terrain conducted by units trained to a higher level than conventional infantry. Techniques include advanced breaching, selected target engagement, and dynamic assault techniques using organizational equipment and assets. MOUT is primarily an offensive operation, where noncombatants are or may be present.

Surveillance & Reconnaissance (S&R) – S&R are conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, opposition forces (OPFOR) units may be positioned ahead of the assault force and permitted a period of time to conduct S&R and prepare defenses to the assaulting force.

Field Training Exercise (FTX) - An FTX is an exercise where the battalion and its combat and combat service support units deploy to field locations to conduct tactical operations under simulated combat conditions.

Ship to Objective Maneuver (STOM) – STOM is conducted to gain a tactical advantage over the enemy in terms of both time and space. The maneuver is not aimed at the seizure of a beach, but builds upon the foundations of expanding the battlespace.

Non-Combatant Evacuation Order (NEO) - NEO operations are conducted when directed by the Department of State, the Department of Defense, or other appropriate authority whereby noncombatants are evacuated from foreign countries when their lives are endangered by war, civil unrest, or natural disaster to safe havens or to the United States.

Assault Support (AS) – AS Assault Support exercises provide helicopter support for command and control, assault escort, troop lift/logistics, reconnaissance, search and rescue (SAR), medical evacuation (MEDEVAC), reconnaissance team insertion/extract and Helicopter Coordinator (Airborne) (HC(A)) duties. Assault support provides the mobility to focus and sustain combat power at decisive places and times. It provides the capability to take advantage of fleeting battlespace opportunities. There are three levels of assault support: tactical, strategic, and operational.

Direct Action – Direct Action is either covert or overt directed against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. Training operations are small-scale offensive actions including raids; ambushes; standoff attacks by firing from ground, air, or maritime platforms; designate or illuminate targets for precision-guided munitions; support for cover and deception operations; and sabotage inside enemy-held territory. Units involved are typically at the squad or platoon level staged on ships at sea. They arrive in the area of operations by helicopter or small rubber boats across a beach.

Hydrographic Surveys - Hydrographic Reconnaissance is conducted to survey underwater terrain conditions and report findings to provide precise analysis typically in support of amphibious landings and precise ship and small craft movement through cleared routes. Exercises involve the methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and to determine the feasibility of landing an amphibious force on a particular beach. Units periodically survey FDM and Tinian to determine the condition of coral around the islands and to detect the presence of unexploded ordnance.

Combat Search & Rescue (CSAR) - CSAR operations train rescue forces personnel the tasks needed to be performed to affect the recovery of distressed personnel during war or military operations other than war. These operations could include aircraft, surface ships, submarines, ground forces (NSW and Marine Corps), and their associated personnel in the execution of training events.

Direct Fires – Direct Fires are used to train personnel in the use of all small arms weapons for the purpose of defense and security. Direct Fire operations are strictly controlled and regulated by specific individual weapon qualification standards.

Bombing Exercise (BOMBEX) – BOMBEX allows aircrews to train in the delivery of bombs and munitions against ground targets. The weapons commonly used in this training on FDM are inert training munitions (e.g., MK-76, BDU-45, BDU-48, BDU-56 and MK-80-series bombs), and live MK-80-series bombs and precision guided munitions (Laser Guided Bombs [LGBs] or Laser Guided Training Round [LGTRs] or Joint Direct Attack Munitions [JDAMS]). Cluster bombs, fuel-air explosives, and incendiary devices are not authorized on FDM. Depleted uranium rounds are not authorized on FDM. BOMBEX exercises can involve a single aircraft, a flight of two, four, or multiple aircraft. The types of aircraft that frequent FDM are attack and fighter aircraft from all services and allied forces when conducting joint combined training exercises. (e.g.FA-18, B-1B, B-2, B-52, JDF F2 and H-60). FDM is an uncontrolled and un-instrumented, laser certified range with fixed targets, which includes CONEX boxes in various configurations within the live-fire zones, and high fidelity anti aircraft missile, armor and gun shape targets within the inert only zone.

Missile Firing Exercises (MISSILEX) - Air-to-ground MISSILEX trains aircraft crews in the use of air-to-ground missiles. On FDM it is conducted mainly by H-60 aircraft using Hellfire missiles and occasionally by fixed wing aircraft using Maverick missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire the target, and launch the missile. The missile is launched in forward flight or at hover at an altitude of 300 feet above ground level.

Firing Exercise (FIREX) - FIREX on FDM consists of the shore bombardment of an impact area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed. On FDM, spotting may be conducted from the special use 'no fire' zone or provided from a helicopter platform.

Obstacles/Breaching - Breaching operations train personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This enables a force to maintain its mobility by removing or reducing natural and man-made obstacles.

Field Carrier Landing Practice (FCLP) – An FCLP is an exercise where a Navy or Marine Corps pilot practices landings and take-offs from a simulated carrier landing deck which are observed by a landing signal officer who grades or critiques each landing. Airspeed, altitude and power are all precisely choreographed to simulate landing conditions on an aircraft carrier.

Amphibious Landings – Amphibious landings get troops and equipment from ship to shore for subsequent inland maneuvers. Tracked amphibious vehicles and large landing craft are used to deliver troops and equipment from ships. Amphibious attack vehicles cross landing beaches without delay and function as armored personnel carriers during inland maneuvers. Landing craft transport wheeled vehicles, equipment and personnel. Small inflatable boats may also be used to land on beaches to be close enough to deliver swimmers to beaches normally under cover of darkness.

Night Vision Goggle (NVG) Training – NVG training involves using NVGs while flying multiple circular or oblong patterns in the vicinity of a designated airfield to practice landing in a remote airfield with little or no ambient light.

Description of Project Associated Facilities

There are no new permanent project associated facilities proposed in conjunction with continuing military training activities in the CNMI. Runways, roadways, bivouac areas and structures already in place will continue to be used. Only temporary equipment appropriate to a specific training activity will be staged and removed at the conclusion of the training activity.

Description of the Combined, Cumulative Coastal Effect of the Project

FDM

FDM is an uninhabited and undeveloped island on lease to the Federal government and excluded from the CNMI's coastal zone per the Covenant. FDM will continue to be used as an inert and live bombing range. Access to the island, including a 3 mile radius of ocean around the island, is restricted to military personnel only. To provide for public safety a 10 NM access restriction has been proposed to assure safety during certain training events. To limit impacts on FDM, cluster bombs, fuel air explosives, incendiaries, and ordnance greater than 2,000 lbs are not allowed to be used on FDM. Combined, cumulative coastal effects from military training operations involving the intermittent use of FDM as a bombing range are as follows:

Air quality – Minor particulate emissions intermittently generated from the impact of ordnance on the land mass of FDM will continue. Particulate emissions will either be deposited on land or blown away by trade winds and dispersed over the surrounding ocean.

Waste Discharges – Metal debris, inert material from inert ordnance , ordnance residues or munitions constituents, and pyrotechnique residues will be deposited on FDM from bombing practice. Minor amounts of ordnance and pyrotechnique residues result from these materials not being consumed in the detonation and ensuing explosion.

Water Discharges – There are no wastewater discharges associated with training activities involving FDM. Small amounts of ordnance and pyrotechnique residues deposited on FDM may be carried out to the ocean by percolating surface waters from precipitation, however, these residues have low solubility in saltwater and will eventually be dispersed over the vast ocean.

Natural Resources – FDM is sparsely vegetated, except in the interior flat areas where there are dense herbaceous communities. This vegetation supports a small population of the endangered Micronesian megapode, especially on the northern part of the island. In 1999, 10 megapodes were identified on the island. Recent surveys (December 2007) conducted by the Navy identified 21 pairs of megapodes. Mitigation measures specified in previous consultations with the US Fish and Wildlife Service (USFWS) for military training, coupled with restricted access preventing poaching activities, may have benefited megapodes on FDM. Mitigation measures include a no-fire zone on the northern portion of the island. In conjunction with the proposed project, the Navy is in consultation with the USFWS for effects on potentially affected threatened and endangered species within the project area.

Tinian

The northern two-thirds of Tinian is also leased to the Federal government and excluded from the CNMI's coastal zone per the Covenant. The area is designated the Military Lease Area (MLA), which is divided into the Exclusive Military Use Area (EMUA) and the Leaseback Area (LBA). Existing and proposed military activities described in the project description are limited to the EMUA. Combined, cumulative coastal effects from military training activities within the EMUA are as follows:

Air Quality – Vehicular emissions will be generated from ships, small water craft, and aircraft transiting to and from Tinian during military training activities and from trucks and light-wheeled vehicles while operating within the EMUA. Emissions will be intermittent and short-term, resulting in no significant impact to the air quality of Tinian.

Waste Discharges – Military activities on Tinian will generate domestic waste (trash) which will be collected and consolidated for disposal on Guam. Other potential wastes include unintentional spills of petroleum, oils and lubricants (POL) and expended training materials. To preclude spills of POL and hazardous materials from occurring, all fuel bladders and hazardous material containers brought to Tinian will be staged on existing pavement within berms with impervious liners or secondary containment. Expended training materials (brass, clips and lead) will be collected for handling on Guam.

Water Discharges – Water discharges will be limited to gray water, which will be contained in soakage trenches and pits fitted with grease traps. Aircraft washdowns will not be conducted on Tinian. Oily waste and bilge water will be disposed on facilities available at Guam or Saipan.

Natural Resources – Potential impacts to natural resources on Tinian from military training activities are listed as follows, with the corresponding avoidance measures that are currently being implemented.

Potential Natural Resource Impact	Avoidance Measure
Coral head breakage when operating landing craft air cushion (LCAC) at landing beaches	Land at high tide, one craft at a time. Remain on cushion when over shallow reef
Damage to sea turtle nests	Survey beach area within 6 hours of landing and flag potential turtle nests for avoidance. Restore beach topography after the exercise by smoothing deep ruts
Disturbance and/or harm to T&E species and habitat from offroad vehicles, noise, vegetation clearing, fire-causing activities.	Designation of No Training (NT), No Wildlife Disturbance (NWD) areas. Prohibit vehicular cross-country, off-road travel. Prohibit vegetation clearing in bivouac areas. Implement a fire prevention plan and have available fire fighting equipment and materials.

In addition, the potential for the introduction of BTS to Tinian from Navy boats, military aircraft, and equipment exists. To preclude the introduction of BTS to the island, the Services will continue its practice of thoroughly inspecting boats, aircraft, vehicles, cargo and personnel before deployment to Tinian.

Cultural Resources - Potential impacts to cultural resources on Tinian from military training activities are listed as follows, with the corresponding avoidance measures that are currently being implemented.

Potential Cultural Resource Impact	Avoidance Measure
Vandalism and/or removal of cultural resources	Designation of No Cultural Resource Disturbance (NCRD) areas. Briefing troops on cultural resources prior to training. Notify highest ranking officer when cultural resources are uncovered where digging is allowed
Disturbance or damage to cultural resources present in beach areas during LCAC and other vehicle operations	Designation of NCRD areas within beach areas. Vehicles to stay within roadways and designated ingress and egress areas.

<u>Saipan</u>

Only land navigation training exercises are conducted on Saipan by the Army Reserve on non-DoD property on the northern east side of Saipan. The Army Reserve Center at Garapan does not support field maneuvers. There are no impacts to the CNMI coastal zone resources from land navigation training.

<u>Rota</u>

Naval Special Warfare (NSW) training activities occur on non-DoD lands on Rota on a very limited basis. By special permission from the Mayor of Rota, the Navy uses Angyuta Island near SongSong's West Harbor as a Forward Staging Base/Bivouac Area and conducts boat refueling and maintenance at the commercial harbor. The Navy also conducts MOUT training with local law enforcement on non-DoD land.

Air Quality – Emissions will be generated from small water craft transiting to and from Rota during military training activities. Emissions will be intermittent and short-term, resulting in no significant impact to the air quality of Rota.

Waste Discharges – Navy training on Rota will generate domestic waste (trash) which will be collected and consolidated for disposal on Guam. Other potential wastes include unintentional spills of petroleum, oils and lubricants (POL) and expended training materials. To preclude spills of POL and hazardous materials from occurring, all fuel bladders and hazardous material containers brought to Rota will be staged on existing pavement within berms with impervious liners or secondary containment. Expended training materials (brass, clips and lead) will be collected for handling on Guam.

Water Discharges – Water discharges will be limited to gray water, which will be contained in soakage trenches and pits fitted with grease traps.

Natural Resources –The potential for the introduction of BTS to Rota from Navy boats and equipment exists. To preclude the introduction of BTS to the island, the Navy will continue its practice of thoroughly inspecting watercraft, cargo and personnel before deployment to Rota.

Additional Information in Support of the DoD's Negative Determination

1998 Biological Opinion/Conference Report of the U.S. Fish and Wildlife Service for Programmatic Aerial Bombardment, Naval Gunfire and Small Arms Gunfire at Farallon de Medinilla, Commonwealth of the Marianas Islands

1999 Biological Opinion and Conference Report (Log Number 1-2-98-1-07), Military Training in the Marianas

1999 Programmatic Agreement Among the Commander in Chief, U.S. Pacific Command Representative Guam and the Commonwealth of the Northern Mariana Islands (USCINCPAC REP GUAM/CNMI), the Advisory Council on Historic Preservation, and the CNMI Historic Preservation Officer Regarding Implementation of Military Training on Tinian

COMNAVMARIANASINST 5440.1D. Instructions to Military Commanders of Tinian Deployed Units. 18 November 1996.

COMNAVMARIANASINST 3500.3M. Fleet Operating Areas and Training Facilities – Marianas Area. 18 August 1998.

COMNAVMARIANASINST 5090.10A. Brown Tree Snake Control and Interdiction Plan. 14 February 2005.

COMNAVMARIANASINST 3502.1. Standard Operating Procedures and Regulations for Restricted Area 7201 and Farallon de Medinilla (FDM) Laser Bombing Range. 25 April 2005.

Appendix D-23
Biological Opinion/Conference Report of the U.S. Fish and Wildlife Service for Programmatic Aerial Bombardment, Naval Gunfire, and Small Arms Gunfire at Farallon de Medinilla, Commonweath of the Northern Mariana Islands

BIOLOGICAL OPINION/CONFERENCE REPORT
of the
U.S. FISH AND WILDLIFE SERVICE
for
PROGRAMMATIC AERIAL BOMBARDMENT, NAVAL GUNFIRE, AND SMALL ARMS GUNFIRE
AT FARALLON DE MEDINILLA,
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

U.S. FISH & WILDLIFE SERVICE

April 6, 1998

TABLE OF CONTENTS

LIST OF FIGURES

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS ECOREGION
300 ALA MOANA BOULEVARD, ROOM 3108
BOX 50088
HONOLULU, HAWAII 96850
PHONE: (808) 541-3441 FAX: (808) 541-3470

In Reply Refer To: mrl 1-2-98-F-03 APR 6 1998

Melvin N. Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division
Naval Facilities Engineering Command
Pearl Harbor, HI 96860-7300

RE: Biological Opinion and Conference Report (Log Number 1-2-98-F-03), Farallon de Medinilla (FDM), Commonwealth of the Northern Mariana Islands (CNMI).

Dear Mr. Kaku:

This represents the biological opinion and conference report of the U.S. Fish and Wildlife Service (Service) in accordance with section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544; Stat. 884), as amended, (Act) regarding potential impacts to the federally endangered Micronesian megapode, *Megapodius laperouse laperouse*, and the proposed threatened Mariana fruit bat, *Pteropus mariannus mariannus*, from proposed programmatic aerial bombardment, naval gunfire, and small arms gunfire. The Department of the Navy (Navy), as the range manager, proposes to use FDM for aerial bombardment, naval gunfire, and small arms gunfire for the next three years (May 1, 1998 to May 1, 2001). In the event that the Mariana fruit bat is listed, the Navy may request that the Service adopt this conference report as a biological opinion under section 7 of the Act, provided that the reinitiation criteria at 50 CFR 402.16 do not apply.

This biological opinion and conference report is based upon 1) the Navy's December 12, 1997, letter requesting formal consultation, 2) information provided in the Service's *Draft Recovery Plan for the Micronesian Megapode* (USFWS 1997), 3) *Endangered and Threatened Wildlife and Plants; Proposed Reclassification From Endangered to Threatened Status for the Mariana Fruit Bat From Guam, and Proposed Threatened Status for the Mariana Fruit Bat From the Commonwealth of the Northern Mariana Islands* (63 FR 14641), 4) the *Draft Recovery Plan for U.S. Pacific Populations of the Green Turtle* and in the *Draft Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle*, 5) the Service's *Status and Distribution of Marine Turtles on the Island of Tinian, Commonwealth of the Northern Mariana Islands - 1994 & 1995*, 6) literature published on megapodes, fruit bats, green sea turtles, and hawksbill sea turtles, 7) a site visit to FDM on November, 4, 1996, 8) a January 8, 1997, memorandum from Tim Sutterfield (Navy) summarizing the results of a site visit on December 16-17, 1996, 9) a March 24, 1997, memorandum from Tim Sutterfield assessing impacts to the fauna of FDM as a result of the training activities covered in the Service's January 29, 1997, biological opinion, 10) a July 8-10, 1997, marine resources survey of FDM, 11) an August 21, 1997, memorandum from Melvin Kaku assessing impacts to the fauna of FDM as a result of the training activities covered in the Service's May 16, 1997, biological opinion, 12) a December 1, 1997, memorandum from Melvin Kaku assessing impacts to the fauna of FDM as a result of the training activities covered in the Service's September 11, 1997, biological opinion, 13) personal communication with Tim Sutterfield assessing impacts to megapodes as a result of training activities on FDM outlined in a January 12, 1998, letter to the Service, and 14) a March 20, 1998, memorandum from Melvin Kaku assessing impacts to the fauna of FDM as a result of the training activities carried out at FDM on February 23, 1998.

The log number for this consultation and conference is 1-2-98-F-03. A complete administrative record of this consultation is on file in the Service's Pacific Islands Office in Honolulu, Hawaii.

Consultation History

Farallon de Medinilla has been used as a bombardment range by the Navy and Air Force since at least 1971. An Environmental Assessment was completed for the use of FDM as a bombardment range by the Navy in 1975. The Navy initiated formal consultation with the Service for naval and aerial bombardment of FDM on December 6, 1996, and April 4, 1997, for ship to shore gunnery practice on August 27, 1997, and aerial bombardment and small arms gunfire on December 12, 1997. The Service completed biological opinions for these actions on January 29, 1997, May 16, 1997, September 11, 1997, and December 30, 1997, respectively. In the January 29, 1997, biological opinion the Service authorized incidental take of ten adult or juvenile megapodes, four active megapode nests, one green sea turtle, one hawksbill sea turtle, and four active turtle nests. In the May 16, 1997, biological opinion, the Service determined that take of megapodes was indeterminate and anticipated the loss of all adult and juvenile megapodes and their nests. The sea turtle take remained the same. Both the September 11, 1997, and December 30, 1997 biological opinions concluded that the authorized take in the May 16, 1997, biological opinion had been met and anticipated the loss of any remaining or newly arrived adult and juvenile megapodes and their nests. Neither the September 11, 1997, nor the December 30, 1997, biological opinions authorized take for sea turtles because it was determined during a July 8-10, 1997, marine resources survey conducted by the Navy, the Service, and the National Marine Fisheries Service (NMFS), that the beaches on FDM were unsuitable for sea turtle nesting (Naughton 1997). In all four biological opinions the Service determined that the level of take was not likely to jeopardize the continued existence of the Micronesian megapode and in the January 29, 1997, and May 16, 1997, biological opinions the Service determined that the level of take was not likely to jeopardize the continued existence of the green sea turtle or hawksbill sea turtle. This conference report represents the first consultation of the Navy with the Service in regards to the proposed threatened Mariana fruit bat. The Mariana fruit bat was proposed as threatened within the CNMI on March 26, 1998 (63 CFR 14641).

Beginning with the first FDM training consultation initiated by the Navy on December 6, 1996, the Service has requested that the Navy initiate a programmatic consultation to cover all routine and continuing training activities on FDM. The Service believed that completion of a

programmatic consultation would alleviate the burden of addressing individual training exercises that are similar in nature. This consultation represents the fulfillment of the Service's request. The Navy initiated programmatic section 7 consultation in a letter received on December 12, 1997.

BIOLOGICAL OPINION/CONFERENCE REPORT

Description of the Proposed Action

The Navy proposes to engage in periodic strategic and tactical bombing, naval gunfire, and small boat gunfire over the next three years on FDM, CNMI. Approximate training tempo and ordnance delivered would consist of:

a. Strategic bombing: U.S. Air Force bombers may fly to FDM up to 160 days per year, with up to 2 range sorties per day (320 range sorties). A total of 5 to 612 live and/or inert ordnance may be dropped per month, with lower numbers being more typical.

b. Close air support bombing: Fighter/attack aircraft may drop a maximum of 80 air-to-surface missiles, 840 air-to-surface rockets (400 2.75-inch, 400 5-inch, and 40 AT-4s), and 4,020 conventional high explosive and inert bombs, of which 1,400 would be small (250 to 500 pounds), and 1,240 would be large (1,000 to 2,000 pounds). This ordnance would be delivered over the course of three, three-week U.S. Marine Corps exercises per year, four, five-day exercises in support of aircraft carriers per year, and five annual seven to fourteen day combined forces exercises.

c. Naval gunfire: Naval guns may fire approximately 1,040 5-inch shells and 400 76-millimeter (mm) shells per year. The exercises would probably occur monthly, with each lasting several days.

d. Small arms fire from raider boats: small groups may fire 7.62-mm and .50 caliber sniper rifles (about 50,000 and 600 rounds per year, respectively) as well as 40-mm grenade launchers (2,600 rounds per year) at the cliffs and, indirectly, to the top surface of the island. These exercises would occur approximately four times per year and last one day each.

It is possible that aerial bombardment, naval gunfire, and small arms gunfire will occur at night. Exercises described above will use small caliber arms and will deploy bomb tonnage similar to those exercises covered under the four previous consultations.

As part of the *Conservation Recommendations* in the January 29, 1997, biological opinion, the Service recommended that the Navy consider funding megapode conservation and recovery projects in the Mariana islands. The Navy has agreed to program funding for this project, up to $100,000 per year for three years. Their participation in this program is now included as part of the project description for the programmatic consultation.

Biology and Population Status of the Species

Although the Micronesian megapode and Mariana fruit bat are the only known listed and proposed species to occur on FDM, there are several other rare or sensitive species that have been recorded on FDM. FDM supports colonies of breeding seabirds, including masked boobies (*Sula dactylatra*), brown boobies (*Sula leucogaster*), red-footed boobies (*Sula sula*), great frigatebirds (*Fregata minor*), common noddies (*Anous stolidus*), black noddies (*Anous minutus*), and white terns (*Gygis alba*). FDM is particularly important for great frigatebirds as it is one of only two small breeding colonies known to exist in the Mariana Island chain (Stinson 1994) and for masked boobies because it represents the largest known nesting site for this species in the Mariana Islands (Reichel 1991). FDM also provides habitat for migratory shorebirds, including bristle-thighed curlews (*Numenius tahitiensis*), whimbrels (*Numenius phaeopus*), ruddy turnstones (*Arenaria interpres*), and lesser golden-plovers (*Pluvialis dominica*) (Lusk and Kessler 1996). All of these seabirds and migratory shorebirds are protected under the Migratory Bird Treaty Act of 1918 [16 U.S.C. 703-712; 40 Stat. 755], as amended.

FDM is not known to have any endangered or threatened plants, and only two plant species that might be considered rare or uncommon have been recorded there. Seaside cotton (*Gossypium hirustum* var. *taitense*) has a patchy distribution throughout the Pacific and bunch grass (*Digitaria gaudichaudii*) has only been recorded approximately twice before in the Marianas (Whistler 1996). No true wetlands are known to occur on the island (Whistler 1996).

Although the beaches on FDM are too small and overwashed to provide sea turtle nesting habitat, sea turtles are known to occur in the waters surrounding FDM (Naughton 1997). Marine mammals are also likely to occur in the waters surrounding FDM (Michael Molina, U.S. Fish and Wildlife Service, personal communication 1998). Both of these species will be covered by the National Marine Fisheries Service in a separate programmatic consultation with the Navy.

a) Micronesian Megapode

The Micronesian megapode is the only species addressed in this biological opinion that is currently listed. The Micronesian megapode was listed as endangered on June 2, 1970 (35 FR 8491). This species formerly occurred on all of the islands in the Marianas archipelago (Figure 1) but was extirpated from Guam, Rota, and Saipan in the 19th and early 20th centuries. Currently, it is found on 12 islands with population estimates as follow: 10-15 megapodes on the island of Aguiguan, less than 10 on Tinian, 10-25 on Saipan, less than 10 on FDM, 200-300 on Anatahan, 545-810 on Sarigan, 500 on Guguan, less than 30 on Alamagan, 50-100 on Pagan, less than 25 on Asuncion, 50-150 on Maug, and an unknown number on Agrihan. Recent estimates yield a total of about 1,440 to 1,975 birds (USFWS 1997) for the entire archipelago.

The Micronesian megapode is a small, pigeon-sized bird in the family Megapodiidae, a family comprised of seven genera found only in the Australasian region. Members of this family are known as "incubator birds" because of their reliance on external heat sources, such as solar energy, volcanic activity, or microbial decay, to incubate their eggs (Clark 1964). Micronesian megapodes apparently use both burrow nesting and mound building in egg incubation (USFWS

1997), are believed to be monogamous, and may defend a territory of approximately one hectare (ha) on a year-round basis (Glass and Aldan 1988). Exact nesting seasons for this subspecies are not known; however, nesting probably occurs year-round on some of the Mariana Islands and seasonally on others, depending upon the heat sources used for incubation (USFWS 1997). These birds are omnivorous and have been observed to feed on seeds, beetles, ants, other insects, and plant matter (Glass and Aldan 1988, Stinson 1993).

Historical extirpations of Micronesian megapodes on Guam, Rota, Tinian, and Saipan were likely due to overexploitation by humans and habitat losses associated with agricultural practices and introduced ungulates. Loss of habitat through the effects of vulcanism is also known to have caused serious declines. Loss of habitat due to development projects and predation by introduced monitor lizards, feral dogs, cats, rats, and pigs are known current threats to this subspecies. Perhaps the most serious potential threat, however, is the possible establishment of the brown tree snake (*Boiga irregularis*) on islands other than Guam in the Marianas archipelago.

b) Mariana Fruit Bat

The Mariana fruit bat was proposed as threatened throughout the Marianas archipelago on March 26, 1998 (63 FR 14641). Should this listing action go final, the fruit bats on Guam, which are currently listed as endangered (49 FR 33881) will be downlisted to threatened and all other fruit bats in the Marianas archipelago will be protected as threatened species. Although the status of the Mariana fruit bat prior to the 20th century is unknown, it likely occurred throughout the Mariana Islands and was probably common on the larger southern islands in the archipelago. Currently, there are estimated to be between 200 and 750 animals on Guam (Wiles 1996, Wiles et al. 1995), 25 to 125 animals on each of the islands of Aguijan, Saipan, and Tinian (Lemke 1984, Wiles 1996, Worthington and Taisacan 1996, Marshall et al. 1995), 1,000 on Rota (Worthington and Taisacan 1996), and a minimum of 7,450 bats on the smaller islands north of Saipan (Anonymous 1984, Wiles et al. 1989). Bats may be uncommon on some of the smaller islands such as Maug, Uracus, and FDM, but are known to occur on all of them (USFWS 1998). Based on these figures, the total population for the Mariana Islands is estimated to be at least 8,725 animals, although this figure is based on very rough estimates from the northern Mariana Islands. Evidence indicates that bats move regularly between the larger southern islands and at least annually between the more remote northern islands (Wiles and Glass 1990, Worthington and Taisacan 1996, Wiles et al. 1989, G. Wiles, pers. comm. 1997). For the purposes of conservation, individual island subpopulations of fruit bats in the Mariana islands should be considered and managed as one contiguous population (Lemke 1986, USFWS 1990, Wiles and Glass 1990, Worthington and Taisacan 1996).

The Mariana fruit bat is a medium-sized fruit bat in the family Pteropididae weighing 0.66 to 1.15 pounds (330 to 577 grams) and has a forearm length ranging from 5.3 to 6.1 in (13.4 to 15.6 cm); males are slightly larger than females (USFWS 1998). The rounded ears and large eyes give a canine-like appearance, giving rise to the nickname "flying foxes." The Mariana fruit bat is highly colonial, forming colonies of a few to over 800 animals (Pierson and Rainey 1992, Wiles 1987a, Worthington and Taisacan 1995). The bats group themselves into harems (one male and two to 15 females) or bachelor groups (predominately males); or reside as single males on the edge of the colony (Wiles 1987a). Reproduction is believed to occur throughout the year on Guam, with no apparent peak in births (Wiles 1987a). Female bats of this family generally have one young per year, resulting in a slow recovery rate when populations are reduced in numbers (Pierson and Rainey 1992). Mariana fruit bats forage and roost primarily in native forest, and occasionally in coconut groves and strand vegetation (Wiles 1987b, Worthington and Taisacan 1996). At least 22 plant species are used as food sources by the Mariana fruit bat, including fruits of 17 species of plants, the flowers of seven, and leaf stems and twig tips of Artocarpus spp. (USFWS 1990, Wiles 1987a).

Fruit bat populations on Guam have been reduced possibly due to the introduction of firearms (Coultas 1931) and the brown tree snake (Wiles 1996, Wiles et al. 1995). Loss of habitat through the effects of typhoons, development projects, and the introduction of feral rats, pigs, and goats has also contributed to the decline of this species throughout the Marianas (Kessler 1997, Marshall et al. 1995, USFWS 1998). Throughout both the inhabited southern and uninhabited northern islands, poaching continues to be one of the most important factors in the decline of the Mariana fruit bat (Glass and Taisacan 1988, Lemke 1992b, Marshall et al.1995, USFWS 1990, Worthington and Taisacan 1996, UFWS 1998).

Environmental Baseline

The environmental baseline describes the status of the species and factors affecting the environment of the species or critical habitat in the proposed action area contemporaneous with the consultation in process. The baseline includes State, local, and private actions that affect a species at the time the consultation begins. Unrelated Federal actions that have already undergone formal or informal consultation are also a part of the environmental baseline. Federal actions within the action area that may benefit listed species or critical habitat are also included in the environmental baseline.

a) Micronesian Megapode

A total of four megapodes were discovered on FDM during a site visit on November 4, 1996 (Lusk and Kessler 1996). Two megapodes were found on the island during a Navy site visit on December 17, 1996 (Figure 2) (Sutterfield *in lit.* 1997). The size of the island, 0.7 km², led the Service to estimate that at the time of the 1996 site visit there were likely no more than ten megapodes on the island. This number represents less than 1.0% of the total estimated population within the Marianas archipelago. Aerial and naval bombardment of the island since the 1996 site visit has likely decreased the numbers of megapodes on the island, but exact loss of megapodes is indeterminate due to inability to visit the island. Megapodes may have emigrated to FDM since 1996, or reproduction on the island may have occurred since then, but recruitment levels through either of these avenues has not been determined. In regards to immigration, the nearest island to FDM with a substantial megapode population, Anatahan, is approximately 50 miles away. No nesting has been recorded on FDM, but the possibility does exist.

b) Mariana Fruit Bat

Two fruit bats were observed roosting in low shrubs on FDM by Tim Sutterfield, Fish and Wildlife Biologist for the Navy, during a site visit in December 1996 (Sutterfield *in lit.* 1997). These two bats probably do not represent a permanent roosting or breeding colony. Although some of the vegetation on the island may provide forage for bats, the low, shrubby nature of the vegetation makes it unlikely that bats utilize FDM for more than a temporary roosting site during travel between larger islands. No roosting or flying bats have been reported from FDM during other site visits or during pre- or post-training helicopter surveys, as would be expected if large numbers of bats were utilizing FDM on a regular basis. The two bats observed on FDM represent a minute fraction of the total population for the Mariana islands.

The Navy has conducted bombing exercises on FDM regularly over the past 20 years and intends to continue to do so in the future. Such exercises occurred in January, May, and September 1997 (SOCEX exercises scheduled for January/February 1998 were canceled). Before and after the January 1997, and May 1997, exercises, Tim Sutterfield conducted helicopter surveys in accordance with the Terms and Conditions of the January 29, 1997, and May 16, 1997, biological opinions. A helicopter survey was conducted by a Navy Fish and Wildlife Biologist before the September exercise in accordance with the September 11, 1997, biological opinion, and a fixed-wing aircraft survey was conducted by a Navy biologist after the exercise. None of the surveys revealed any direct evidence of death or injury to megapodes or fruit bats. However, observations of megapodes on FDM indicate that they are likely to remain underneath brushy cover and, therefore, deaths or injury from either direct strikes or indirectly from shrapnel would be difficult to detect from aerial surveys. Death or injury to fruit bats would be equally difficult to ascertain from aerial surveys for similar reasons. On-the-ground surveys are not permitted by the Navy due to the high incidence of unexploded ordnance distributed over the island.

Effects of the Action

The primary concerns of the Service with regard to the effects of aerial bombardment and small arms gunfire practice on the Micronesian megapode and Mariana fruit bat are (1) direct death of megapodes and fruit bats, (2) destruction or abandonment of active megapode nests, (3) abandonment of juvenile fruit bats by mothers, and (4) destruction of required foraging, roosting, and/or nesting habitat. The potential for all of these effects was apparent when on August 2, 1997, the Navy conducted post-bombardment surveys of FDM in accordance with the terms and conditions set forth in the Service's May 16, 1997, biological opinion. As detailed in the Navy's August 21, 1997, memorandum, 25 to 50 new bomb craters were observed and a large section of the central northern portion of the island, an area believed to represent megapode habitat, was "burned to bare earth" (Kaku *in lit.* 1997). The Service believes the August 2, 1997, survey to be representative of the type of damage that can occur during aerial bombardment, naval gunfire, and/or from small arms fire such as grenade launchers or anti-tank rockets. Although fruit bats are strong fliers and likely to abandon the island once bombardment begins, there still exists the strong possibility of death or injury to roosting bats from training activities.

The impact areas for aerial bombardment, naval gunfire, and small arms gunfire cover the entire area of FDM. Therefore the Service anticipates the possible direct death of any remaining megapodes and destruction of their nests, and the death of any fruit bats occurring on the island during the next three years of training.

Cumulative Effects

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The Service has not identified any cumulative effects in the project area that may impact Micronesian megapodes or Mariana fruit bats.

Conclusion

After reviewing the current status of the Micronesian megapode and Mariana fruit bat, the environmental baseline of these species in the action area, and the effects of the proposed action, including cumulative effects, it is the Service's biological opinion that aerial bombardment, naval gunfire, and small arms gunfire over the next three years is not likely to jeopardize the continued existence of the Micronesian megapode or Mariana fruit bat. No critical habitat has been designated for these species; therefore, none will be affected.

INCIDENTAL TAKE

Sections 4(d) and 9 of the Act, as amended, prohibit the taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct) of a listed species of fish and wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in the death or injury to listed species by significantly impairing behavioral patterns, such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement. The measures described below are non-discretionary and must be implemented by the Navy in order for the exemption in section 7(o)(2) to apply.

The Navy has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Navy fails to adhere to the terms and conditions of the incidental take statement the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service believes that the last two military exercises, which occurred from July 21 to August 1, 1997, and from September 12 to 13, 1997, may have resulted in the taking of all the megapodes that occurred on FDM at the time of the bombing and gunnery practice. Such taking

likely took the form of direct death or injury, harm and harassment. We, therefore, believe that the level of incidental take authorized in biological opinion #1-2-97-F-05 and biological opinion #1-2-97-F-08 has likely been met. The military exercise covered under the December 30, 1997, biological opinion (#1-2-98-F-02) was not conducted. We anticipate that any megapodes still present on FDM, or that may colonize the island prior to the onset of any of the military exercises covered under this biological opinion over the next three years, may also be incidentally taken. We also anticipate that any bats present on the island at the time of commencement of military activities covered under this conference report over the next three years may also be incidentally taken. However, because the inability to conduct on-the-ground surveys precludes exact analysis, the Service authorizes take for both megapodes and bats at an indeterminate level.

Effect of the Take

The Service has determined that this level of impact is not likely to result in jeopardy to the Micronesian megapode or Mariana fruit bat because, even if all of the megapodes and/or bats are extirpated from FDM, such losses do not represent a threat to the stability of the overall populations of the species in the Marianas archipelago.

Reasonable and Prudent Measure

The reasonable and prudent measure, with its implementing terms and conditions, is designed to minimize the impacts of the incidental take that might otherwise result from the proposed action. With implementation of this measure, the Service believes that take of Micronesian megapodes and Mariana fruit bats will be minimized.

The Navy will minimize take of adult and juvenile megapodes and fruit bats, and minimize disruption to breeding activities (including destruction of any active megapode nests) during project implementation.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, it is mandatory that the Navy comply with the following term and condition, which implements the reasonable and prudent measure described above:

(1) The Navy shall restrict their impact zone to the central interior portion and/or southern tip of the island and western cliff faces, to the extent possible.

(2) The Navy shall prohibit the use of cluster bombs in training on FDM.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

Loss of even small numbers of megapodes and their nests or fruit bats slows the recovery of these species and represents an adverse effect. Further, destruction of nesting, foraging, and/or roosting habitat for megapodes and fruit bats by shell impacts or by resulting fires may not represent a permanent loss, but it does slow the recovery process of these species by requiring time for the habitat to recover suitably and therefore, represents an adverse effect. In order to minimize the effect of these losses of individuals and habitat, the Service recommends that the Navy fund conservation and recovery projects for the megapode and fruit bats in the Marianas. Examples of conservation and recovery projects that should be considered for funding by the Navy include: (1) efforts to eradicate feral ungulates on uninhabited northern islands, (2) surveys to assess status, distribution, and nesting/roosting areas of megapodes and fruit bats, (3) basic research into the life history and demography of the megapode and/or fruit bat, and (4) rat (*Rattus* spp.) eradication on uninhabited northern islands.

In addition, the Service recommends that the Navy monitor the effects of their training activities on megapode and fruit bat habitat and the direct take of megapodes and fruit bats whenever possible. To monitor changes in megapode and fruit bat habitat, the Navy should monitor the extent of vegetation change on FDM by conducting helicopter overflight surveys of FDM with two qualified biologists at least twice a year during each of the three years covered by this biological opinion. One of the biologists on the flight should be a biologist familiar with megapode and/or fruit bat foraging, breeding, and roosting habitat. To assess the direct take of megapodes and fruit bats, if the Navy can ever safely conduct an on the ground reconnaissance mission of any type on FDM, the Navy should allow at least one biologist familiar with megapode and/or fruit bat biology to accompany the Navy reconnaissance team on the ground.

In order to minimize and avoid impacts to nesting and roosting seabirds colonies on FDM, the Service recommends that the Navy concentrate impacts on the southern portion, or within the central interior portion of the island. The Navy should also consider establishing a long-term monitoring program to evaluate the effects of aerial bombardment, naval gunnery, and small arms gunfire on seabird populations.

In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

This concludes formal section 7 consultation on this action. As provided in 50 CFR 402.16, reinitiation of formal consultation is required if (1) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered

in this opinion, (2) the agency action is subsequently modified in a manner that causes an adverse effect to the listed species or critical habitat that was not considered in this opinion, or (3) a new species is listed or critical habitat designated that may be affected by this action.

If you have questions concerning any of the information contained in this biological opinion, please contact Interagency Program Leader Margo Stahl or Wildlife Biologist Michael Lusk (phone: 808/541-3441, fax: 808/541-3470, e-mail: Michael_Lusk@mail.fws.gov).

Sincerely,

Brooks Harper

Brooks Harper
Field Supervisor
Ecological Services

cc: CNMI, DFW, Saipan
NMFS, Honolulu
USFWS, Region I, Larry Salata

REFERENCES CITED

Anonymous. 1984. Oxford University expedition to the Mariana Islands. Bulletin of Oxford University Exploration Club 7:73-84.

Clark, G. A. 1964. Life histories and the evolution of megapodes. Living Bird 3:149-167.

Coultas, W. F. 1931. Whitney south sea expedition journals, Vol. W. Journal and letters, Vol. II, of William F. Coultas, November 1930 to December 1931. American Museum of Natural History, New York. Unpublished. 290 pp.

Glass, P. O. and D. T. Aldan. 1988. Micronesian megapode surveys and research. Pp. 131-153, In Division of Fish and Wildlife Progress Report: 1982-1987. CNMI Division of Fish and Wildlife, Saipan.

Glass, P. and E. M. Taisacan. 1988. Marianas fruit bat surveys and research. In: Five Year Progress Report, Fiscal Year 1982-87. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands, pp. 1-22.

Kessler, C. 1997. Feral animal monitoring and management. In: Annual Progress Report, Fiscal Year 1996. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands, pp. 8-14.

Lemke, T. O. 1984. Marianas fruit bat surveys and inventories. In: Annual Report, Fiscal Year 1984. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands, pp. 3-16.

Lemke, T.O. 1986. Petition to list the Marianas Fruit bat (Pteropus mariannus mariannus) as an endangered species in the Commonwealth of the Northern Mariana Islands. Unpublished.

Lemke, T.O. 1992. Status of the Marianas fruit bat (Pteropus mariannus) in the Northern Mariana Islands north of Saipan. In: Wilson, D.E. and G.L. Graham (eds.), Pacific Island Flying Foxes: Proceedings of an International Conservation Conference. U.S. Fish and Wildlife Service Biological Report 90(23):68-73.

Lusk, M. R. and C. Kessler. 1996. Trip Report: Farallon de Medinilla, 3 - 4 November. U.S. Fish and Wildlife Service, Pacific Island Ecoregion, Honolulu, HI. 8 pp.

Marshall, A. P., D. J. Worthington, G. J. Wiles, D. J. Grout, C. C. Kessler, V. A. Camacho, E. M. Taisacan, and T. Rubenstein. 1995. A survey of the Mariana fruit bat (Pteropus mariannus) on Anatahan, Commonwealth of the Northern Mariana Islands, July 1995.. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands. Unpublished report. 28 pp.

Naughton, J. J. 1997. Farallon de Medinilla survey. National Marine Fisheries Service, Southwest Region, Long Beach, CA. 10 pp.

Pierson, E. and W. Rainey. 1992. The biology of flying foxes of the genus Pteropus: A Review. In: Wilson, D. E. and G. L. Graham (eds.), Pacific Island Flying Foxes: Proceedings of an International conservation Conference. U.S. Fish and Wildlife Service Biological Report 90(23):1-17.

Reichel, J. D. 1991. Status and conservation of seabirds in the Mariana islands. ICBP Technical Publications, No. 11: 249-262.

Stinson, D. W. 1993. Micronesian megapode research. In Division of Fish and Wildlife Wildlife Research and Management Program, Progress Report: 1987-1992. Pp. 217-233. CNMI Division of Fish and Wildlife, Saipan.

Stinson, D. W. 1994. Birds and mammals recorded from the Mariana islands. Nat. Hist. Res., Special Issue, No. 1:333-344.

U.S. Fish and Wildlife Service. 1990. Guam Mariana Fruit Bat and Little Mariana Fruit Bat Recovery Plan. Portland, Oregon. 57 pp. + Appendix.

U.S. Fish and Wildlife Service. 1997. Technical/Agency Draft Recovery Plan for the Micronesian megapode. U.S. Fish and Wildlife Service, Portland, OR. 71 pp.

U.S. Fish and Wildlife Service. 1998. Endangered and threatened wildlife and plants: proposed reclassification from endangered to threatened status for the Mariana fruit bat from Guam, and proposed threatened status for the Mariana fruit bat from the Commonwealth of the Northern Mariana Islands. 63 FR 14641.

Whistler, W. A. 1996. Botanical survey of Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. Report for Belt Collins Hawaii. 20 pp.

Wiles G.J. 1987a. Current research and future management of Mariana fruit bats (Chiroptera: Pteropodidae) on Guam. Australian Mammalogy 10:93-95.

Wiles, G.J. 1987b. The status of fruit bats on Guam. Pacific Science 41:148-157.

Wiles, G. J. 1996. Current status, distribution, and natural history of Marianas fruit bats (1410, 1440, 1450). In: Annual Report, Fiscal Year 1996. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Aquatic and Wildlife Resources, Guam.

Wiles, G. J., C. F. Aguon, G. W. Davis, and D. J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. Micronesica 28(1):31-49.

Wiles, G. J. and P. Glass. 1990. Interisland movements of fruit bats (Pteropus mariannus) in the Mariana Islands. Atoll Research Bulletin 343: 1-6.

Wiles, G. J., T. O. Lemke, and H.H. Payne. 1989. Population estimates of fruit bats (Pteropus mariannus) in the Mariana Islands. Conservation Biology 3:66-76.

Worthington, D. J. and E. M. Taisacan. 1995. Fruit bat research. In: Annual Report, Fiscal Year 1994. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands. pp. 5-12.

Worthington, D. J. and E. M. Taisacan. 1996. Fruit bat research. In: Annual Report, Fiscal Year 1995. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands. pp. 6-17.

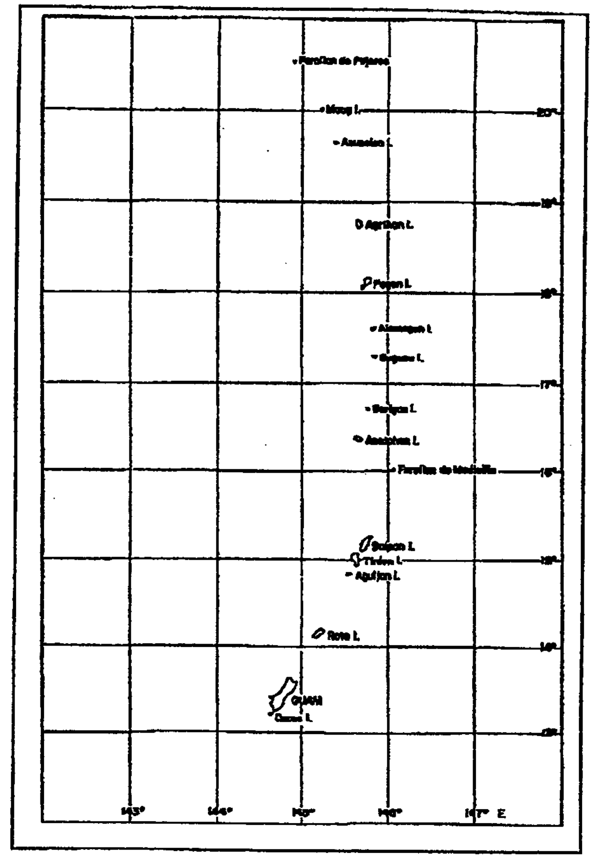


Figure 1. Mariana Islands archipelago.

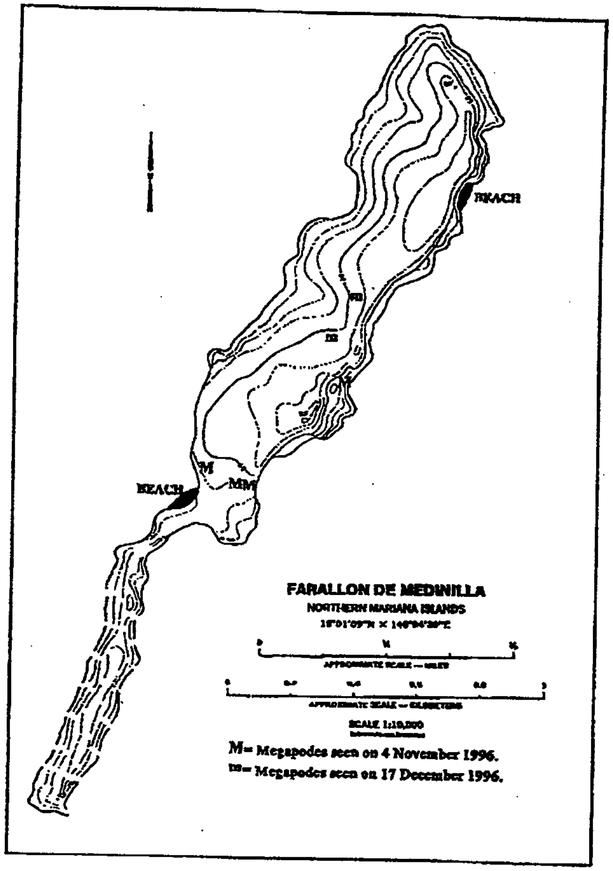


Figure 2. Location of megapode sightings and beaches on Farallon de Medinilla (beaches not to scale).

Appendix D-24
Biological Opinion and Conference Report (Log Number 1-2-98-F-07), Military Training in the Marianas

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

In Reply Refer To: 1-2-98-F-07 (LTG)

JAN -4 1999

Mr. Fred Minato
Environmental Planning Division
Pacific Division, Naval Facilities Engineering Command
Building 258 Makalapa
Pearl Harbor, Hawaii 96860-7300

RE: Biological Opinion and Conference Report (Log Number 1-2-98-F-07), Military Training in the Marianas

Dear Mr. Minato:

This responds to your August 19, 1998, request for formal consultation under section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, Stat. 884), as amended (Act), relative to military (*i.e.*, Air Force, Navy, Guam National Guard, Army Reserve, and Marine Corps) training activities on the islands of Guam, Rota, Tinian, and Farallon de Medinilla in the Mariana Islands. The Department of Defense (DOD) is the action agency for this project. This document represents the Service's biological opinion (BO) on the effects of the proposed project on the endangered hawksbill sea turtle (*Eretmochelys imbricata*), Micronesian megapode (*Megapodius laperouse*), the threatened Tinian monarch (*Monarcha takatsukasae*) and green sea turtle (*Chelonia mydas*), and conference report on the effects of the proposed project on the proposed Mariana fruit bat (*Pteropus mariannus mariannus*) within the Commonwealth of the Northern Mariana Islands (CNMI) in accordance with section 7(a)(2) of the Act. Potential effects to the federally endangered Guam rail (*Rallus owstoni*), Mariana crow (*Corvus kubaryi*), Guam swiftlet (*Collocalia bartschi*), Mariana common moorhen (*Gallinula chloropus guami*), and Hayun lagu tree (*Serianthes nelsonii*) were also identified. However, the Service has concurred that the proposed military training activities are not likely to adversely affect these species.

Your August 19, 1998, request for formal consultation was received on August 21, 1998. This biological opinion and conference report is based on the following information: 1) the June 1998 draft environmental impact statement (DEIS) for Military Training in the Marianas; 2) previous biological opinions; 3) the biological literature (see References Cited section at the end of the document); and 4) other information sources. Our log number for this consultation is 1-2-98-F-07. Copies of pertinent materials and documentation are maintained in an administrative record in the Service's office in Honolulu, Hawaii.

Consultation History

The following are summaries of previous section 7 consultations regarding military training activities in the Mariana Islands applicable to the proposed action and a description of correspondence for the proposed action.

On May 2, 1984, the Service issued a BO (1-2-84-F-26) to the Navy addressing the potential impacts of "Kennel Bear" exercises on Tinian on federally listed species, including the Tinian monarch. These activities included unloading and loading of personnel, supplies, and equipment from C-130 aircraft, clearing of vegetation for establishing bivouac camps, setting up a perimeter defense around camps, and firing of weapons at the firing range. These activities were to occur twice each year for one to two weeks each time.

On July 17, 1984, the Service issued a BO (1-2-84-F-44) to the Navy addressing the potential impacts of Marine Corps exercises on Tinian on federally listed species, including the Tinian monarch. These activities included unloading and loading of personnel, supplies, and equipment from and on C-130 aircraft, establishing bivouac camps, firing of weapons at firing ranges, and tactical airdrops. The training involved approximately 400 persons and was to occurr approximately three times per year for four weeks each.

On July 25, 1989, the Service issued a BO (1-2-89-F-47) to the Navy addressing the potential impacts of helicopter training on Anderson Air Force Base, Guam. The federally listed species at issue was the Mariana crow.

On May 4, 1990, the Service issued a BO (1-2-90-F-003) to the Navy addressing the potential impacts of engineering field survey work needed prior to the construction and operation of the Relocatable Over-the-Horizon Radar Project P-225 on Guam (WESTPAC Finegayan) and in the northern portion of Tinian. The federally listed species at issue were the Tinian monarch, Mariana crow, and the Mariana fruit bat.

On August 15, 1990, the Service issued a BO (1-2-90-F-024) to the Navy for reinitiation of consultation for the construction of the P-223 radar transmitter facility on Tinian due to an increase in the number of acres of forest to be cleared. The federally listed species at issue was the Tinian monarch.

On June 22, 1992, the Service issued a BO (1-2-92-F-07) to the Navy addressing the potential impacts of VRC-50 flight squadron field carrier landing practice (FCLP) at Anderson Air Force Base, Guam. The federally listed species at issue were the Mariana crow and the Mariana fruit bat.

On July 30, 1993, the Service issued a BO (1-2-93-F-14) to the Navy addressing the potential impacts from the Navy's permanent relocation of the VRC-50 Squadron to Andersen and the need to conduct VRC-50 flight squadron field carrier land practice (FCLP) training missions. The federally listed species at issue were the Mariana crow and Mariana fruit bat.

On June 27, 1994, the Service issued a BO (1-2-94-F-05) to the Navy addressing the potential impacts of including aircraft training operations by carrier air wing CVW-5, at Anderson Air Force Base, Guam. The federally listed species at issue were the Mariana crow and the Mariana fruit bat.

On September 3, 1994, the Service issued a BO (1-2-94-F-06) to the Navy addressing the potential impacts of performing air operations, including field carrier landing practices (FCLPs) with aircraft from a transiting carrier air wing (CVW) at Andersen Air Force Base, Guam. The federally listed species at issue were the Mariana crow and the Mariana fruit bat.

On February 28, 1996, the Service responded to the DOD's Notice of Intent to prepare the Draft Environmental Impact Statement (DEIS) for Marianas Military Training Plan for the Territory of Guam and the Commonwealth of the Northern Mariana Islands (CNMI). In our response, we stated that the DEIS should describe endangered and threatened species, migratory fishes and birds, and rare, and native species to be affected by the proposed project, and assess the impacts to these species and identify appropriate mitigation measures, as well as address the possible introduction of the brown treesnake (*Boiga irregularis*) into the CNMI. We also recommended that section 7 consultation be initiated prior to issuance of the DEIS. The U.S. Pacific Command was identified as the lead agency for the proposed project and the Pacific Division, Naval Facilities Engineering Command as the coordinating agency.

On January 29, 1997, the Service issued a BO (1-2-97-F-01) to the Navy addressing the potential impacts of aerial bombardment and gunnery training over a four week period in February and/or March 1997 on Farallon de Medinilla (FDM). The federally listed species at issue were the Micronesian megapode, the green sea turtle, and the hawksbill sea turtle.

On April 16, 1997, the Service provided comments on the DEIS for Military Training in the Mariana Islands (January 1997 version) to the Department of the Interior (DOI). The Service recommended that a revised DEIS be prepared due to numerous deficiencies. In August 1998, the Service received the Revised DEIS for Military Training in the Marianas (June 1998 version) and provided comments to the DOI on September 21, 1998.

In an informal consultation dated May 2, 1997 with the U.S. Air Force, overflight conditions for activities at AAFB were negotiated in order to establish a not likely to adversely affect determination for the Mariana crow and Mariana fruit bat.

On May 16, 1997, the Service issued a BO (1-2-97-F-05) to the Navy addressing the potential impacts of gunnery training and aerial bombardment from July 21, 1997 to August 1, 1997, on FDM. The federally listed species at issue were the Micronesian megapode, green sea turtles, and hawksbill sea turtles.

On September 11, 1997, the Service issued a BO (1-2-97-F-08) to the Navy addressing the potential impacts of ship to shore gunnery practice during September 1997, on FDM. The federally listed species at issue were the Micronesian megapode, green sea turtle, and the hawksbill turtle.

On December 30, 1997, the Service issued a BO (1-2-98-02) to the Navy addressing aerial bombardment and small arms gunfire during January and February 1998 on FDM. The federally listed species at issue were the Micronesian megapode and the Mariana fruit bat.

On April 6, 1998, the Service issued a BO (1-2-98-03) to the Navy addressing aerial bombardment, naval gunfire, and small arms gunfire for the next three years on FDM. The federally listed species at issue were the Micronesian megapode and the proposed Mariana fruit bat.

On August 21, 1998, we received a request from the Department of the Navy on behalf of the Department of Defense to initiate section 7 consultation regarding Military Training in the Marianas. On October 2, 1998, the Service wrote a letter stating that the BO would be delivered on or before January 13, 1999 (should have stated January 2, 1999) and that all information required for the consultation was available.

BIOLOGICAL OPINION/ CONFERENCE REPORT

I. Description of the Proposed Action

A. Proposed Action

The following descriptions of the proposed military training actions are taken from the June 1998 Draft Environmental Impact Statement for Military Training in the Marianas and proposed action modifications and clarifications identified in Navy biologist Tim Sutterfield's October 1 and October 19, 1998 electronic mail messages to Assistant Field Supervisor Karen Rosa.

Guam

a) Waterfront Annex

The Waterfront Annex includes Orote Point and most of the shoreline of the Inner and Outer Harbors of Apra Harbor.

Ongoing or continuing activities at the Waterfront Annex include general field maneuvers, logistics support, aviation training, amphibious landing training, live fire ranges, and underwater demolitions. Field maneuvers are defined as all general military training that occur on land, with the exception of live weapons fire and aviation-related activities. This includes tactical maneuvers on foot, travel in wheeled and tracked vehicles, use of signals and flares, clandestine raiders, rappelling, bivouacs, nuclear biological and chemical (NBC) training, and other miscellaneous activities. A training group for a field maneuver activity may consist of one to 2,000 individuals. Ongoing aviation training includes helicopter insertion and extraction, paradrops, firefighting bucket off loading, search and rescue, and cast and recovery training. Other ongoing training activities include amphibious landings of Landing Craft Air Cushions (LCAC), Landing Craft Utility (LCU), and Amphibian Assault Vehicles (AAV), riverine training, live fire ranges (*i.e.*, small arms known range, distance range, pistol range), and underwater demolitions.

Proposed or new training includes field maneuvers (stress course and rapid runway repair), aviation training, amphibious landing training, underwater demolition training, and live fire ranges. Proposed new aviation training includes forward area refueling near the small arms range and helicopter insertions and extractions in the North Tipalao rappelling area. Proposed new amphibious training includes LCAC landings at Tipalao, Dadi, and Toyland beaches; AAV landing sites at Sumay Cove Marina, the former WWII refueling pier, Tipalao, Toyland, Polaris Point, and Drydock Island beaches; and LCU landing sites at Sumay Cove Marina, the former WWII refueling pier, and Polaris Point and Toyland beaches. A new fire and maneuver range, skeet range, and shooting house is proposed for the southern section of Orote Point. One new deep-water underwater demolition training area is proposed offshore from Dadi Beach and three new shallow-water underwater demolition training sites are proposed (Tipalao, Spanish Steps, west tip of Outer Apra Harbor breakwater).

b) Ordnance Annex

The Ordnance Annex is located in the southern half of Guam and covers 36 square kilometers (sq km). Fena Reservoir, Guam's major surface water body, is located within Ordnance Annex.

Ongoing or continuing activities include field maneuvers, logistics support, and aviation training. Field maneuvers and logistics support training involve water purification, land navigation, small unit reconnaissance patrolling, command post exercises, and bivouac (small to medium). Ongoing aviation training involves using existing helicopter landing zones to land and recover embarked personnel and equipment, personnel insertions and extractions, simulated Tactical Recovery of Aircraft and Personnel (TRAP) and Close Air Support (CAS) in areas north of the ammunition storage area, and using Fena Reservoir to train helicopter crews to load an external fire bucket.

New proposed training activities include paradrops and live firing ranges. Proposed paradrops will use an existing drop zone for small groups of troops delivered from helicopters. A new range area that contains a sniper range, breaching house, jungle trail range, and one SDZ is proposed for the entire southern portion of the Ordination Annex.

c) Andersen Air Force Base and Communication Annexes

Andersen Air Force Base (AAFB), Andersen South, and the two Communication Annexes (*i.e.*, Barrigada and Finegayan) comprise 92 sq km. A National Wildlife Refuge Overlay has been established over much of northwest AAFB and an Ecological Reserve Area has been established at the Communications Annex Finegayan, including Haputo Beach.

Ongoing training activities include the continued use of the area for field maneuvers, aviation training, Explosive Ordnance Disposal (EOD) demolition, and live fire training.

The proposed new training activities involve the rapid runway repair to be conducted on a former taxiway of Northwest Field, fire bucket off loads in the Main Base area, and the use of mortars (training rounds) at the small arms range at AAFB's Tarague Beach.

<u>Non-DOD Lands</u>

a) Guam

The continuing activity involves the Army National Guard conducting parachute jumps at the Casper and Ghost Drop Zones, near NASA Road in Talofofo on private land in Dandan. This training is conducted bimonthly in small units (typical training unit of 24 personnel).

b) Rota

Continuing activities on Rota include the use of a small island in Songsong Harbor for a small forward staging base for approximately 7 days per month.

<u>Tinian</u>

The action area for military training activities (proposed and ongoing) on Tinian occurs within the Military Lease Area (MLA) and a portion of the southern one-third of Tinian. The MLA consists of the northern two-thirds of the island of Tinian. On the southern one-third of the island troops are brought into the MLA via West Tinian Airport or San Jose Harbor. Troops brought in at the airport and harbor will conduct a "movement to contact" by tactically moving north to the MLA by vehicle or by foot.

Ongoing or continuing training activities considered on Tinian include large-scale maneuvers (airfield seizure/defense and bivouacs), a variety of aviation training, and LCAC training. Ongoing aviation training includes airmobile training (airmobile landings, C-130 cargo drops), airborne training (paradrops), helicopter insertion and extraction, night vision goggle training, fighter and attack aircraft training, firefighting and forward area refueling. Ongoing amphibious landing training on Tinian includes LCAC training at Unai Chulu and Unai Dankulo beaches and LCU landings at Kammer Beach.

Proposed new activities include constructing a small logistics support base camp and new amphibious training. The new camp will be located on the eastern edge of the VOA. New amphibious landings proposed are AAV landings at Kammer and Unai Babui beaches.

After the receipt of the DEIS, several changes and clarifications concerning the training activities on Tinian were made by biologist Tim Sutterfield in his October 1 and October 19, 1998, electronic mail messages to the Service, including:

1) The fire and maneuver range was deleted from the preferred alternative;

2) The only beaches to be used for LCAC landings are Unai Chulu and Unai Dankulo beaches; Tachagna Beach will not be used;

3) No clearing of vegetation is proposed for training areas and bivouac areas; and

4) The only vegetation to be cleared is for the logistic support facility that will be located in the boundary of the VOA site and will require the clearing of 0.75 acres of grassland.

<u>Farallon de Medinilla (FDM)</u>
All of the military training activities on FDM were reviewed in the Service's April 6, 1998, BO (1-2-98-F-03). No new military activities for FDM are proposed in the DEIS that were not covered in this previous BO (Tim Sutterfield, personal communication 1998).

B. <u>Actions to minimize threats to endangered and listed species</u>

1. Brown Treesnake Control/Interdiction Plan (BTS Plan) for Military Training Exercises

Included within the DEIS is a description of the measures to be implemented by DOD to minimize the threat of further dispersal of the brown treesnake (BTS) in the Pacific due to military activities. These measures are described in the BTS Plan in Appendix E of the DEIS.

Specific measures identified in the BTS Plan are as follows:

a) The USDA Wildlife Services (WS) office on Guam is the primary agent for BTS control for the military and is responsible for the following:

   1) Inspection of military cargo staged at AAFB and in Apra Harbor on Guam for BTS;
   2) Maintenance of trapping and night searches at high-risk areas, airfields, and ports whether training occurs or not;
   3) Providing personnel, traps, lights, bait, and guidance for military training exercises on Tinian;
   4) Establishing quarantine procedures on Tinian in coordination with local wildlife and/or customs officials and performing inspections of all arriving cargo, in coordination with the CNMI Department of Fish and Wildlife. Quarantine activities required at all ports of entry include erecting temporary barriers, establishing sterile areas, and activating snake traps.
   5) Delegation of manpower and dogs construct cargo containment areas (snake proof enclosures or exclosures); and
   6) Providing additional information and assistance as needed.

b) Military aircraft will not be able to take off from Guam without having been properly inspected by WS;

c) All training personnel arriving on Guam for an military training exercise will be provided with an BTS information packet and briefed on the BTS hazard prior to leaving Guam for Tinian or Rota;

d) Any person sighting a BTS should attempt to kill or trap the snake and report the incident immediately to WS officials;

e) For all exercises involving interisland transport, COMNAVMARIANAS or AAFB environmental personnel will advise WS in as many days in advance as possible;

f) COMNAVMARIANAS will monitor compliance with the BTS Plan by coordinating with WS and base environmental personnel on at least a quarterly basis to keep abreast of lessons learned and new problem solving techniques.

2. Mitigation for amphibious vehicle landings on turtle nesting beaches:
   a) Prior to beach landings by amphibious vehicles, known turtle nesting

beaches will be surveyed by a Navy biologist for the presence of sea turtle nests no more than six hours prior to a landing;

b) Areas free of nests will be flagged, and vehicles will be directed to remain within these areas;

c) A Navy biologist will monitor beaches during any nocturnal landings.

d) If any sea turtles are observed or known to be in the area, training will be discontinued until all nests have been located and turtles have left the area;

e) LCAC landings on Tinian will occur during high tide, LCAC's must maintain a full cushion until they reach the top of the beach (off of the sand), and complete the initial 180 degree turn prior to coming off full cushion;

f) On Tinian surveys will be conducted before and after each LCAC landing and AAV landing at least two times per year at Unai Chulu and Unai Babui with Unai Lamlam surveyed as a control site. Navy contracted surveyors will record percent coral cover, turbidity, fish assemblage, sedimentation rates, and the topography of the site;

g) AAV landings at Unai Babui will be restricted to an established approach lane and allowed to land only during high tide and in single file.

3. Overflight conditions over AAFB to minimize impacts to the Mariana crow and Mariana fruit bat.

a) No overflights below 1,600 feet Above Mean Sea Level (MSL) are allowed over Munitions Storage Area 1.

b) For the rest of Andersen AFB, overflights would be allowed below the 1,600 foot MSL during the three- month crow non-breeding season (June through August).

c) No overflights are allowed below 1,600 foot MSL directly above crow territories during the nine-month crow breeding season (September through May). Crow territories will be determined by consultation with the Guam Division of Aquatic and Wildlife Resources.

d) Helicopters are to remain ½ nautical mile from the perimeter of the bat colony at Pati Point, with the exception of flights originating from the end of runways (similar to fixed wing aircraft operations).

4. Areas designated as "No wildlife disturbance"

Within a "no wildlife disturbance" area, the following activities are prohibited:

a) Off-road vehicular traffic;
b) Pyrotechnics or open fires;
c) Firing blanks;

d) Live ammunition or training demolition;
e) Digging;
f) Mechanical vegetation clearing;
g) Flights below 305 meters (m) (1,000 feet) AGL: and
h) Helicopter landing zones.

5. Areas designated as "No training"

Within a "no training" area, no training is allowed, except troop and vehicle movement along established roads to protect wetlands and other rare habitats.

II. <u>Biology and Population Status of the Species</u>

A. <u>Species Not Likely to Be Adversely Affected</u>

The following are summaries of the species considered by the Service during the consultation period for which no adverse effects are anticipated:

Guam rail (*Rallus owstoni*)

Guam rails have been reintroduced to Area 50, AAFB, Guam. Area 50 has been fenced and is in the process of having brown treesnakes removed from the site. The Service does not anticipate that military training activities within AAFB are likely to adversely affect the Guam rail.

Mariana fruit bat (*Pteropus mariannus mariannus*)

Fruit bats are known to forage within the Ordnance Annex on Guam. Military training activities within the sniper range could cause fruit bats foraging in the area to disperse to other areas of Guam. The Service does not anticipate that these activities are likely to adversely affect the Mariana fruit bat on Guam.

Mariana Crow (*Corvus kubaryi*)

In a July 1996 report issued by the Service to the Navy entitled *The Effects of Aircraft Overflights on Endangered Mariana Crows and Mariana Fruit Bats at Andersen Air Force Base, Guam*, the Service documented that low altitude aircraft flights (< 183 meters (m) [600 foot (ft)] Above Ground Level (AGL)) can elicit distress, cause crows to flush, and disrupt nest building, incubation, and nest attendance at least temporarily. Mariana crows also maintain year-round territories and are very susceptible to disturbance during the nest tree selection process immediately prior to the breeding season. The pre-nest building phase of the breeding season is critical for successful breeding and is generally categorized by behaviors such as increased vocalizations, allopreening, and carrying and offering sticks. Disturbance during this critical phase could preclude breeding altogether.

In an informal consultation (May 2, 1997) with the U.S. Air Force, overflight conditions for activities at AAFB were negotiated in order to establish a not likely to adversely affect determination for the Mariana crow. Overflight conditions over Andersen AFB are as follows: (1) no overflights below 487 m (1,600 ft) Above Mean Sea Level (MSL) are allowed over Munitions Storage Area 1, (2) for the rest of Andersen AFB, overflights would be allowed below the 487 m (1,600 ft) MSL during the three- month crow non-breeding season (June through August), and (3) no overflights are allowed below 487 m (1,600 ft) MSL directly above crow territories during the nine-month crow breeding season (September through May). Crow territories will be determined by consultation with the Guam Division of Aquatic and Wildlife Resources.

Guam Swiftlet (*Collocalia bartschi*)

The Guam swiftlet is endemic to the Mariana Islands of Guam, Aguiguan, and Saipan and is the only resident swift in the Mariana Islands. Guam swiftlets seem to prefer to forage above forested ridges and open grassy areas, but they forage over a wide variety of terrain and vegetation and they roost and nest in caves (Pratt *et al.* 1987, USFWS 1991). Caves are occupied throughout the year (USFWS 1991).

Guam swiftlets are found in Mahlac and Fachi Caves, and have been observed foraging along Fena Valley Reservoir and Sadog Gago River (J. Morton, USFWS, personal communication 1998), all of which are located within the Ordnance Annex on Guam. Mahlac Cave harbors what is estimated to be 90% of all swiftlets on Guam, housing between 280-300 birds (USFWS 1991). It is the only significant breeding colony that remains on Guam. Fachi Cave, located within an ammunition bunker, harbors an estimated 15-25 swiftlets (J. Morton, USFWS, personal communication 1998). Military training is not allowed within the area of these two caves. The only public access being considered for Mahlac Cave by the Navy is a recreational fishing program initiated on August 3, 1996, at Fena Lake. It is not likely that this fishing program will lead to more visitors to Mahlac Cave, due to the close supervision of the public and the distance of the lake from Mahlac Cave (L. Morton, Natural Resources Manager, Naval Activities, Guam, personal communication 1996). It is also important that the name of the cave be omitted from any published reports, as the name may serve as a locational guide to persons familiar with the location of Mahlac Stream, which flows through the east side of the Navy base near the cave. The Navy has previously agreed to omit locational information (Biological Opinion 1-2-96-F-06).

Military training activities within the sniper range (Ordnance Annex) would likely cause swiftlets foraging within the lower portion of Fena Valley Reservoir or along Sadog Gago River to disperse to other foraging grounds. Therefore, the Service has determined that the proposed project is not likely to adversely affect the Guam swiftlet.

Mariana Common Moorhen (*Gallinula chloropus guami*)

Moorhens in the Mariana Islands are found primarily at freshwater human-made and natural wetlands that are both seasonal and permanent. Occasionally, they are recorded in brackish water wetlands. The current total estimated population of Mariana common moorhens in the Mariana Islands is approximately 300 to 400 birds (USFWS 1996a). Within the action area, Lake Hagoi, Mahalang, and Batcha Wetlands on Tinian and four wetlands each within the Ordnance Annex and the Waterfront Annex on Guam support moorhens. Lake Hagoi supports approximately 40 birds (USFWS 1996a) and is designated as a "no training" area by the military. The only military training activities allowed within a "no training" area are troop and vehicle movements along established roads. It is anticipated that military training will not affect moorhens using Lake Hagoi. Mahalang and Batcha Wetlands are estimated to support no more than 10 moorhens (USFWS 1996a). Military training activities near these wetlands would likely cause moorhen to temporarily disperse to other wetlands.

Riverine training in Atantano River (Waterfront Annex) is expected to occur seven days a month and involve 16-20 people. The area surrounding the proposed training area is a mangrove swamp and is known to occasionally support moorhen (M. Ritter, USFWS, personal communication 1998). The mangrove swamp is designated as a "no training" area; however, it is anticipated that military training activities in the Atantano River could cause moorhen using the mangrove swamp to disperse to another wetland. There is no military training proposed or ongoing that will affect the other three wetlands known to support moorhen within the Waterfront Annex.

There are four wetlands within the Ordnance Annex that provide habitat for the moorhen. Two seasonal wetlands are located within a "no training" area and the majority of Fena Reservoir is within a "no wildlife disturbance area." A "no wildlife disturbance" designation is described as an area in which the following are prohibited: off-road vehicular travel, pyrotechnics, demolition, digging, mechanical vegetation clearing, flights below 305 m (1,000 ft) AGL, and helicopter landing zones. Hellborne firebucket (onload) and combat swimmer training occur within the northern portion of Fena Valley Reservoir, which is not known to support moorhen. There are no proposed or ongoing military training exercises affecting the fourth wetland within the Ordnance Annex. It is anticipated that no moorhens within the Ordnance Annex will be affected by ongoing or proposed military training activities. However, it is anticipated that military activities in Atantano River on Guam and near Mahalang and Batcha Wetlands on Tinian could cause moorhens using the wetlands to temporarily disperse to another part of the wetland or another wetland. It has been determined that the proposed training exercises are not likely to adversely affect the Mariana moorhen:

Serianthes nelsonii

Two populations of *Serianthes nelsonii* are known from Rota and Guam. All remaining individuals of *Serianthes nelsonii* occur in native limestone forest on soils derived from limestone substrates, with most trees growing on or near steep hillsides or cliffs. However, the species formerly inhabited sites with volcanic soils in southern Guam (USFWS 1993). There were 122 individual plants known in 1993 (USFWS 1993). Currently, there is one mature tree remaining on Guam on Anderson Air Force Base on top of the sea cliffs at Ritidian Point and three seedlings persist on Northwest Field in the vicinity of the tree that was destroyed in 1992 during Typhoon Omar (G. Hughes, USFWS, personal communication 1998; Wiles *et al.* 1995). The mature tree is enclosed within a 3,048 square m (10,000 square ft) fence and the three seedlings are contained within a protective cage to prevent browsing by ungulates. Another 121 individuals are scattered along the Sabana cliffs on Rota, primarily above the town of Songsong. However, this population does not occur within an area of ongoing or proposed military activities. The Service has determined that the proposed project is not likely to adversely affect populations of *Serianthes nelsonii* due to the fencing that protects the mature plant on Guam from training activities and the fact that the plants on Rota do not occur within the action area.

B. Species Likely to be Adversely Affected

Green Sea Turtle (*Chelonia mydas*)

The green sea turtle was listed as a threatened species on July 28, 1978. Green sea turtles are distributed globally throughout tropical and subtropical seas with temperatures above 20 degrees Centigrade (National Marine Fisheries Service [NMFS] 1998a), and are known to occur in the waters of the CNMI (USFWS 1996b).

Green sea turtle hatchlings average 4.7 to 5.4 centimeters (cm) (1.9 to 2.2 inches [in]) in carapace length and weigh between 22 to 31 grams (gm) (0.8 to 1.1 ounces [oz]) and can grow to more than one meter in carapace length and weigh over 100 kilograms (kg) (220 pounds [lbs]) (NMFS 1998a). The color of the green sea turtle's carapace changes as it grows from a hatchling to an adult. The dorsal side of hatchlings is black and the ventral side is pure white (NMFS 1998a). Juveniles are between 35-65 cm (14-26 in) in length have a streaked or radiating sunburst of patterns of yellowish-gold, olive, light and dark brown, reddish-brown, and black (NMFS 1998a). The color of an adult carapace varies from light to dark brown, sometimes shaded with olive, with radiating wavy or mottled markings of a darker color or with large blotches of dark brown (NMFS 1998a).

Green sea turtles greater than 30-35 cm (12-14 in) feed exclusively on macroalgae and seagrasses, while post-hatchlings and juveniles feed carnivorously (*e.g.*, invertebrates and fish eggs) (NMFS 1998a).

Wild green sea turtles have exhibited slow growth and delayed sexual maturity (NMFS 1998a). Studies have estimated that the average age for sexual maturity is at least 25 years (NMFS 1998a). Green sea turtles have been documented to migrate long distances, over 1,000 kilometers (km) (600 miles), between foraging grounds and nesting beaches (NMFS 1998a). For example, a turtle tagged on Tinian was recently sighted in the Philippines (George Balazs, NMFS, personal communication 1997). After completing migration to nesting beaches, green sea turtles lay several successive clutches of eggs during the nesting season before returning to the foraging grounds. On average the green sea turtle lays 1.8 clutches of eggs per season or up to 6 clutches. Each clutch is laid at 10 to 15 day intervals and contains approximately 100 eggs per clutch. Eggs incubate in the sand for 54 to 88 days (mean of 64.5 days). Green sea turtles are known to nest in the CNMI from January through August, which means hatching may continue into October (USFWS 1996b). Female green sea turtles migrate to breed only once every two or possibly more years.

There are no population estimates for the CNMI populations of green sea turtles, but there are some records available. In 1995, six to ten turtles were recorded nesting on the island of Tinian and a similar number probably nested there in 1994 (USFWS 1996). This implies that the nesting population in the CNMI is not very large presently, but at one time may have been much larger (USFWS 1996). Fewer than ten green turtles nest on the islands of Saipan, Tinian, and Rota each year (NMFS 1998a). Turtles are also known to nest on FDM and Guam (G. Davis, Guam Department of Wildlife Resources, personal communication 1998).

The green sea turtle was listed due to its declining numbers associated with overexploitation for commercial and other purposes, habitat loss and degradation. Populations of the green sea turtle in the Pacific region have continued to decline due to directed harvest (both illegal and legal) and negative impacts to essential habitats (NMFS 1998a). Spread of fibropapilloma has also slowed the recovery of green sea turtle populations (NMFS 1998a).

Green sea turtles are known to nest on the beaches of Tinian and FDM. Amphibious landing training on several beaches of Tinian and bombing activities on FDM are likely to adversely affect the green sea turtle.

Hawksbill Sea Turtle (*Eretmochelys imbricata*)

Hawksbills are usually less than 95 cm (38 in) in carapace length, which is considered relatively small. They have a narrow head with a tapering beak, thick, overlapping shell scutes, and strongly serrated posterior margin of the carapace (NMFS 1998b). Hatchlings of the hawksbills average 13.2 gm (0.5 oz) and have a tan-colored carapace, top of the head and neck, while the sides and bottom of the head and neck (including the beak) are dark grey; the dorsal and ventral sides of the fore flippers are grey with a whitish fringe around the posterior edge; the dorsal and ventral sides of the hind flippers and plastron are dark grey with two whitish ridges posteriorly on the plastron (NMFS 1998b). Juvenile hawksbill turtles vary in color; the carapace ranges from light brown to black with varying amounts of distinct yellow streaks and blotches (NMFS 1998b). The adult has a carapace that is dark brown with faint yellow streaks and blotches; the scales on the dorsal side of the flippers and head are dark brown to black with yellow margins; the ventral side of the flippers and the plastron are pale yellow, with scattered dark scales on the flippers (NMFS 1998b).

The hawksbill sea turtle was listed as an endangered species on June 2, 1970. Hawksbill sea turtles occur globally, generally occurring between 30 degrees north and 30 degrees south latitudes in the Atlantic, Pacific, and Indian oceans and associated bodies of water (NMFS 1998b), and are known to occur in the waters of the CNMI (USFWS 1996). Hawksbill sea turtles appear to feed exclusively on sponges (NMFS 1998b).

Hawksbill sea turtles have been documented to migrate long distances, over 1,000 km (600 miles), between foraging grounds and nesting beaches (NMFS 1998b). Hawksbill turtles lay several successive clutches of eggs during the nesting season before returning to the foraging grounds. The hawksbill turtle lays between three to six clutches per season. There is a 13- to 19-day interval between consecutive clutches with approximately 100 eggs per clutch. Eggs incubate for approximately 60 days. The size of a clutch and the days of incubation vary from nest to nest, and site to site. There is no information available regarding the exact month(s) hawksbills nest in the CNMI or Guam. In other areas of the world, hawksbill sea turtles have been recorded nesting year-round (NMFS 1998b).

There are no population estimates for hawksbill sea turtles in the CNMI and Guam, and there is little evidence that hawksbill turtles nest within the CNMI and Guam. However, this does not rule out that they are nesting at low levels at unknown locations (NMFS 1998b). Although no hawksbill turtles were observed nesting on Tinian in 1995, there have been a few reports of hawksbills nesting on Rota and Saipan within the CNMI and on Guam (USFWS 1996).

Hawksbill turtles in the Pacific Islands have dramatically declined. The most serious threat is the harvesting of turtles on nesting beaches and in coastal waters by humans (NMFS 1998b). Other threats to hawksbills in the Pacific include habitat loss due to expansion of resident human populations and/or increased tourism development, and the incidental take of turtles in distant-water fisheries (NMFS 1998b).

Hawksbill sea turtles are known to nest within the action area on Guam. Amphibious landing exercises on Guam are likely to adversely affect the hawksbill sea turtle.

Mariana fruit bat (*Pteropus mariannus mariannus*)

The Mariana fruit bat, locally known as *fanihi*, is a medium-sized fruit bat in the family Pteropididae. This subspecies is restricted to the Mariana archipelago, comprised of the

Territory of Guam and the CNMI. These bats weigh between 330 to 577 gm (0.66 to 1.15 lbs) and have a forearm length ranging from 13.4 to 15.6 cm (5.3 to 6.1 in); males are slightly larger than females (USFWS 1998a). The underside (abdomen) is colored black to brown, with gray hair interspersed, creating a grizzled appearance. The shoulders (mantel) and sides of the neck are usually bright golden brown, but may be paler in some individuals. The head varies from brown to dark brown. The well-formed and rounded ears and large eyes give a canine-like appearance giving rise to the nickname "flying foxes."

The Mariana fruit bat on Guam was listed as endangered on August 27, 1984, without critical habitat (49 FR 33881). On March 26, 1998, the Service proposed to downlist the Mariana fruit bat on Guam to threatened status, and designate all Mariana fruit bats in the Mariana archipelago as threatened (63 FR 14641). Should the proposed rule go final, the fruit bats on Guam, which are currently listed as endangered, will be downlisted to threatened and all of the fruit bats in the Marianas archipelago will be protected as a threatened species.

The Mariana fruit bat is highly colonial, forming colonies of a few to over 800 animals (Pierson and Rainey 1992, Wiles 1987a, Worthington and Taisacan 1995). The bats group themselves into harems (one male and two to 15 females) or bachelor groups (predominately males), or reside as single males on the edge of the colony (Wiles 1987a). Reproduction is believed to occur throughout the year on Guam, with no apparent peak in births (Wiles 1987a). Female bats of this family generally have one young per year, resulting in a slow recovery rate when populations are reduced in numbers (Pierson and Rainey 1992). Length of gestation and age of sexual maturity are unknown for the Mariana fruit bat, but other related bats have a gestation period of approximately 4.6 to 6.3 months (Pierson and Rainey 1992). Female Mariana fruit bats on Guam may be able to breed as soon as at 6 to 18 months of age (USFWS 1990b), but sexual maturity in Pteropodid bats usually does not occur until the bats are 18 to 24 months old (Pierson and Rainey 1992).

Native forest is the primary habitat required by the Mariana fruit bat, although some introduced plant species can provide roosting and feeding resources. Fruit bats are important in tropical forests because they naturally disperse plant seeds and thereby help maintain forest diversity and contribute to plant recovery after typhoons and other catastrophic events (Cox *et al.* 1992). Mariana fruit bats forage and roost primarily in native forest, and occasionally in coconut groves and strand vegetation (Wiles 1987b, Worthington and Taisacan 1996). At least 22 plant species are used as food sources by the Mariana fruit bat, including fruits of 17 species of plants, the flowers of seven, and leaf stems and twig tips of *Artocarpus* spp. (USFWS 1990b, Wiles 1987a).

Although the status of the Mariana fruit bat prior to the 20th century is unknown, it likely occurred throughout the Mariana Islands and was probably common on the larger southern islands in the archipelago. Currently, there are estimated to be between 200 and 750 animals on Guam (Wiles 1996, Wiles *et al.* 1995), 25 to 125 animals on each of the islands of

Aguiguan, Saipan, and Tinian (Lemke 1984, Marshall *et al.* 1995b, Wiles 1996, Worthington and Taisacan 1996), 1,000 on Rota (Worthington and Taisacan 1996), and a minimum of 7,450 bats on the smaller islands north of Saipan (Anonymous 1984, Wiles *et al.* 1989). Bats may be uncommon on some of the smaller islands such as Maug, Uracas, and FDM, but are known to occur on all of them (USFWS 1998a). Based on these figures, the total population for the Mariana Islands is estimated to be at least 8,725 animals, although this figure is based on rough estimates from the northern Mariana Islands. Evidence indicates that bats move regularly between the larger southern islands and at least annually between the more remote northern islands (Wiles and Glass 1990, Wiles *et al.* 1989, Worthington and Taisacan 1996).

Fruit bat populations on Guam have been reduced possibly due to poaching, particularly since the introduction of firearms (Coultas 1931), and predation by the brown tree snake (Wiles 1996, Wiles *et al.* 1995). Loss of habitat through the effects of typhoons, development projects, and the introduction of feral rats, pigs, and goats has also contributed to the decline of this species throughout the Marianas (Kessler 1997, Marshall *et al.* 1995, USFWS 1998). Throughout both the inhabited southern and uninhabited northern islands, poaching continues to be one of the most important factors in the decline of the Mariana fruit bat (Glass and Taisacan 1988, Lemke 1992, Marshall *et al.* 1995b, USFWS 1990b, USFWS 1998a, Worthington and Taisacan 1996).

Fruit bats are known to occur within the action area. Aerial bombardment, gunnery training, naval gunfire, and small arms gunfire exercises conducted on FDM are likely to adversely affect the Mariana fruit bat.

Micronesian megapode (*Megapodius laperouse*)

The Micronesian megapode (known locally as *sasangat* or *sasangal*) is a pigeon-sized bird with dark gray-brown to black body plumage, an ash-gray head with a slightly darker, short, rough crest, a yellow bill, very sparse or absent feathers around the eye, ear, and throat revealing red skin and a red throat patch, and heavily built yellow legs and feet (Baker 1951, Pratt *et al.* 1987, USFWS 1998b). The U.S. Fish and Wildlife Service (Service) listed the Micronesian megapode as endangered in 1970 (35 FR 8491-8498). Two subspecies of the Micronesian megapode are found in Micronesia, *M. l. laperouse* in the Mariana Archipelago, and *M. l. senex* in Palau (USFWS 1998b). Critical habitat has not been designated for this species.

The Megapodiidae are part of a family within the order Galliformes (chicken-like birds) found only in the Australasian region. The family comprises seven genera found in Australasia, Australia, New Guinea and surrounding islands, eastern Indonesia, the Nicobar Islands, the Philippines, Micronesia, Vanuatu, and Niuafo'ou of the Tonga Islands (USFWS 1998b). Megapodes are ground-dwelling birds, but, in spite of their terrestrial habits, megapodes fly well and apparently cross large bodies of water easily (Olson 1980, Pratt *et*

al. 1980).

The Micronesian megapode is generally a bird of the forest. On the southern Mariana Islands they are primarily restricted to native limestone forest (USFWS 1998b). On Sarigan, megapodes are often seen in coconut forest as well as native vegetation, and on Guguan and Maug megapodes seem to prefer forest but are also seen in scrubby and even barren areas (USFWS 1998b). Megapodes encountered in fields of grass and vines are mostly juveniles rather than territorial pairs, suggesting that this is less preferred habitat (Glass and Aldan 1988, Rice and Stinson 1992). The Micronesian megapode seems to be an omnivore taking a variety of plant and animal foods available on the forest floor, including seeds, beetles, ants, other insects, and plant matter (Baker 1951, Glass and Aldan 1988, Stinson 1993a).

Megapodes are sometimes called "incubator birds" because they rely on solar energy, volcanic activity, or microbial decomposition as a heat source for incubation (Clark 1964). They are also characterized by laying large eggs without an air chamber and chicks that lack an egg tooth at hatching and kick their way out of the egg (Clark 1964, Dekker and Brom 1992). Megapode chicks are precocial (feathered, able to walk, and able to regulate their body temperature) at hatching and the adults do not care for the young (Jones *et al.* 1995). There is no information on the number of eggs laid per season by the Micronesian megapode (USFWS 1998b). Apparently one egg is laid at a time but the interval between egg laying is unknown (USFWS 1998). Nicobar megapodes (*M. nicobariensis abbotti*) have an interval of nine days between each egg that is layed (Dekker 1992) while the laying interval is 9 to 20 days (average 13 ± 4 days) for the orange-footed megapode (*M. reinwardt*) (Crome and Brown 1979). The Polynesian megapode (*M. pritchardii*) may lay 10 to 12 eggs per year (Todd 1983) and one orange-footed megapode laid 12 or 13 eggs over a 4.5-month breeding season (Crome and Brown 1979).

Micronesian megapodes are known to give at least three types of calls, including two calls that are different for males and females and that may be given in a duet. Duetting in birds is correlated with year-round territorial behavior and life-long pair bonds. The existence of duetting in the Micronesian megapode supports the report of Glass and Aldan (1988) that on Saipan megapodes seem to remain together throughout the year in territories that are advertised and defended at least part of the year. It is not known how, or if, territoriality functions at or near heavily used communal nesting areas like the one on Guguan (USFWS 1998b). Seasonality in vocalizations, particularly duetting, is believed to be indicative of seasonal changes in breeding activity, but no clear pattern has thus far emerged for the Micronesian megapode (USFWS 1998b). Chicks were reported to leave nests from January or February to June (Oustalet 1896). Chicks of all sizes have been seen in May and June on Guguan (Glass and Aldan 1988, Rice and Stinson 1992; R.B. Clapp *in litt.* 1983) and in September on Sarigan (Rice *et al.* 1990). Megapodes have been observed digging nest burrows on Maug in late March and early June and on Guguan in May, August, and September (Glass and Villagomez 1986, Reichel *et al.* 1988, Rice and Stinson 1992).

Nesting on some islands may occur year-round and breeding seasonality may differ between islands depending on the source of heat for incubation (USFWS 1998b). There is no information on the nesting success or the age of sexual maturity for the Micronesian megapode.

The Micronesian megapode was historically widespread throughout the Mariana Island chain and has been recorded on all the islands, with the possible exception of Uracus (USFWS 1998b). But numbers declined on all of the southern Mariana Islands (Guam, Rota, Aguiguan, Tinian, and Saipan) in the 19th and early 20th centuries. It is doubtful if the species has ever been abundant during the last century. Definitive population surveys have not been undertaken, but observations indicate that the bird exists in small, but relatively stable, numbers, particularly on the northern islands. The megapode was extirpated on Guam and Rota, and small, remnant populations persist on Aguiguan and Tinian (fewer than 10), along with a very small (possibly reintroduced) population on Saipan (10-25 birds). Megapodes have been consistently found in small numbers (10-15) on Aguiguan during this century (Craig *et al.* 1992, Engbring *et al.* 1986, Lusk 1993, Owen 1974, Stinson 1993a, Takatsukasa 1932-1938, USFWS 1998b). A total of four megapodes were observed on Farallon de Medinilla in November 1996 (Lusk and Kessler 1996). The total island population is estimated to be less than ten birds (USFWS 1998b). The megapode remains in relatively large numbers only on the smaller, mostly uninhabited northern islands. Megapodes were not recorded on Anatahan until 1971 (Falanruw 1975) but current estimates are 200-300 birds (Reichel and Glass 1988a, USFWS 1998b). A recent forest bird survey on Sarigan estimated the population at 545-810 birds (Fancy *et al.* In review). Guguan probably supports the largest megapode population in the Marianas of around 500 birds (Rice and Stinson 1992). Megapode numbers on Guguan are believed to have declined for unknown reasons since estimates were made in 1986 of 1,200 to 2,200 birds (Glass and Villagomez 1986, USFWS 1998b). Fewer than 30 birds are reported on Alamagan, 50 to 100 on Pagan, an unknown number on Agrihan, fewer than 25 on Asuncion, 50 to 100 on Maug (on three islands), and none on Uracus (USFWS 1998b).

Current population estimates of the megapode total about 1,440 to 1,975 birds in the island chain (USFWS 1998b). The megapode was listed as endangered due to historical extirpations on Guam, Rota, Tinian, and possibly Saipan. The decline in numbers is thought to have resulted from intense exploitation by humans (hunting of adults and collection of eggs) and habitat loss (USFWS 1998b). Agriculture and overgrazing by feral goats, cattle and pigs have had a profound effect on the vegetation of the islands and are of concern for megapode (and other native forest species) populations in the northern islands (USFWS 1998b). Loss of habitat through volcanism is also known to have caused serious declines (USFWS 1998b). In addition to possible direct human predation, megapodes are known to be preyed upon by introduced monitor lizards and may also be preyed upon by feral dogs, cats, and pigs (Dekker 1989, Ludwig 1979).

A serious potential threat to megapode populations is the establishment of the brown treesnake from Guam to other islands in the Marianas archipelago (USFWS 1998b). The brown treesnake was accidentally introduced to Guam shortly after World War II and has systematically spread throughout the island, causing the loss of nearly all of the avifauna (birds) and many of the other native vertebrate and invertebrate species of Guam (USFWS 1996c). It is of great concern that there have been recent (1991) sightings of brown treesnakes in cargo from Guam on Rota, Tinian, and Saipan. Should this predatory snake become established on any island where megapodes remain, the bird's populations on these islands would be expected to decrease rapidly within a relatively short period of time.

Megapodes are known to occur within the action area. Proposed military training activities on Tinian and FDM are likely to adversely affect Micronesian megapodes.

Tinian monarch (*Monarcha takatsukasae*)

The Tinian monarch, locally known as *Chichirikan Tinian*, is a small (15 cm [6 in]) flycatcher (Dicuridae: Monarchinae) with light rufous underparts, olive-brown upper parts, dark brown wings and tail, and white rump and undertail coverts (Baker 1951). The monarch is endemic to the island of Tinian, CNMI.

The Tinian monarch was originally listed as endangered in 1970 (35 FR 8491) under the authority of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668cc). Critical habitat was not designated for the Tinian monarch. The endangered status of the monarch was continued under the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended. The decision to list the monarch as endangered was based upon an estimate by Gleize (1945) of 40-50 monarchs on Tinian after WW II (52 FR 10890), although it is not clear if his report was an estimate of the number of birds he saw, or an estimate of the entire population. About the same time as Gleize, Downs (1946) reported that monarchs were restricted in distribution to distinct locations on the island, while Marshall (1949) considered the monarch to be abundant.

In the late 1970s, Pratt *et al.* (1979) estimated monarchs to number in the tens of thousands. In 1982, the U.S. Fish and Wildlife Service (Service) conducted forest bird surveys of the southern islands in the Mariana archipelago. They found the monarch to be the second most abundant species on Tinian with a population estimate of 40,000, ubiquitously distributed throughout the island and across all forested habitat types (Engbring *et al.* 1986). Engbring *et al.* (1986) recommended the reassessment of the monarch's endangered status. This reassessment led to the reclassification of the Tinian monarch from endangered to threatened in 1987 (52 FR 10890).

Between 1994 and 1995 the Service conducted a life history study of the Tinian monarch and reported a population estimate of 52,904 monarchs. The Service found that the monarch was successfully foraging and breeding in secondary and tangantangan forests throughout the island and recommended that the threatened status of the monarch be reassessed (USFWS 1996c).

Subsequently, a survey of the avifauna of Tinian was conducted in 1996 by the Service following the methodology of the 1982 surveys for comparative purposes. The 1996 survey estimated the monarch population at 55,721 birds, significantly higher than the 1982 estimates (Lusk *et al.* 1997). The 1996 survey also found that vegetation density had significantly increased from 1982 levels. This may be related to a marked decrease in grazing pressure in recent years (Lusk *et al.* 1997). It is hypothesized that the increase in the Tinian monarch population is related to the increase in density of both native and introduced forest habitat types, which may represent an increase in monarch habitat quality (Lusk *et al.* 1997). Currently, the Service is considering removal of the Tinian monarch from the list of endangered and threatened species.

Tinian monarchs inhabit a variety of forest types on Tinian, including native limestone forest (dominated by such species as *Ficus* spp., *Elaeocarpus joga*, *Mammea odorata*, *Guamia mariannae*, *Cynometra ramiflora*, *Aglaia mariannensis*, *Premna obtusifolia*, *Pisonia grandis*, *Ochrosia mariannensis*, *Neisosperma oppositifolia*, *Intsia bijuga*, *Melanolepis multiglandulosa*, *Eugenia* spp., *Pandanus* spp., *Artocarpus* spp., and *Hernandia* spp.), secondary vegetation (consisting primarily of *Acacia confusa*, *Albizia lebbeck*, *Casuarina equisetifolia*, *Cocos nucifera*, and *Delonix regia* mixed with native species), and almost pure stands of introduced *Leucaena leucocephala* (tangantangan) (Engbring *et al.* 1986, USFWS 1996c).

Currently, the vegetation on Tinian is highly disturbed, with the single most predominant habitat type on Tinian being tangantangan thickets (Engbring *et al.* 1986, Falanruw *et al.* 1989, Fosberg 1960). According to Engbring *et al.* (1986), 38 percent of Tinian is dominated by tangantangan, while Falanruw *et al.* (1989) estimated 54 percent of the island to be covered in secondary vegetation, which in her definition included tangantangan thickets. Only five to seven percent of the island is estimated to remain in native forest (Engbring *et al.* 1986, Falanruw *et al.* 1989), which is restricted to steep limestone escarpments (Falanruw *et al.* 1989).

During the study conducted by the Service between 1994 and 1995, information was obtained on the abundance, distribution, and breeding ecology of several species found on Tinian such as the Tinian monarch (USFWS 1996c). It was found that the native limestone forest may be preferred by monarchs over secondary and tangantangan forest types, based on the following: 1) monarch home range sizes were found to be four to five times smaller in native limestone forest than in secondary and tangantangan forests (home range sizes in limestone forest averaged 1,221 square m [1,334 square yards(yds)]), while home range sizes in secondary and tangantangan forest types averaged 5,196 and 6,385 square m (5,679 and

6,979 square yds), respectively, indicating that native forest is higher quality monarch habitat because smaller areas are able to support a monarch home range; 2) 64 percent of all monarch nests were constructed in native tree species; 3) of 114 monarch nests, 62 were found in native forest while only 52 were found in the secondary and tangantangan forest types combined, indicating that monarchs have higher nest densities in native forest; 4) nesting success in native limestone forest was greater than in secondary and tangantangan forest types (of 19 nests that produced nestlings, 13 were in native limestone forest and only 6 were in secondary forest and tangantangan forests combined); and 5) based on resightings of banded birds, monarch densities were found to be four to five times higher in limestone forest than in either secondary or tangantangan forest (30.7 birds/hectare (ha)(76.7 acre), 7.7 birds/ha (19.3 acre), and 6.0 birds/ha (15.0 acre), respectively).

Other information provided by the previously mentioned study has described the Tinian monarch as a forager of the mid-level forest. It perches on relatively slender branches beneath the forest canopy and gleans invertebrates (*e.g.*, moths, butterflies, ants, caterpillars, and several species of long-legged insects) from leaf and bark surfaces. Foraging habits of the Tinian monarch are similar in all three different forest habitats (*i.e.*, limestone forest, secondary forest, and tangantangan).

The Tinian monarch likely breeds year-round. However, peak nesting periods for the Tinian monarch appear to be associated with periods of increased rainfall, which, during the time of the Service's 1994-95 study (USFWS 1996c), occurred during the months of January, May, and September. Tinian monarchs have been observed nesting in three different forest habitats (*i.e.*, native limestone, secondary, and tangantangan). Mean clutch size for the Tinian monarch is two eggs, with an occasional occurrence of one or three eggs (USFWS 1996c).

Likely predators on monarchs and their eggs and nestlings are collared kingfishers (*Halcyon chloris*), Micronesian starlings (*Aplonis opaca*), feral cats (*Felis domesticus*), and the roof rat (*Rattus rattus*) (USFWS 1996c). There is one observation of a monitor lizard (*Varanus indicus*) crawling in a tree with an egg inside its mouth that matched the size and color of a monarch or rufous fantail egg. Another cause of mortality is inclement weather, which has been known to cause a nestling and its nest to fall to the ground when the nest was hit by a large falling branch.

Tinian monarchs are known to occur throughout the action area on Tinian. Therefore, it is likely that the proposed project will adversely affect the Tinian monarch.

III. Environmental Baseline

The environmental baseline describes the status of the species and factors affecting the environment of the species or critical habitat in the proposed action area contemporaneous with the consultation in process. The baseline usually includes State, local, and private actions that affect a species at the time the consultation begins. Unrelated Federal actions that have already undergone formal or informal consultation are also a part of the environmental baseline. Federal actions within the action area that may benefit listed species or critical habitat are also included in the environmental baseline.

A. **Status of the species within the action area**

Green sea turtle
Guam: There is some regular low-level nesting of green turtles on Guam (NMFS 1998a). Green sea turtles have been known to nest at Tarague Beach (Wiles *et al.* 1995).

Tinian: Green sea turtles have been observed nesting at Unai Babui, Unai Dankulo, and Unai Chulu (USFWS 1996). There are also records of sea turtles nesting at Kammer Beach in the past (USFWS 1996).

FDM: The action area is the entire island of FDM, which includes two small beaches (both approximately 50 m long by 10 m wide), one on the southwestern corner and one on the northeastern corner of the main body of the island. Following a visit to FDM in 1997, Service biologist Michael Molina determined that the two beaches on FDM likely do not represent suitable nesting habitat for sea turtles, due to the extremely shallow nature of the beaches, the fact that the beaches are entirely or almost entirely overwashed during periods of high tide or swell, and the rocky nature of much of their substrate (BO 1-2-97-F-08). However, according to Gerald Davis of Guam DAWR, two green sea turtle nests were found during surveys of FDM in 1982. Based on this information, the Service has determined that green sea turtles may, in fact, presently nest on FDM.

Hawksbill sea turtle
Guam: Gerald Davis (Guam Department of Wildlife Resources) discovered a hawksbill nesting on Guam in November 1991 (NMFS 1998b) at Sumay Cove Marina. Hawksbill nesting on Guam is rare, although nesting hawksbills leave minimal crawl traces and not all beaches on the island are properly surveyed for nesting sea turtles (NMFS 1998b).

There are no records of hawksbills nesting in the CNMI (NMFS 1998b). This is due to: 1) beaches being scarce on the remote islands in the north of the Mariana Archipelago, 2) the long history of occupation on the more southern islands, and 3) almost no hawksbill nesting surveys of small pocket beaches have been conducted in remote areas of the CNMI. However, the lack of evidence doesn't rule out the possibility of hawksbills nesting at low levels at unknown locations (NMFS 1998b).

Mariana Fruit Bat
Guam: Almost all of the Mariana fruit bats that remain on Guam occur on Andersen AFB at Pati Point and between Ritidian Point to the northern rim of Tarague Basin (Wiles *et al.*

1995) In March 1997, between 300 to 350 bats were observed on Guam (G. Wiles, personal communication 1997). Bats are also known to occur in the limestone forest areas between Mount Almagasa and East Tower and in the western portion of the Ordnance Annex (Belt Collins 1998).

Rota: There are a total of 1,000 bats on Rota (Worthington and Taisacan 1996). Probably no bats are found in the proposed action area.

Tinian: Between 25 to 125 Mariana fruit bats have been observed on Tinian (Lemke 1984; Wiles 1996, Worthington and Taisacan 1996), but its residence status on Tinian is uncertain (Marshall *et al.* 1995b). The Mariana fruit bat has been observed roosting in large trees surrounding Lake Hagoi and along the clifflines and forest plateau south of Lake Hagoi, near Mount Lasso (Belt Collins 1998). Bats have also been seen near the West Tinian Airport and the Carolinas Ridge (Belt Collins 1998).

FDM: Two fruit bats were observed roosting in low shrubs on FDM by Tim Sutterfield, Fish and Wildlife Biologist for the Navy, during a site visit in December 1996 (Sutterfield *in lit.* 1997). These two bats probably do not represent a permanent roosting or breeding colony. Although some of the vegetation on the island may provide forage for bats, the low, shrubby nature of the vegetation makes it unlikely that bats utilize FDM for more than a temporary roosting site during travel between larger islands. No roosting or flying bats have been reported from FDM during other site visits or during pre- or post-training helicopter surveys, as would be expected if large numbers of bats were utilizing FDM on a regular basis. The two bats observed on FDM represent a small fraction of the total population for the Mariana islands. Exact take of any fruit bats on the island as the result of aerial and naval bombardment have been indeterminate due to an inability to visit the island.

Micronesian Megapode
Tinian: It is estimated that the remnant population of megapodes on Tinian consists of 10 or fewer individuals (USFWS 1998b). Three confirmed sightings of megapodes were recorded during surveys conducted in 1995, all of which occurred within the Military Leaseback Area (MLA) of Tinian (USFWS 1996c). It is estimated that approximately one-half (5 individuals) to one-third (8 individuals) of the known individuals of megapodes are located within the MLA, which represents less than 1% of the total estimated population within the Marianas archipelago.

FDM: A total of four megapodes were discovered on FDM during a site visit on November 4, 1996 (Lusk and Kessler 1996). Two megapodes were found on the island during a Navy site visit on December 17, 1996 (Figure 2) (Sutterfield *in lit.* 1997). The size of the island, 0.7 km^2, led the Service to estimate that at the time of the 1996 site visit there were likely no more than ten megapodes on the island. This number represents less than 1% of the total estimated population within the Marianas archipelago. Aerial and naval bombardment of the island since the 1996 site visit has likely decreased the numbers of megapodes on the island, but exact loss of megapodes is indeterminate due to an inability to visit the island. Megapodes may have emigrated to FDM since 1996, or reproduction on the island may have occurred since then, but recruitment levels through either of these avenues has not been determined. With regard to immigration, the island nearest FDM with a substantial megapode population, Anatahan, is approximately 50 miles away. No nesting has been recorded on FDM, but the possibility does exist.

Tinian Monarch
As previously mentioned, the current estimate of the Tinian monarch population is 55,721 birds. Within the action area on Tinian, there are approximately 45,600 monarchs, which represents approximately 82% of the total population.

The northern third of Tinian is used exclusively by the military for training purposes. The central third of Tinian is classified as the Military Lease Area which may be used for military training, but has been leased back to the CNMI government for compatible economic agriculture use and the expansion of the West Tinian Airport. These areas contain three habitat types, native limestone, secondary forest and tangantangan, that support Tinian monarchs.

B. Factors affecting species environment within the action area

Guam
Within the action area on the island of Guam, past and present Federal, State, private, and other human activities that may affect the hawksbill sea turtle, and green sea turtle include military training activities and surveys and habitat improvement projects for the above mentioned species as well as other species. Military activities within the action area on the island of Guam are ongoing. The Service has prepared five previous BOs (1-2-90-F-003, 1-2-92-F-07, 1-2-93-F-14, 1-2-94-F-05, and 1-2-94-F-06) regarding these military activities and their potential to adversely effect the green sea turtle, hawksbill sea turtle, and other listed species. The consultations covered military activities, such as helicopter training, VRC-50 flight squadron field carrier landing practice (FCLP), and the permanent relocation of the VRC-50 Squadron, aircraft training.

No incidental take was anticipated or authorized for the green sea turtle and hawksbill sea turtle for activities on Guam.

A 24-hectare wild game exclosure surrounded by a chain-link fence was constructed by Andersen Air Force Base at Area 50 of Northwest Field to exclude deer and pigs. A bulge barrier has been retrofitted to the fence to prevent brown treesnakes from entering the enclosed area. The intent at this location is to remove all, or nearly all, brown treesnakes from within the plot, and to introduce rare species (*e.g.*, the federally endangered Guam rail)

into the area.

In 1990, Guam Department of Aquatic and Wildlife Resources (GDAWR) began annual crow surveys in northern Guam (*e.g.*,AAFB) to monitor their status (Aguon 1997). Also, efforts to reverse the decline of the Mariana crow began in 1986 with attempts to protect active crow nests from brown treesnake predation. Steel sleeves and an adhesive resin were placed around trunks of active nest trees to act as a snake barrier and snake trapping was begun. Increased nest protection was achieved with the development of electrical barriers and effective snake trapping during the early 1990's. GDAWR also conducts annual monitoring of the Mariana fruit bat colony at Pati Point.

Rota
There have been no activities on Rota that have undergone section 7 consultation that anticipated the incidental take of federally listed species.

Tinian
Within the action area on the island of Tinian, past and present Federal, State, private, and other human activities that may affect the Tinian monarch include military training activities, agricultural and grazing activities, and the expansion of the West Tinian Airport. The Navy has consulted four times (BO's 1-2-84-F-26, 1-2-84-F-44, 1-2-90-F-003, and 1-2-90-F-024) regarding its training activities (*e.g.*,loading and unloading of personnel, supplies, and equipment from C-130 aircraft, clearing of vegetation for establishing bivouac camps, setting up a perimeter defense around camps, firing of weapons at the firing range, and tactical airdrops) within the action area. The consultations resulted in the anticipated incidental take (harassment) of 79 monarchs and loss (harm) of 19 nests (including eggs and young). Also, incidental take was permitted for the harassment of monarchs for ongoing activities such as the Navy's "Kennel Bear" exercises, which occurs twice a year for one to two weeks each time and Marine Corps training, which occurs three times a year for four weeks at a time.

Three other consultations have been conducted with the U.S. Army Corps of Engineers and the U.S. Information Agency for the Tinian Voice of America (VOA) project and the Federal Aviation Administration (FAA) for the expansion of the West Tinian Airport. These consultations anticipated the incidental take for the harm and harassment of 812 Tinian monarchs and the loss (harm) of 681 nests (with young and eggs). The FAA and the CNMI Commonwealth Ports Authority are working with the Tinian Legislature, CNMI DFW, the U.S. Navy, and the Service to set-aside approximately 379 hectares (ha) (937 acres (ac)) of land located to the north of West Tinian Airport to preserve into perpetuity habitat for the Tinian monarch as well as other wildlife and plant species.

FDM
The Navy has consulted five times for aerial bombardment, gunnery training, naval gunfire, and small arms gunfire exercises conducted on FDM (BO's 1-2-97-F-01, 1-2-97-F-05, 1-2-

97-F-08, 1-2-98-F-02, and 1-2-98-F-03). The consultations resulted in the anticipated incidental take of all Micronesian megapodes on the island, three adult green sea turtles and three adult hawksbill sea turtles, 12 active turtle nests, and an indeterminable number of Mariana fruit bats.

The Navy has funded the removal of feral ungulates from the island of Sarigan for the purpose of improving habitat for the Micronesian megapode and Mariana fruit bat.

IV. Effects of the Action

Green Sea Turtle & Hawksbill Sea Turtle
The primary concerns of the Service with regard to the effects of military activities on green sea turtles are (1) direct death of sea turtles on nesting beaches, (2) the destruction of active turtle nests, (3) harassment of sea turtles on nesting beaches, and (4) destruction of nesting habitat.

Mariana Fruit Bat
FDM: The primary concerns of the Service with regard to the effects of ongoing aerial bombardment and small arms gunfire practice on the Mariana fruit bat on FDM are (1) direct death of fruit bats, (2) abandonment of juvenile fruit bats by mothers, and (3) destruction of required foraging and roosting habitat. Although fruit bats are strong fliers and likely to abandon the island once bombardment begins, there remains the probability of death or injury to roosting bats from training activities.

The impact areas for aerial bombardment, naval gunfire, and small arms gunfire cover the entire area of FDM. Therefore, the Service anticipates the possible direct death or injury of fruit bats occurring on the island during the future years of training as proposed.

Micronesian Megapode
Tinian: If megapodes nest on Tinian and either build mounds or burrow between the roots of trees as incubation strategies, there is a potential that troop movements (of up to 2,000 personnel) through limestone forest or adjacent non-native secondary forests could directly affect the megapode by trampling nests that are not seen by personnel.

FDM: The primary concerns of the Service with regard to the effects of ongoing aerial bombardment and small arms gunfire practice on the Micronesian megapode on FDM are (1) direct death of megapodes, (2) destruction or abandonment of active megapode nests, and (3) destruction of required foraging, roosting, and/or nesting habitat. The potential for all of these effects was apparent when on August 2, 1997, the Navy conducted post-bombardment surveys of FDM in accordance with the terms and conditions set forth in the Service's May 16, 1997, biological opinion. As detailed in the Navy's August 21, 1997, memorandum, 25 to 50 new bomb craters were observed and a large section of the central northern portion of

the island, an area believed to represent megapode habitat, was "burned to bare earth" (Kaku *in lit.* 1997). The Service believes the August 2, 1997, survey to be representative of the type of damage that can occur during aerial bombardment, naval gunfire, and/or from small arms fire such as grenade launchers or anti-tank rockets.

The impact areas for aerial bombardment, naval gunfire, and small arms gunfire cover the entire area of FDM. Therefore the Service anticipates the possible direct death of any remaining megapodes and destruction of their nests occurring on the island during the future years of training on FDM.

Tinian Monarch
Ongoing and proposed field maneuver training on Tinian ranges from basic land navigation and cross-country movement skills for individuals (use of a map, compass, and Global Positioning System (GPS)) through exercises for up to 1,000 or more participants combining many offensive and defensive maneuvers and logistics support. Large-scale activities will occur a maximum of three times per year, for up to three weeks each time, whereas training for individuals may occur daily, weekly, or on a monthly basis. These activities can occur in areas that contain limestone forest, secondary forest, and tangantangan forest, all of which support Tinian monarchs.

Tinian monarchs are known to nest throughout the action area. Due to the number of people that will be traveling though the area during the day or night and the fact that Tinian monarch nests are found mid-level in trees, there is potential for soldiers moving through the area to directly affect monarchs by knocking nests out of trees.

V. Cumulative Effects

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. There are no known future State, local, or private actions that are reasonably certain to occur in the action area.

VI. Conclusion

After reviewing the current status of the green sea turtle, hawksbill sea turtle, Micronesian megapode, and the Tinian monarch, the environmental baseline of these species in the action area, and the effects of the proposed action, including cumulative effects, it is the Service's biological opinion that the proposed military training activities are not likely to jeopardize the continued existence of these species. No critical habitat has been designated for these species; therefore, none will be affected.

After reviewing the current status of the Mariana fruit bat (within the CNMI), the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's conference opinion that these military training activities, as proposed, is not likely to jeopardize the continued existence of the proposed Mariana fruit bat. No critical habitat has been proposed, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Department of Defense so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The Department of Defense has a continuing duty to regulate the activity covered by this incidental take statement. If the Department of Defense (1) fails to assume and implement the terms and conditions or (2) fails to require adherence to the terms and conditions of the incidental take statement through enforceable terms that are added to a permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Department of Defense or (applicant) must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement (50 CFR 402.14(i)(3)).

Amount or extent of take anticipated for listed species

Guam
Hawksbill sea turtle: The Service has determined that hawkshill sea turtles may be incidentally taken during amphibious landing training (*e.g*, AAV and LCU) near Sumay Cove, if such training is conducted during the nesting period, which could occur year round (NMFS 1998b). Specifically, incubating eggs may be inundated with water from wind and wave action from amphibious vehicles landing on the boat ramp at the Sumay Cove Mariana. The incidental take is expected to be in the

form of the loss of one turtle nest (eggs and associated hatchlings) per year.

Tinian
Green sea turtle: The Service has determined that green sea turtles may be incidentally taken during the amphibious landing training (*e.g.*, LCAC, AAV, and LCU) proposed at Unai Chulu, Unai Dankulo, and Unai Babui if such training occurs during the nesting season. Specifically, incubating eggs may be crushed by the landing craft or by off-loaded vehicles; vehicle tracks in the sand may prevent hatchlings from reaching the ocean; and activities on or near the beach may prevent turtles from nesting on the beach. The incidental take is expected to be in the form of the loss of one turtle nest (eggs and associated hatchlings) per nesting season.

The Service is concerned that if a nest is not found prior to a landing that it could be crushed and any eggs or hatchlings within or near the nest could be affected.

Tinian monarch: The Service has determined that Tinian monarchs may be incidentally taken during troop movements of 10 or more personnel occurring within monarch habitat during peak nesting periods, which is during the months of January, May, and September as associated with periods of increased rainfall (USFWS 1996a). The Service estimates that 1% of the troops moving through the forest, especially at night, could inadvertently knock a monarch nest out of the nest tree and result in the take of a egg or a chick. The incidental take is expected to be in the form of the loss of a combination of 60 eggs or chicks per year.

Micronesian megapode: The Service's primary concern is that troops moving through the forest, especially at night, may inadvertently step on and crush a megapode nest. The incidental take is expected to be in the form of the loss of one megapode nest, and any associated eggs per year.

FDM
Green sea turtle: Military training activities on FDM from the year 2001 and into the future are anticipated to result in the take of green sea turtles. The incidental take is expected to be in form of the loss of one nest per year from bombing and gunnery practice on FDM.

Micronesian megapode: The Service believes that the two military exercises, which occurred from July 21 to August 1, 1997, and from September 12 to 13, 1997, may have resulted in the taking of all megapodes that occurred on FDM at the time of the bombing and gunnery practice. Such taking likely took the form of direct death or injury, harm and harassment. We therefore believe that the levels of incidental take authorized in biological opinion #1-2-97-F-05 and biological opinion #1-2-97-F-08 have likely been met. The military exercise covered under the December 30, 1997, biological opinion (#1-2-98-F-02) was not conducted. We anticipate that any megapodes still present on FDM, or that may colonize the island prior to the onset of any of the military exercises covered under biological opinion #1-2-98-F-03, which covers the time period of May 1, 1998 to May

1, 2001, may also be incidentally taken.

Under this consultation, military training activities on FDM from the year 2001 and into the future are anticipated to result in the take of Micronesian megapodes. The incidental take is expected to be in form of the death of one megapode per year from bombing and gunnery practice on FDM.

Amount or extent of take anticipated for proposed species

FDM

Mariana fruit bat: For previous consultations for military training activities on FDM, it was anticipated that any bats present on the island at the time of commencement of military activities covered under the above timeline would also be incidentally taken. Under this consultation, military training activities on FDM from the year 2001 and into the future are anticipated to result in the take of Mariana fruit bats. The Service is concerned that if fruit bats are present on FDM, they will be hit by the ammunition used for training. The incidental take is expected to be in form of the death or injury of one adult or juvenile Mariana fruit bat per year from bombing and gunnery practice on FDM.

Effect of the take

In the accompanying biological opinion/conference report, the Service determined that this level of anticipated take is not likely to result in jeopardy to the green sea turtle, hawksbill sea turtle, Micronesian megapode, Mariana fruit bat, and Tinian monarch or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures for Listed Species

The Service believes the following reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of green sea turtles, hawksbill sea turtles, Micronesian megapodes, and Tinian monarchs.

1. Minimize the loss of nests, eggs, and hatchlings of green sea turtles on the islands of Tinian and FDM.

2. Minimize the loss of nests, eggs, and hatchlings of hawksbill sea turtles at Sumay Cove, Guam.

3. Minimize the loss of eggs of megapodes on Tinian and adult and juvenile megapodes and any nests on FDM.

5. Minimize the loss of eggs and chicks of Tinian monarchs on Tinian.

Terms and Conditions for Listed Species

In order to be exempt from the prohibitions of section 9 of the Act, the Department of Defense must comply with the following terms and conditions, which implement the reasonable and prudent

measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

In order to address reasonable and prudent measure #1, the following terms and conditions apply:

1a) Minimize amphibious landing exercises on Tinian and aerial bombardment, gunnery training, naval gunfire, and small arms gunfire exercises conducted on FDM during the green sea turtle nesting period (January to October);

1b) Report to the Service within one month of the completion of amphibious vehicle landings on known turtle nesting beaches on Tinian the amount or extent of take of green sea turtles that has occurred as a result of implementation of the proposed action; and

1c) Report to the Service within one month of the completion of aerial bombardment, gunnery training, naval gunfire, and small arms gunfire exercises on FDM the amount or extent of take of green sea turtles or their nests that has occurred as a result of implementation of the proposed action.

In order to address reasonable and prudent measure #2, the following terms and conditions apply:

2a) For AAV and LCU landings at Sumay Cove, Guam, conduct the mitigation/minimization measures as stated in the project description section of the BO for amphibious landing exercises.

2b) Temporarily cease amphibious landing exercises will be temporarily ceased at any given time that there is a sea turtle or nest present within Sumay Cove, Guam until the turtle or nest is not in harm's way;

2c) Minimize amphibious landing exercises at Sumay Cove, Guam, during the hawksbill sea turtle nesting period; and

2d) Report to the Service within one month of the completion of amphibious vehicle landings at Sumay Cove, Guam, the amount or extent of take of hawksbill sea turtles that has occurred as a result of implementation of the proposed action.

In order to address reasonable and prudent measure #3 the following terms and conditions apply:

3a) On FDM, the military shall restrict its impact zone to the central interior portion and/or southern tip of the island and western cliff faces, to the extent possible;

3b) The use of cluster bombs shall be prohibited in training on FDM; and

3c) The Department of Defense shall report within one month of completion each time military training activities have taken place on FDM on the amount or extent of take of megapodes and fruit bats that has occurred as a result of implementation of the proposed action.

In order to address reasonable and prudent measure #4 the following terms and conditions apply:

4a) On Tinian, limit the amount of troop movements occurring at night through Tinian monarch habitat during peak breeding season, which is during the months of January, May, and September as associated with periods of increased rainfall (USFWS 1996a), and through limestone forest and adjacent secondary forest during the Micronesian megapode nesting season;

4b) Avoid conducting troop movements within monarch nesting habitat during the peak nesting season for monarchs; and

4c) Report to the Service on an annual basis (by December 31) regarding troop movements on Tinian and the amount or extent of take of Tinian monarchs or Micronesian megapodes that has occurred as a result of implementation of the proposed action. The reports should be sent to the Pacific Islands Manager, U.S. Fish and Wildlife Service, 300 Ala Moana Boulevard, Room 3-122, Box 50088, Honolulu, Hawaii, 96850.

The following term and condition applies to each species in which incidental take has been permitted:

5) Any injured or dead listed birds, mammals or reptiles found during any of the proposed and ongoing military training activities in the Mariana Archipelago should be reported to the Service's Law Enforcement Office in Guam, Guam Department of Aquatic and Wildlife Resources (GDAWR), and the CNMI DFW. Care instructions will be provided regarding any sick or injured listed species. If dead individuals are found, the Service's Law Enforcement Office in Guam should be notified within one working day. Dead listed species should be wrapped in aluminum foil and refrigerated (dead birds should not be wrapped in plastic or placed in a freezer) and then given to the Service's staff for disposition. The Service's Law Enforcement Office will provide further instructions on the proper disposal of the animals, including shipping requirements to facilities to determine cause of death, if the cause is not known. The Service's Law Enforcement Office in Guam (U.S. Fish and Wildlife Service, P.O. Box 23774, GMF, Barrigada, Guam, 96921; telephone: 671/472-7151), the Pacific Islands Ecological Services Office in Honolulu (U.S. Fish and Wildlife Service, 300 Ala Moana Boulevard, Room 3-122, Box 50088, Honolulu, Hawaii, 96850; telephone: 808/541-3441), GDAWR (192 Dairy Road, Manglao, GU 96923, 671/735-3957),and the CNMI DFW (P.O. Box 10007, Saipan, MP, 96950; telephone: 670/322-9628) should be provided with a written report describing the events surrounding the demise or

injury of the species, if known, and measures must be taken to prevent further injuries or deaths.

Reasonable and Prudent Measures for Proposed Species
The prohibitions against taking the species found in section 9 of the Act do not apply until the species is listed. However, the Service advises the Department of Defense to consider implementing the following reasonable and prudent measures. If this conference report is adopted as a biological opinion following a listing or designation, these measures, with their implementing terms and conditions, will not be discretionary.

1. Minimize the loss of adult and juvenile Mariana fruit bats on FDM.

Terms and Conditions for Proposed Species
In order to be exempt from the prohibitions of section 9 of the Act, the Department of Defense must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

In order to address reasonable and prudent measure #1 the following terms and conditions apply:

1a) On FDM, the military shall restrict its impact zone to the central interior portion and/or southern tip of the island and western cliff faces, to the extent possible;

1b) The use of cluster bombs shall be prohibited in training on FDM; and

1c) The Department of Defense shall report within one month of completion each time military training activities have taken place on FDM on the amount or extent of take of megapodes and fruit bats that has occurred as a result of implementation of the proposed action.

In summary, the Service anticipates that no more than two nests of green sea turtles per nesting season (one nest on Tinian and one nest on FDM), one hawksbill sea turtle nest per year on Guam, 60 eggs or chicks per year of Tinian monarchs, one Micronesian megapode egg per year on Tinian, one megapode per year on FDM, and one Marina fruit bat per year on FDM will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Brown Treesnake Control/Interdiction Plan for Military Training Exercises (BTS Plan) and the U.S. Department of Agriculture, Wildlife Services (WS), Brown Treesnake Control Procedures In Support of Scheduled Military Training Exercises, are located in Appendices E-1 and E-2 respectively of the DEIS. These documents describe various proposed measures to prevent the export of the brown treesnake from Guam to other Mariana and Pacific islands and the U.S. Mainland. However, the plans are several years old and some of the protocols in them have become outdated. The Service recommends that the BTS Plan be updated by consolidating the most effective protocols regarding prevention and control of the brown treesnake in order to avoid any confusion by those carrying out the measures. Comments regarding the design and implementation of the revised BTS Plan should be solicited from WS, DFW, the Biological Resources Division of the U.S. Geological Survey (BRD), and the Service. Also, the effectiveness of the BTS Plan should be assessed periodically by involving external expertise on snake control techniques and strategies. As new information and techniques become available, the BTS Plan should be updated.

The Service recommends that the DOD consider funding the following conservation and recovery projects for threatened and endangered species found within the Mariana Islands: (1) efforts to eradicate feral ungulates on uninhabited northern islands, (2) surveys to assess status, distribution, and nesting/roosting areas of threatened or endangered species, (3) basic research into the life history and demography of threatened or endangered species, and (4) rat (*Rattus* spp.) eradication on uninhabited northern islands.

In addition to FDM providing habitat for the green sea turtle, Micronesian megapode, and Mariana fruit bat, FDM also supports colonies of breeding seabirds, including masked boobies (*Sula dactylatra*), brown boobies (*Sula leucogaster*), red-footed boobies (*Sula sula*), great frigatebirds (*Fregata minor*), common noddies (*Anous stolidus*), black noddies (*Anous minutus*), and white terns (*Gygis alba*). FDM is particularly important for great frigatebirds as it is one of only two small breeding colonies known to exist in the Mariana island chain, and for masked boobies because it represents the largest known nesting site for this species in the Mariana or Caroline islands. Although none of these birds are listed under the Act, they are protected under the Migratory Bird Treaty Act of 1918 [16 U.S.C. 703-712; 40 Stat. 755], as amended. The Service recommends that the Navy concentrate impacts within the interior portion of the island to lessen harm to nesting and roosting seabirds and that bombing activities be limited to low periods in the seabird breeding season. Also, the Navy should establish a long-term monitoring program to evaluate the effects of aerial bombing and naval gunnery on seabird populations.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Conclusion

The Service has determined the military activities carried out by the Department of Defense on Guam, Rota, FDM, and Tinian, as described in the DEIS are not likely to jeopardize the continued existence of the green sea turtle, hawksbill sea turtle, Mariana fruit bat, Micronesian megapode, and the Tinian monarch.

This concludes formal consultation and conference on the actions outlined in the request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

You may ask the Service to confirm the conference report as a biological opinion issued through formal consultation if the Marianas fruit bat is listed within the CNMI. The request must be in writing. If the Service reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, the Service will confirm the conference report as the biological opinion of the project and no further section 7 consultation will be necessary.

After listing of the Mariana fruit bat in the CNMI as endangered/threatened and/or designation of critical habitat for the Mariana fruit bat and any subsequent adoption of this conference report, the Federal agency shall request reinitiation of consultation if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect the species or critical habitat in a manner or to an extent not considered in this conference report; (3) the agency action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this conference report; or (4) a new species is listed or critical habitat designated that may be affected by the action.

The incidental take statement provided in this conference report does not become effective until the species is listed and the conference report is adopted as the biological opinion issued through formal consultation. At that time, the project will be reviewed to determine whether any take of the Mariana fruit bat within the CNMI has occurred. Modifications of the report and incidental take statement may be appropriate to reelect that take. No take of the Mariana fruit bat in the CNMI may occur between the listing of the species and the adoption of the conference report through formal consultation, or the completion of a subsequent formal consultation.

This BO and formal conference report satisfies section 7 requirements of the Act. However, it does not cover requirements pertaining to wildlife and plant species under local territorial or commonwealth laws and regulations.

If you have any questions concerning this biological opinion or conference report, please contact Assistant Field Supervisor Karen Rosa or Fish and Wildlife Biologists Leila Gibson (telephone: 808/541-3441; facsimile: 808/541-3470).

Sincerely,

Robert P. Smith

Robert P. Smith
Pacific Islands Manager

LITERATURE CITED

Anonymous. 1984. Oxford University expedition to the Mariana Islands. Bulletin of Oxford University Exploration Club 7: 73-84.

Aguon, C. F. 1997. Survey for Mariana crows and their nest sites. In: Job Progress Reports - Federal Aid in Wildlife Restoration, Division of Aquatic and Wildlife Resources, Guam.

Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. Univ. Kansas Publ., Mus. Nat. Hist. 3: 1-359.

Belt Collins. 1998. Draft Environmental Impact Statement (DEIS) Military Training in the Marianas. U.S. Pacific Command.

Clark, G.A. 1964. Life histories and the evolution of megapodes. Living Bird 3: 149-167.

Coultas, W.F. 1931. Whitney south sea expedition journals, Vo. W. Journal and letters, Vol. II, of William F. Coultas, November 1930 to December 1931. American Museum of Natural History, New York. Unpublished. 290 pp.

Cox, P., T. Elmqvist, E. Pierson, and W. Rainey. 1992. Flying Foxes as pollinators and seed dispersers in Pacific island ecosystems. In: Wilson, D. E. and G. L. Graham (eds.), Pacific Island Flying Foxes: Proceedings of an International Conservation Conference. U.S. Fish and Wildlife Service Biological Report 90(23):18-23.

Craig, R.J., R. Chandran, and A. Ellis. 1992. Bird populations on Aguiguan: a ten year update. In Craig, R.J. (ed.) The Aguiguan Expedition. Proceedings: Marianas Research Symposium 1: 8-15. Northern Mariana College, Saipan.

Crome, F.H.J. and H.E. Brown. 1979. Notes on the social organization of the orange-footed Scrubfowl *Megapodius reinwardt*. Emu 79: 111-119.

Dekker, R.W.R.J. 1989. Predation and the western limits of megapode distribution (Megapodiidae: Aves). J. Biogeography 16: 317-321.

Dekker, R.W.R.J. 1992. Status and distribution of the Nicobar megapode *Megapodius nicobariensis abbotti* on Great Nicobar, India. Unpubl. Rept. National Museum of Natural History, Leiden, the Netherlands.

Dekker, R.W.R.J. and T.G. Brom 1992. Megapode phylogeny and the interpretation of incubation strategies. Pp. 19-31 in Dekker, R.W.R.J. and D.N. Jones (eds.) Proceedings of the First International Megapode Symposium, Christchurch, New Zealand, December 1990. Zoologische Verhandelingen 278: 1-78. Leiden.

Downs, T. 1946. Birds on Tinian in the Marianas. Trans. Kansas Acad. Sci., 49:87-106.

Engbring, J., F.L. Ramsey, and V.J. Wildman. 1986. Micronesian forest bird survey, 1982: Saipan, Tinian, Aguijan, and Rota. U.S. Fish and Wildlife Report, Honolulu, HI. 143 pp.

Falanruw, M.C.V. 1975. Distribution of the Micronesian Megapode *Megapodius laperouse* in the Northern Mariana Islands. Micronesica 11: 149-150.

Falanruw, M.C., T.G. Cole, and A.H. Ambacker. 1989. Vegetation survey of Rota, Tinian, and Saipan, Commonwealth of the Northern Mariana Islands. USDA Forest Service Resource Bulletin PSW-27.

Fancy, S.G., R.J. Craig, and C.W. Kessler. (In review). Forest bird and fruit bat populations on Sarigan, Mariana Islands.

Fosberg, F.R. 1960. *Serianthes* Benth. (Leguminosae-Mimosoideae-Ingeae). Reinwardtia 5: 293-317.

Glass, P.O. and D.T. Aldan. 1988. Micronesian Megapode Surveys and Research. Pp. 131-153 in Division of Fish and Wildlife Progress Report: 1982-1987. CNMI Division of Fish and Wildlife, Saipan.

Glass, P. and E.M. Taisacan. 1988. Marianas fruit bat surveys and research. Pp. 1-22 *In* Five Year Progress Report, Fiscal Year 1982-87. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Glass, P.O. and E.C. Villagomez. 1986. Trip Report: Guguan, 8-20 September. CNMI Division of Fish and Wildlife, Saipan.

Gleize, D.A. 1945. Birds of Tinian. Bull. Mass. Audubon Soc. 29: 220.

Jones, D.N., R.W.R.J. Dekker, and C.S. Roselaar. 1995. The Megapodes. Oxford: Oxford University Press.

Kessler, C. 1997. Feral animal monitoring and management. Pp. 8-14 *In* Annual Progress Report, Fiscal Year 1996. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Lemke, T.O. 1984. Marianas fruit bat surveys and inventories. Pp 3-16 *in* Annual Report, Fiscal Year 1984. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Lemke, T.O. 1986. Petition to list the Marianas fruit bat (*Pteropus mariannus mariannus*) as an endangered species in the Commonwealth of the Northern Mariana Islands. Unpublished.

Lemke, T.O. 1992. Status of the Marianas fruit bat (Pteropus mariannus) in the Northern Mariana Islands north of Saipan. In: Wilson, D.E. and G.L. Graham (eds.), Pacific Island Flying Foxes: Proceedings of an International Conservation Conference. U.S. Fish and Wildlife Service Biological Report 90(23):68-73.

Ludwig, G.M. 1979. Fish and Wildlife Concerns and Recommendations for Northern Marianas Islands based on July 1978 Field Trip. Unpublished report, U.S. Fish and Wildlife Service, Honolulu.

Lusk, M. 1993. Field Trip Report: Aguiguan, 23-26 August. CNMI Division of Fish and Wildlife, Saipan.

Lusk, M and C. Kessler. 1996. Trip Report: Farallon de Medinilla, 3-4 November. U.S. Fish and Wildlife Service, Pacific Island Ecoregion, Honolulu, HI.

Lusk, M.R., S. Hess, M. Reynolds, and S. Johnston. 1997. Population status of the Tinian monarch (*Monarcha takatsukasae*) from the island of Tinian, Commonwealth of the Northern Mariana Islands. U.S. Fish and Wildlife Service report. 12 pp.

Marshall, A.P., D.J. Worthington, G.J. Wiles, D.J. Grout, C.C. Kessler, V.A. Camacho, E.M. Taisacan, and T. Rubenstein. 1995b. A survey of the Mariana fruit bat (*Pteropus mariannus*) on Anatahan, Commonwealth of the Northern Mariana Islands, July, 1995., Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands. Unpublished report. 28 pp.

Marshall, J.T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam, and Palau. Condor 51:200-221.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. 1998a. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. 1998b. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*). National Marine Fisheries Service, Silver Spring, MD.

Olson, S.L. 1980. The significance of the distribution of the Megapodiidae. Emu 80: 21-24.

Oustalet, M.E. 1896. Les mammiferes et les oiseaux des Iles Mariannes. Nouv. Arch. Mus. Nat. Paris, Ser. 3,8: 24-74.

Owen, B. 1974. Environmental impact study on the terrestrial fauna and flora of Tinian with respect to the proposed establishment of a U.S. miltary base on that island. Unpubl. Rept., Trust Territory Conservation Office (cited in Glass and Aldan 1988).

Pierson, E. and W. Rainey. 1992. The biology of flying foxes of the genus *Pteropus*: A Review. *In* Wilson, D.E. and G.L. Graham (eds.), Pacific Island Flying Foxes: Proceedings of an International conservation Conference. U.S. Fish and Wildlife Service Biological Report 90(23): 1-17.

Pratt, H.D., P. L. Brunner, and D. G. Berrett. 1979. America's unknown avifauna: the birds of the Mariana Islands. American Birds 33(3):227-235.

Pratt, H.D., J. Engbring, P.L. Bruner, and D.G. Berrett. 1980. Notes on the taxonomy, natural history, and status of the resident birds of Palau. Condor 82: 117-131.

Pratt, H.D., P.L. Bruner, and D.G. Berrett. 1987. A Field Guide to the Birds of Hawaii and the Tropical Pacific. Princeton: Princeton University Press.

Reichel, J.D. and P.O. Glass. 1988. Field Trip Report: Anatahan, 27-29 September. CNMI Division of Fish and Wildlife, Saipan.

Reichel, J.D., S. Taisacan, and P.O. Glass. 1988. Field Trip Report, Northern Islands, 27 May - 5 June. CNMI Division of Fish and Wildlife, Saipan.

Rice, C.G. and D.W. Stinson. 1992. Field Trip Report: Chiba Institute Northern Islands Trip, 11-20 May, 24 May-9June. CNMI Division of Fish and Wildlife, Saipan.

Rice, C.G., D.W. Stinson, and R.J. Craig. 1990. Field Trip Report, Sarigan, 18-22 September. CNMI Division of Fish and Wildlife, Saipan.

Stinson, D.W. 1993a. Micronesian Megapode Research. Pp. 217-233 in Division of Fish and Wildlife Research and Management Program, Progress Report: 1987-1992. CNMI Division of Fish and Wildlife, Saipan.

Stinson, D.W. 1993b. Northern Marianas. *In*: Scott, D.A. (ed.). A directory of wetlands in Oceania: 263-283. IWRB, Slimbridge, U.K. and AWB, Kuala Lumpur, Malaysia. 444 pp.

Takatsukasa, S. 1932-1938. The Birds of Nippon. London: H.F. & G. Witherby.

Todd, D. 1983. Pritchard's Megapode on Niaufo'ou Island, Kingdom of Tonga. Journal of the World Pheasant Assoc. 8: 69-88.

U.S. Fish and Wildlife Service. 1990. Guam Mariana fruit Bat and Little Mariana Fruit Bat Recovery Plan. Portland, Oregon. 57 pp. + Appendix.

U.S. Fish and Wildlife Service. 1991. Recovery Plan for the Mariana Islands Population of the Vanikoro Swiftlet, *Aerodramus vanikorensis bartschi*. U.S. Fish and Wildlife Service, Portland, OR. 49 pp.

U.S. Fish and Wildlife Service. 1993. Recovery Plan for *Serianthes nelsonii*. U.S. Fish and Wildlife Service, Portland, OR. 60 pp.

U.S. Fish and Wildlife Service. 1996a. Characteristics of Mariana common moorhens and wetland habitats within the U.S. Department of Navy's Military Lease Area and Exclusive Military Use Area on the Island of Tinian, Commonwealth of the Northern Mariana Islands. U.S. Fish and Wildl. Serv., Div. Ecol Serv., Honolulu, HI. 32 pp + photos.

U.S. Fish and Wildlife Service. 1996b. U.S. Fish and Wildlife Service Research Report Part III: Status and distribution of marine turtles on the Island of Tinian, CNMI - 1994 & 1995. U.S. Fish and Wildlife Service, Honolulu, HI. 37 pp.

U.S. Fish and Wildlife Service. 1996c. Wildlife research report for navy-leased lands on the island of Tinian, CNMI. Prepared for Department of the Navy, PACNAVFACENGCOM, Pearl Harbor, HI. 100 pp.

U.S. Fish and Wildlife Service. 1998a. Endangered and threatened wildlife and plants: proposed reclassification from endangered to threatened status for the Mariana fruit bat from Guam, and proposed threatened status for the Mariana fruit bat from the Common wealth of the Northern Mariana Islands. 63 FR 14641.

U.S. Fish and Wildlife Service. 1998b. Recovery Plan for the Micronesian Megapode (*Megapodius laperouse laperouse*). U.S. Fish and Wildlife Service, Portland, OR. 65 + pp.

Wiles, G.J. 1987a. Current research and future management of Mariana fruit bats (Chiroptera: Pteropodidae) on Guam. Australian Mammalogy 10: 93-95.

Wiles, G.J. 1987b. The status of fruit bats on Guam. Pacific Science 41: 148-157.

Wiles, G.J. 1996. Current status, distribution, and natural history of Marianas fruit bats (1410, 1440, 1450). In: Annual Report, Fiscal Year 1996. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Aquatic and Wildlife Resources, Guam.

Wiles, G. J. and P. Glass. 1990. Interisland movements of fruit bats (Pteropus mariannus) in the Mariana Islands. Atoll Research Bulletin 343: 1-6.

Wiles, G.J., C.F. Aguon, G.W. Davis, and D.J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. Micronesia 28:31-49.

Wiles, G.J., T.O. Lemke, and H.H. Payne. 1989. Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Conservation Biology 3: 66-76.

Worthington, D.J. and E.M. Taisacan. 1995. Fruit bat research. Pp. 5-12 *in* Annual Report, Fiscal Year 1994. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Worthington, D.J. and E.M. Taisacan. 1996. Fruit bat research. Pp. 6-17 *in* Annual Report, Fiscal Year 1995. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

PROGRAMMATIC AGREEMENT AMONG THE COMMANDER IN CHIEF, U.S. PACIFIC COMMAND REPRESENTATIVE GUAM AND THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (USCINCPAC REP GUAM/CNMI), THE ADVISORY COUNCIL ON HISTORIC PRESERVATION AND THE CNMI HISTORIC PRESERVATION OFFICER REGARDING IMPLEMENTATION OF MILITARY TRAINING ON TINIAN

WHEREAS, The U.S. Department of Defense (DoD) has leased 16,554 acres on the island of Tinian and near shore areas from the Commonwealth of the Northern Mariana Islands (CNMI) for military purposes; and

WHEREAS, under the lease agreement, DoD is granted full possession of approximately 7510 acres of an Exclusive Military Use Area at the north end of the island; and

WHEREAS, the Commander in Chief, Pacific Command Representative, Commander U.S. Naval Forces Marianas (USCINCPAC REP), is the administrative agent for DoD in the Mariana Islands; and

WHEREAS, USCINCPAC REP has assigned Pacific Division, Naval Facilities Engineering Command (PACNAVFACENGCOM) as coordinating agency to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act of 1969, as amended (P.L. 91-190) and review proposed military training exercises under Section 106 of the National Historic Preservation Act of 1969, as amended (16 U.S.C. 470f) hereinafter Section 106 and Section 110 of the same Act (16 U.S.C. 470h-2(f)); and

WHEREAS, USCINCPAC REP has conducted an inventory survey of the majority of Exclusive Military Use Area (EMUA) to identify and evaluate historic properties; and

WHEREAS, the USCINCPAC REP has determined that the military training program may have an effect upon the North Field National Historic Landmark and other historic properties determined eligible for inclusion in the National Register of Historic Places (NRHP), as identified in the reports *Archaeological Inventory Survey in Conjunction with EIS for Training Exercises on Tinian Island* and *Military Exercises and Historic Sites in Military Training Areas on the Island of Tinian: An Archaeological Assessment*, and has consulted with the Advisory Council on Historic Preservation (ACHP) and the CNMI Historic Preservation Officer (HPO) pursuant to 36 CFR Part 800.13, implementing Section 106; and

Enclosure (1)

WHEREAS, the public has been notified of the proposed military training program and views were solicited through the EIS scoping meetings and Draft EIS public hearings held on the islands of Tinian, Saipan, Rota and Guam; and

WHEREAS, National Park Service, through its Western Regional Office Division, and the Historic Preservation Coordinator of the Municipality of Tinian and Aguigan (Tinian HPC) have participated in the consultation; and

NOW, THEREFORE, USCINCPAC REP, the Council, and the CNMI HPO agree that military training program shall be administered in accordance with the following stipulations to satisfy USCINCPAC REP Section 106 responsibility for all individual undertakings of the military exercises on Tinian and near shore areas.

STIPULATIONS

USCINCPAC REP will ensure that the following measures are carried out:

I. IDENTIFICATION OF HISTORIC PROPERTIES.

A. USCINCPAC REP has completed an archaeological inventory survey of about 6,000 acres in the EMUA to identify historic properties, with findings presented in the report *Archaeological Inventory Survey in Conjunction with EIS for Training Exercises on Tinian Island.* Review copies of this report have been provided to the CNMI HPO and the Tinian HPC.

B. USCINCPAC REP will inventory the remaining 1,600 acres in the EMUA and about 10,000 leaseback lands in two separate on-going inventory surveys and evaluation of historic properties to be completed in 2000.

C. USCINCPAC REP will provide copies of the reports from the on-going surveys to the signatories of this PA for their review and comment on the National Register eligibility of identified historic properties. If comments are not received within 30 days of receiving the reports, USCINCPAC REP will assume concurrence from the CNMI HPO on the National Register eligibility determinations.

II. CONSTRAINED AREAS.

A. USCINCPAC REP will ensure that introduction of forces and other military training exercises will make all attempts and make every effort to avoid affecting any historical remains associated with the North Field National Landmark and archaeological sites associated with ancient Chamorro occupation or the historic period that are eligible for listing on the NRHP. Restrictions on training exercises will be accomplished by defining constrained areas on maps (Attachment 1) as No Training (NT) or No Cultural Resource Damage (NCRD) areas.

1. NT means complete avoidance with no training exercises.

2. NCRD means no vehicular travel off-road, no pyrotechnic, no demolition, and no digging without prior written approval from USCINCPAC REP. Military training activities can be carried out in NCRD areas on a limited basis without affecting historic properties. Access on designated roadways limits traffic to pedestrians and rubber-tired vehicles up to 1 1/4-ton trucks.

B. USCINCPAC REP will update the constraints maps as new information, gathered during inventory survey and other investigations of federally controlled land on Tinian, concerning the location and status of historic properties, becomes available that changes the status of NT or NCRD areas to eliminate, reduce or expand authorized training activities.

III. INSTRUCTION OF TRAINING PARTICIPANTS.

A. USCINCPAC REP shall instruct all personnel participating in military training exercises on the following prior to the exercises, to assure compliance with Stipulation II.A.

1. Tinian's historic significance and the significance of archaeological, historic, and cultural properties including Chamorro, pre-World War II, and World War II resources.

2. Location and definition of NT and NCRD and areas limited to pedestrian and rubber-tired vehicle traffic.

IV. FIELD MITIGATION AND MONITORING.

USCINCPAC REP shall ensure that all mitigation and monitoring carried out pursuant to this agreement is carried out by or under the direct supervision of a person or persons assigned by DoD that meet or exceed Professional Qualification Standards as stated in the Department of the Interior Regulations 36 CFR Part 61 Appendix A.

A. Japanese Air Command Post

1. The DoD qualified person will oversee the placement of temporary targets and bullet traps that are designed to stop the trajectory and ricochet of bullets to mitigate and avoid potential adverse effect to the Japanese Naval Air Command Post during Training in an Urban Environment (TRUE) exercises. The DoD qualified person will ensure that shell casings are removed and the site is restored to its condition prior to the exercise.

2. The DoD qualified person will photo-document the structure before and after each TRUE exercise and examine the photographs to ensure the targets and bullet traps successfully mitigate the potential adverse affect. Based upon the Criteria of Adverse

Effect at 36 CFR Part 800.9(b), the DoD qualified person, in consultation with the CNMI HPO, will determine whether the TRUE exercise has had an adverse effect on the Command Post. The TRUE training will be allowed to continue as long as no adverse effects are recorded. If there are adverse effects, USCINCPAC REP will consult with the CNMI HPO on how to mitigate the adverse effects such as modifications to the TRUE exercise or placement of temporary targets and bullet traps.

B Unai Chulu and Unai Dankulo

USCINCPAC REP shall monitor introduction of forces for military training exercises by Air Cushioned Landing Craft (LCAC) at Unai Chulu and Unai Dankulo to ensure vehicles and pedestrians remain on designated ingress and egress paths and comply with NT and NDCR constraints.

C. Site TN-073

Site TN-073 will be protected by specifications agreed to and stated in Attachment (2) of this document to allow Tinian residents use with recreational vehicles and military use by pedestrians and rubber-tired vehicles.

V. ARTIFACT STORAGE.

USCINCPAC REP will turn all artifacts and cultural materials that are inadvertently discovered or displaced during training over to CNMI HPO for proper storage and curation.

VI. TRAINING PROGRAM REVISIONS.

USCINCPAC REP will notify and coordinate with CNMI HPO and Tinian HPC on a case by case basis for introduction of forces and maneuvers on any location not previously described in this document or the EIS on Tinian and near shore areas to establish constraints and mitigation measures.

VII. PUBLIC OBJECTIONS.

At any time during implementation of the measures stipulated in this PA, should an objection to any such measure or its manner of implementation be raised by a member of the public, USCINCPAC REP shall take the objection into account and consult as needed with the objecting party, the SHPO, or the ACHP to resolve the objection.

VIII. REPORTING REQUIREMENTS.

A. Schedule: USCINCPAC REP shall provide the CNMI HPO and the ACHP with a report that summarizes its activities under this PA within four (4) months after each Tandem Thrust or a similar type of training exercise that this PA is in effect.

B. Contents: These reports will, at a minimum, include the following information:

1. Photographs as described in Stipulation IV.B.2 that document the Japanese Air Command before and after each TRUE exercise, including an assessment or any other relevant information regarding the effect of each TRUE exercise.

2. Summaries of all other actions carried out under Stipulations IV, V, and VI.

3. Any recommendations to amend this PA or improve communications among parties.

C. Review by CNMI HPO and ACHP: The CNMI HPO and ACHP will review each report and provide USCINCPAC REP with comments. The CNMI HPO or ACHP may request additional documentation or further explanations from USCINCPAC REP.

IX. MONITORING

The ACHP and the CNMI HPO may review activities carried out pursuant to this PA and will review such activities if so requested. USCINCPAC REP will cooperate with the ACHP and the CNMI HPO in carrying out their review responsibilities.

X. AMENDMENT.

Any party to this PA may request that it be amended, whereupon the parties will consult in accordance with 36 CFR Part 800.13 to consider such amendment. In particular, the parties will consider the information developed in USCINCPAC REP's reports under Stipulation VIII to determine if USCINCPAC REP's military training program can be more effectively or efficiently managed through revisions to this PA. No amendment shall take effect until it has been executed by all consulting parties to this PA.

XI. DURATION.

It is anticipated that a Tandem Thrust training exercise or other military training exercises of similar scale are carried out on Tinian every two years. Other smaller scale military training exercises such as the TRUE exercises are carried out on an irregular basis. This PA is in effect until terminated during the entire period that DoD uses its leased lands on Tinian to carry out its military training program.

XII. TERMINATION.

Any party to this PA may terminate it by providing thirty (30) days notice to the other parties. The parties will consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the event of termination, USCINCPAC REP will comply with 36 CFR Part 800.4 through 800.6 with regard to individual undertakings covered by this PA.

XIII. FAILURE TO CARRY OUT AGREEMENT.

In the event USCINCPAC REP does not carry out the terms of this PA, USCINPAC REP will comply with 36 CFR Part 800.4 through 800.6 with regard to individual undertakings covered by this PA.

EXECUTION AND IMPLEMENTATION of this Programmatic Agreement evidences that USCINCPAC REP has satisfied its Section 106 responsibilities for all individual undertakings of the military training program on Tinian and near shore areas.

COMMANDER IN CHIEF U.S. PACIFIC COMMAND REPRESENTATIVE GUAM AND THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (USCINPACREP GUAM/CNMI)

By: Jonathan Greenert Date: 7 Jun 1999
Rear Admiral Jonathan Greenert

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
HISTORIC PRESERVATION OFFICER

By: [signature] Date: 6/04/99

ADVISORY COUNCIL ON HISTORIC PRESERVATION

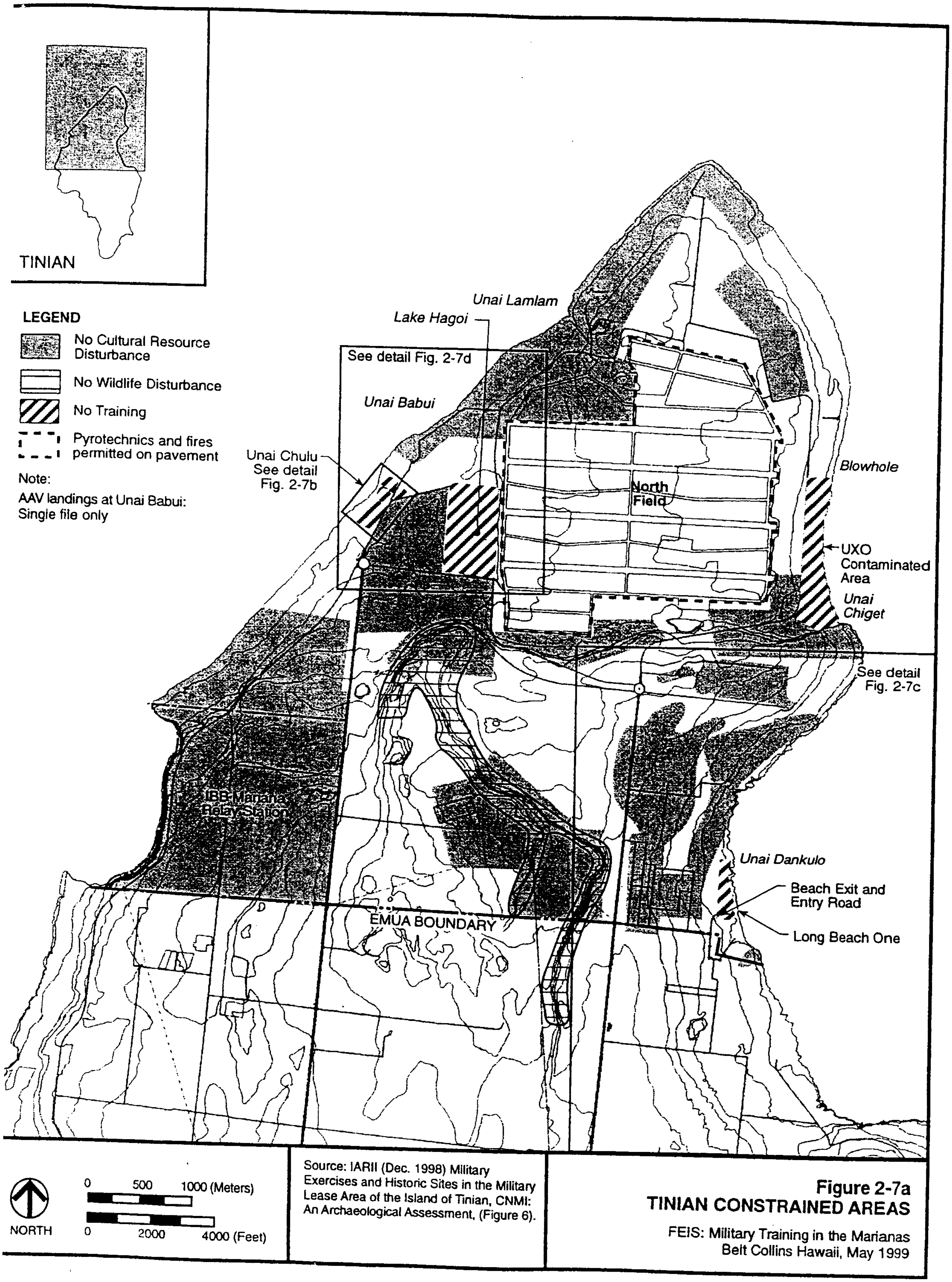
By: John M. Fowler Date: 6/18/99

ATTACHMENT 1

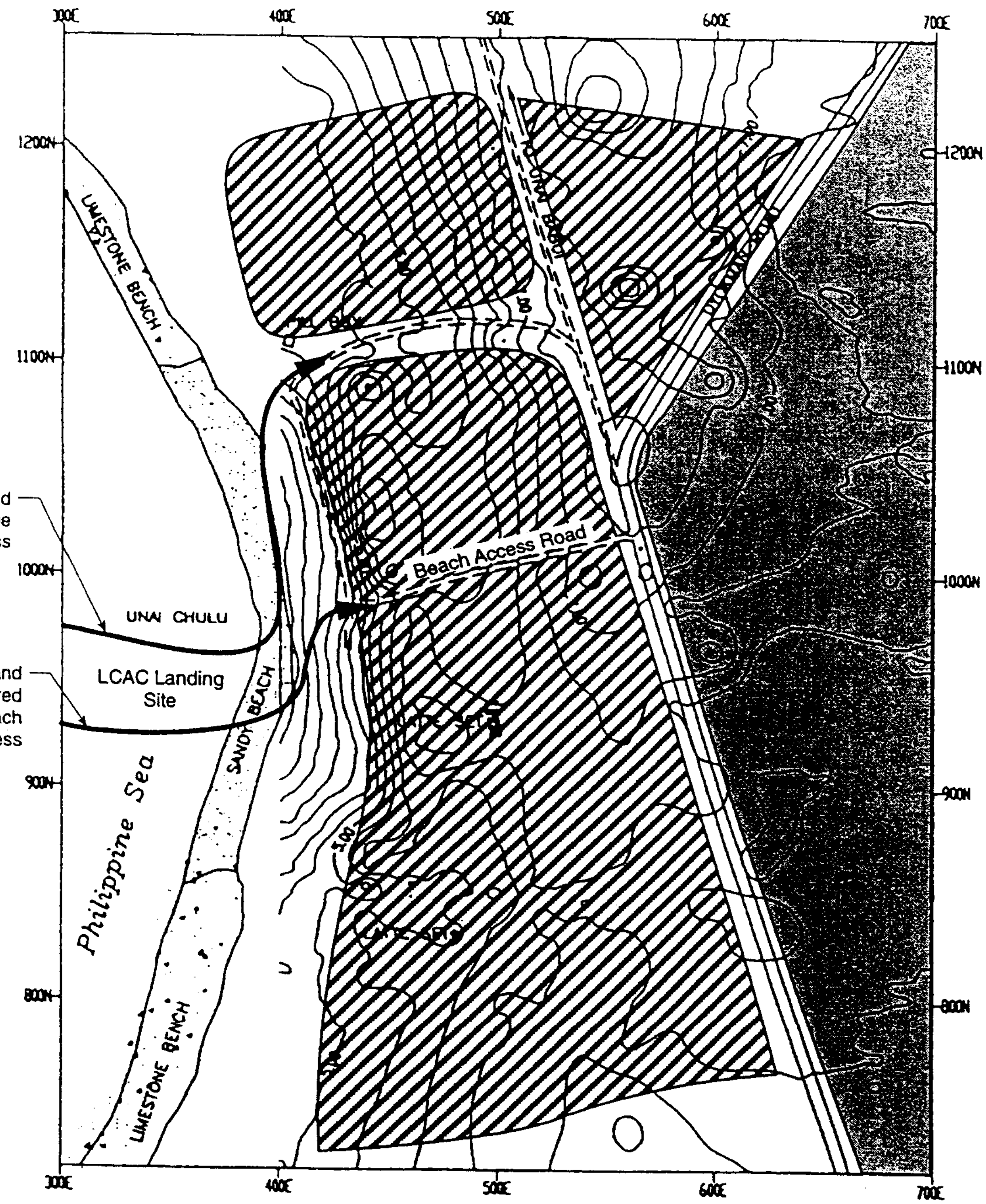
ATTACHMENT 1a
TINIAN CONSTRAINED AREAS

ATTACHMENT 1b

ATTACHMENT 1c
DETAILED CONSTRAINTS AT UNAI DANKULO



ATTACHMENT 1a



LEGEND

(blank box)	Permissible vehicle traffic areas
(stippled box)	No Cultural Resource Disturbance
(hatched box)	No Training

Source: IARII (Dec. 1998) *Final Military Exercises and Historic Sites in the Military Lease Area of the Island of Tinian, CNMI: An Archaeological Assessment*

Note: Contour lines at 0.5m intervals.

NORTH

0 25 50 75 100 (Meters)

0 100 200 300 (Feet)

Figure 2-7b
DETAILED CONSTRAINTS AT UNAI CHULU

FEIS: Military Training in the Marianas
Belt Collins Hawaii, May 1999

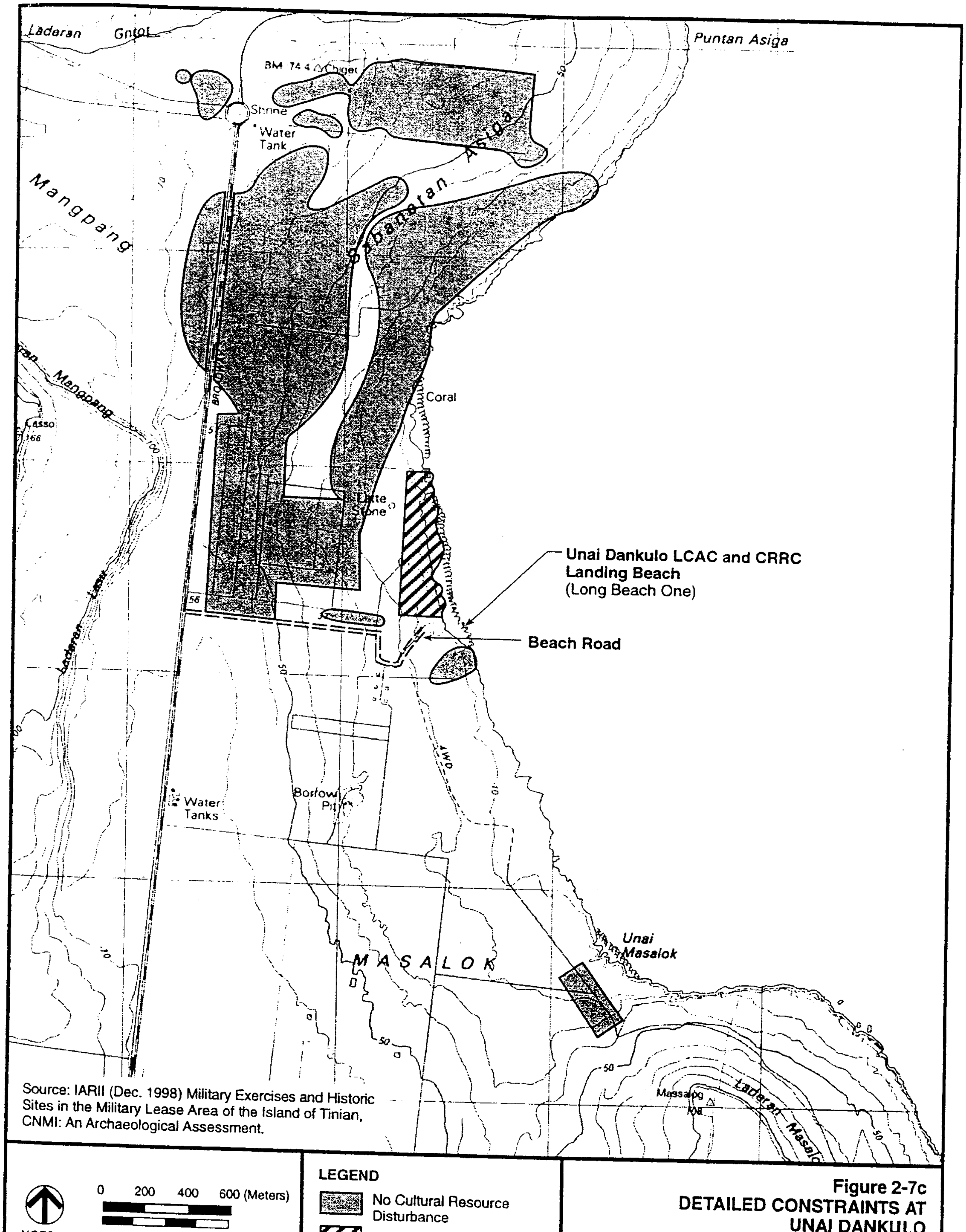


Figure 2-7c
DETAILED CONSTRAINTS AT UNAI DANKULO
FEIS: Military Training in the Marianas
Belt Collins Hawaii, May 1999

ATTACHMENT 2

PRESERVATION PLAN, SITE TN-73, TINIAN ISLAND, CNMI
UNAI CHULU

I. BACKGROUND

Beginning on 24 July 1944, with the invasion by the 2nd and 4th U.S. Marine Divisions, Chulu Beach (Unai Chulu) has been the site of military activity and has continued with the recent Tandem Thrust 99 military training exercise. Unai Chulu is also the site of a large prehistoric village, which has been assessed as "highly significant for information content and cultural value", Prefinal Report Archaeological Investigations at Unai Chulu, Paul H. Rosendahl, Inc. (1996). The archaeological investigations were carried out in 1995 as a result of an unauthorized road clearing activities through the site. This study has determined that about 1.0m below the present surface has been previously disturbed. The origin and date of the current access road that bisects the site (see Attachment 1) is uncertain. For the past two or three years since the road clearing, Tinian residents have been using this road to access the beach.

The road follows a low area, and joins the beach through a natural cut in the dune line caused by typhoon surge. The shape of the beachline at Unai Chulu focuses storm surge waters directly at the point where the road crosses the low dune line to the beach.

II. BEACH LANDING AT UNAI CHULU

During the recent Tandem Thrust 99 (TT 99) military training exercise, Unai Chulu was selected for Landing Craft Air Cushioned (LCAC) landings. This involved two separate landings by two craft. Each LCAC carried military vehicles, which were off-loaded at the beach. Ten vehicles were off-loaded, and quickly exited using the center access road. Two of these vehicles were five-ton trucks, all with rubber tires.

The beach landing and use of the center access road through Site TN-73 was monitored by a qualified archaeologist from USCINCPAC REP. Photographs of the center access road were taken before and after the LCAC landings. After the landings, the road surface was inspected very closely to determine to extent of disturbance. Except for the fresh rubber-tire marks, no appreciable impact was done to the road.

III. FUTURE TRAINING ON TINIAN

Tandem Thrust training exercises will require the use of Unai Chulu. The center road in Unai Chulu is needed to provide a direct access for vehicles to and from the beach during landings. As previously observed during TT99, the use of the center access over the site by rubber-tired military vehicles did not result in any disturbance to Site TN-73. Nevertheless, to ensure protection and preservation of Site TN-73 for continued use of the center access road for training, as well as for Tinian residents, USCINCPAC REP will implement this preservation plan prior to the next Tandem Thrust exercise.

IV. PRESERVATION PLAN

The National Park Service, Archaeological Assistance Program, Technical Brief #5 (September 1989, Revised 1991) demonstrates the procedures, and reasons for purposeful site burial. This technical brief entitled, "INTENTIONAL SITE BURIAL: A Technique to Protect Against Natural or Mechanical Loss," is the basis for and provides guidance to the development of this plan. As stated in this publication, "The burial or intentional covering of archaeological properties has been used as a means of protecting resources from natural or mechanical loss".

A. Center Access Road Cap: The entire length and width of the current center access road will be capped with a layer of crushed coral. The crushed coral cap will be no less than 20cm thick and 3 meters wide. It will cover the access road from the Dyckman Road intersection to the intersection with the existing beach access road that parallels the beach.

B. Road Fencing: To keep vehicles remain on the capped access road, fencing will be installed running parallel to the road on both shoulders for the entire length of the road. Double strand round wire with metal fence poles will be used. The archaeological testing of Site TN-73 has determined that the upper one-meter of the area has been severely impacted. Therefore, the fence poles will be set no deeper than 50cm, and set in concrete for stability.

C. Monitoring: USCINCPAC REP will ensure that a qualified archaeologist will monitor the road capping and installation of the fence.

D. Maintenance: USCINCPAC REP will periodically monitor the condition of the capped road and fence. Any deterioration of the road surface or the fence will be repaired immediately.

It has been determined that for future military training in the Mariana Islands, Unai Chulu will continue to play an important role for beach landings. It was determined during the recent Tandem Thrust 99 exercise that no significant impact occurred to the center access road at Unai Chulu. However, because of the importance of Site TN-73 it is necessary, in order to prevent future impact to the site, that preservation and protection measures be implemented.

DEPARTMENT OF THE NAVY
U.S. PACIFIC FLEET
COMMANDER U.S. NAVAL FORCES MARIANAS
FPO AP 96536-0051

IN REPLY REFER TO:

COMNAVMARIANASINST 5440.1D
N3 18 NOV 1996

FOR OFFICIAL USE ONLY

COMNAVMARIANAS INSTRUCTION 5440.1D

Subj: INSTRUCTIONS TO MILITARY COMMANDERS OF TINIAN DEPLOYED UNITS

Ref: (a) CINCPACFLT Pearl Harbor HI 0501472Z Nov 83 (NOTAL)
(b) COMNAVMARIANASINST 5090.1B
(c) COMNAVMARIANASINST 3500.3
(d) Environmental Assessment, Military Exercise, Island of Tinian: TANDEM THRUST 95 of Nov 94
(e) 32CFR775.6(c)

Encl: (1) Political Development/Situation
(2) Visits by Local Government Officials/Citizens
(3) Military Training Area/Leased Area
(4) Map of Tinian Exclusive Military Use Area/Leased Area
(5) Map of Tinian Constrained Areas
(6) Request Requirements
(7) Safety
(8) Environmental/Historical/Archaeological
(9) Fire Prevention and Suppression
(10) Troop Brief
(11) Liberty Policy
(12) Administrative/Logistic
(13) Entry Requirements
(14) Medical Information
(15) Medical Evacuation (MEDEVAC)
(16) Search and Rescue (SAR)
(17) Communications
(18) Incident Reporting
(19) Weapons/Ammunition
(20) Explosives/Explosive Ordnance Disposal (EOD)
(21) Civic Action Project (CAP)
(22) Timeline - Exercise Planning
(23) Initial Request Format
(24) Sample Format Assignment
(25) Training Plan Format
(26) After Action Report Message Format
(27) Public Affairs

1. Purpose. To provide background information and guidance to Military Commanders using the Tinian Military Training Area.

2. Cancellation. COMNAVMARIANASINST 5440.1C.

3. Background

a. Tinian. Tinian is one of the islands in the Commonwealth of the Northern Mariana Islands (CNMI) which shares a commonwealth relationship with the United States (see enclosure (1)). The Commonwealth was established effective 3 November 1986. Residents are United States citizens.

b. Lease Agreement. A Covenant between the CNMI and the United States provides for a lease of two-thirds of Tinian, the entire island of Farallon De Medinilla, and 177 acres on Saipan. The 50-year lease was signed in 1983, with a 50-year renewal option exercised at signature.

R) c. Plant Account Responsibility. In reference (a), Commander in Chief, U.S. Pacific Fleet (CINCPACFLT) assigned Commander U.S. Naval Forces Marianas (COMNAVMARIANAS) full management and plant account responsibility for leased lands on Saipan, Tinian and Farallon De Medinilla. The leased lands are considered U.S. soil and require full compliance with all U.S. laws including environmental regulations.

A) d. Environmental and Natural Resources Protection. Reference (b) covers reporting alleged noncompliance, site inspections, community programs and environmental permits.

A) e. Training Services, Areas, Facilities, Joint Utilization and Deconflicting Exercises. In reference (c), COMNAVMARIANAS promulgated information concerning training services, areas and facilities available in the Marianas area for military training. Prescribed requesting procedures, specified responsibility for coordination of joint service utilization of training areas and facilities, as well as deconflicting exercises are also contained in reference (c).

→ Add 3.f.

4. Applicability. This instruction and enclosures are applicable to all military or DoD units or representatives of DoD using Tinian.

R) 5. Action. Each Commanding Officer (CO)/Officer in Charge (OIC) deploying to Tinian shall be thoroughly familiar with this instruction and will ensure compliance with all regulations regarding training on Tinian.

and reference (d),

MARY M. HUMPHREYS-SPRAGUE
Chief of Staff

Distribution:
Special - by COMNAVMARIANAS (N3) only

POLITICAL DEVELOPMENT/SITUATION

1. The people of the CNMI desire to remain politically aligned with the United States, as witnessed by the fact that the Commonwealth Government is a "mirror image" of the U.S. Federal Government. The three branches of government are the executive, headed by a Governor; the bicameral legislature; and the judicial branch. Elected officials are members of the Democratic and Republican parties in the United States, although party platforms are more local and limited and seldom embrace national party platform elements.

2. Island government positions on Tinian are:

a. Mayor (elected),

b. Director of Public Works,

c. Director of Natural Resources,

d. Director of Public Health Services,

e. Director of Finance and Accounting,

f. Director of Community and Cultural Affairs,

g. Director of Public Safety,

h. Mayor's Office Staff:

(1) Administrative Services,

(2) Special Assistant to the Mayor,

(3) Public Relations Officer,

(4) Principal of School.

3. Tinian citizens elect four legislators (three senators and one representative) to the CNMI Senate and House of Representatives on Saipan. Collectively, this group is referred to as the Tinian Delegation. Since they normally work on Saipan, their influence with the CNMI Government is significant.

4. All contact with Tinian Government officials should be conducted through the Mayor's Office. The Mayor may (or may not)

appoint a representative to coordinate with a deployed military unit. The Mayor, or his representative, must be kept informed of all military activities performed outside the Military Training Area as described by enclosure (3), paragraph (4).

VISITS BY LOCAL GOVERNMENT OFFICIALS/CITIZENS

1. Prior approval by COMNAVMARIANAS is required before any contact is made with officials at the Mayor's Office or the CNMI Government. However, once authorized, COMNAVMARIANAS encourages close coordination and cooperation with local officials during Tinian military deployments. The support of these officials is often helpful in our civic action programs and in general community relations. (R

2. Commanders of Tinian deployed units are encouraged to offer local officials tours of the Military Training Area and the camp site. COMNAVMARIANAS may desire to visit the deployed unit when local officials are hosted and should be notified of such visits whenever possible.

3. Scheduled visits to the camp site by local citizenry can stimulate interest of young adults to seek recruitment in the military and, therefore, such activities are encouraged. Advance liaison with the Mayor's Office and the school principals, as appropriate, is necessary to schedule such an event.

N3

MILITARY TRAINING AREA/LEASED AREA

1. Military Leased Area. Illustrated in enclosure (4), and narratively described as a line crossing Tinian from west to east, starting north of the West Field Commercial Airport, crossing Broadway and then east-northeast across the cattle ranch. (R

2. Military Training Area. Illustrated in enclosure (4), and narratively described as the area north of a line crossing Tinian west from Puntan Lamanibot Sanpapa to the east coast crossing 8th Avenue and Broadway. (R

3. The distinction between the Military Training Area and the Military Leased Area is clearly illustrated in enclosure (4). Although the Military Training Area is available for military training exercises there are some constrained areas due to the existence of endangered species or historically significant sites (see enclosure (5)),6). The remainder of the leased area is reserved for future base development. Since no base development is currently planned, that area has been made available for lease-back to the Commonwealth and is not normally available for use, but may be used on a case-by-case basis. (R

4. Per Article 12b of the Lease Agreement, public access to the Military Training Area may be restricted in the interest of safety and security. However, prior notification must be given to the CNMI Military Liaison Office and the Tinian Mayor's Office to ensure seven days public notice can be given. COMNAVMARIANAS (N5) is responsible for providing this notice.

5. Although military operations are not normally conducted outside the Military Training Area, if desire to accomplish specific training objectives arises, a request may be submitted in conjunction with the training plan for consideration.

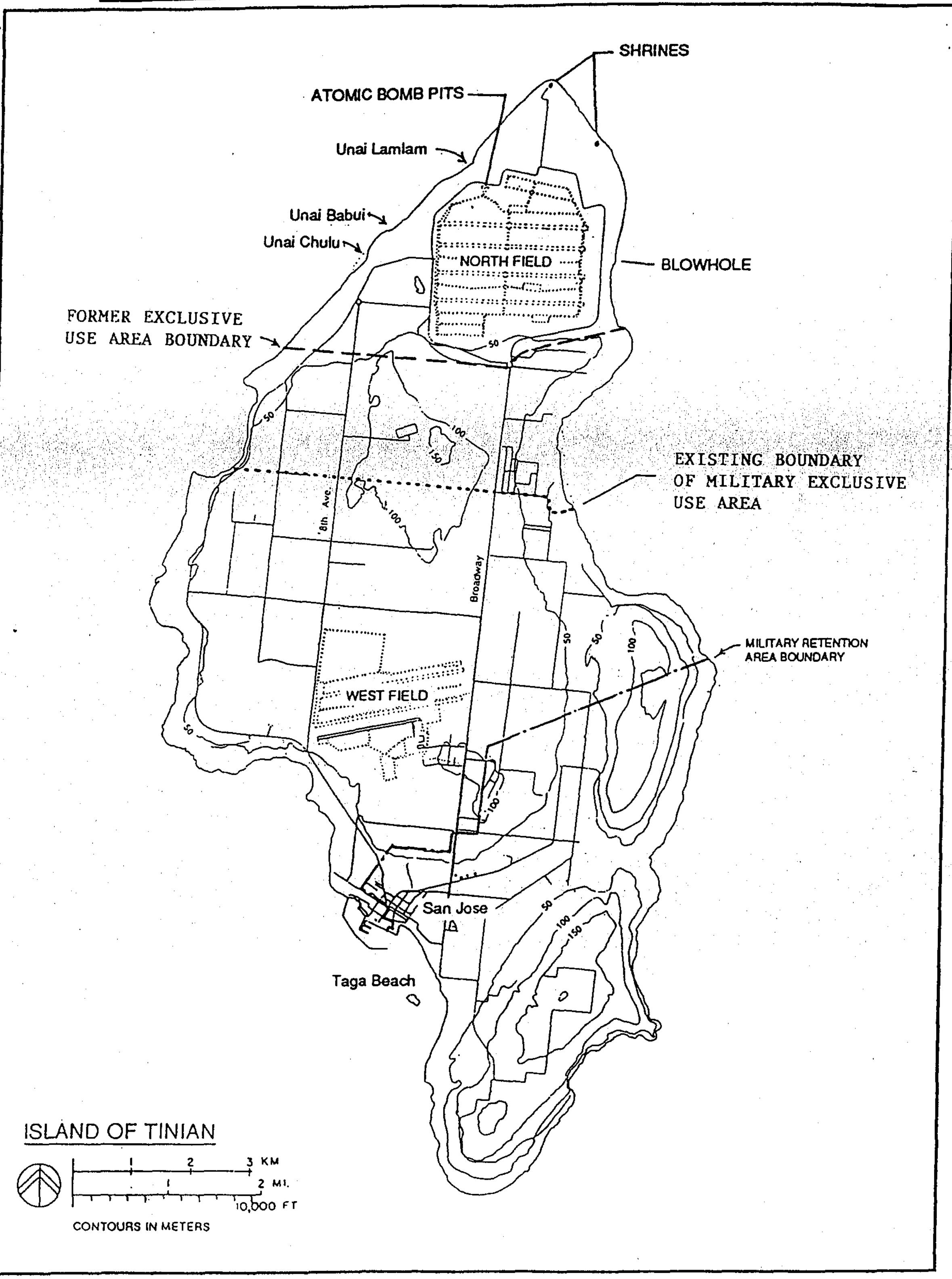
6. Weapons shall not be transported outside the Military Training Area, except as approved by COMNAVMARIANAS. (R

- Enclosure 4 replaced with Figure 2-4 MTH.
- Enclosure 5 changed to Enclosure 5+6,
  new Encl (5) - Fig 3-1 MTH
  new Encl (6) - Fig 3-5 MTH

n3

Replace with MTH, Fig 2-4

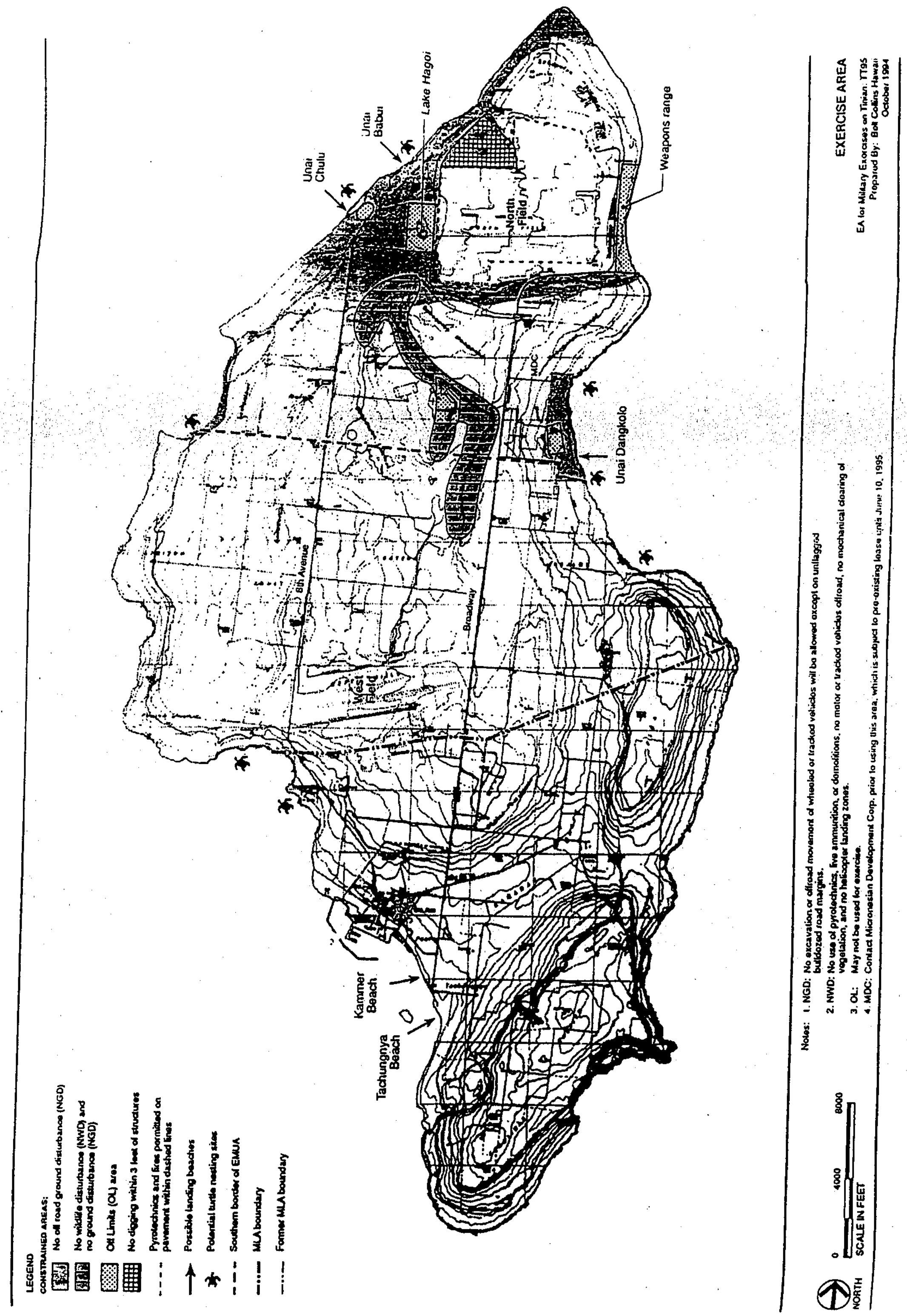
MAP OF TINIAN EXCLUSIVE MILITARY USE AREA/LEASED AREA



N3

Replace with Encl.(5) and Encl(6)
Encl(5) MTH Fig 3-1; Encl(6) MTH Fig 3-5

MAP OF TINIAN CONSTRAINED AREAS



N3

REQUEST REQUIREMENTS

Requests for use of the Tinian Military Training Area . . .

1. Each unit desiring training on Tinian will submit a training request per enclosure (23) to COMNAVMARIANAS (N3). Upon receipt, COMNAVMARIANAS (N3) will issue a formal assignment (see enclosure (24)). A detailed training plan, providing as a minimum the information contained in enclosure (25), will be submitted to COMNAVMARIANAS (N5) for review and approval. COMNAVMARIANAS (N4) will conduct an Environmental Assessment (EA), in accordance with reference (b), for each operation (see enclosure (8)). COMNAVMARIANAS (N5) will provide official notification to the CNMI/Tinian Government as appropriate. Following execution of the exercise, an After Action Report will be submitted to COMNAVMARIANAS (N3) [A] This report is ~~normally~~ required within ten working days of the completion of training. [(see enclosure ( ))] (A

2. Each Commanding Officer of a unit deploying to Tinian will be briefed by the COMNAVMARIANAS Staff (N3, N4 ~~or~~ and N5) regarding the use of Tinian. These briefings will be conducted prior to actual deployment to Tinian.

3. Approval shall be obtained from COMNAVMARIANAS prior to making contact or entering into any agreement with any CNMI or Tinian Government official. All contact with Tinian Government officials should be conducted through the Mayor's Office. The Mayor may (or may not) appoint a representative to coordinate with a deployed military unit. The Mayor, or his representative, must be kept informed of all military activities performed outside the Military Training Area (per enclosure (3), paragraph 4).

– Replace Enclosure 23 w/attached msg.

SAFETY

1. Units training on Tinian must ensure the utmost considerationion is given to safety. (A

2. The Mayor's Office and local commercial operators regularly conduct tours of the numerous historical sites inside the training area. Additionally, individual tourists and local residents visit the area on a daily basis. Tinian often requests organized tour groups be permitted to visit historic sites in the Military Training Area. Military Commanders are to be aware there will often be other individuals within the training area when training is being conducted and are encouraged to allow such visits at a mutually convenient time. These visits should not sacrifice the safety of participants or non-participants. Restricting access will only be done with prior coordination by COMNAVMARIANAS and the Tinian Mayor's Office, or when overriding safety or security issues are involved.

3. Prior to commencing any exercise involving aircraft landings, parachute jumps, or other potentially hazardous operations, the CO/OIC will ensure the Military Training Area is clear of all unauthorized civilian personnel. The entire area will be cordoned off, with control points at the entrance to the Military Training Area on both 8th and Broadway Avenues (the two main North-South roads). As an alternative, the control points may be set at the two traffic circles if the entire Military Training Area is not required. The unit must have positive control of the Military Training Area for safety purposes during air operations. Small-scale exercises which are limited in area may require a modification to this, but must be cleared with COMNAVMARIANAS prior to deploying.

ENVIRONMENTAL/HISTORICAL/ARCHAEOLOGICAL

1. Reference (d) is an Environmental Assessment (EA) of various training exercises on Tinian and describes required mitigation measures to reduce environmental impacts. If proposed training exercises are included and addressed in reference (d) and COMNAVMARIANAS does not anticipate any substantial environmental degradation resulting from continuing the training actions, then the proposed action will not require any further environmental documentation. Under these circumstances the proposed action would not be considered a major federal action as defined in reference (e). The action proponent will document this determination in a memo-for-record with an additional signature block for COMNAVMARIANAS (N4).

2. If the proposed action is considered a major federal action, then an EA per reference (b) shall be completed on the effects the training activities may have on the cultural, archaeological and ecological environment. The EA should be coordinated through COMNAVMARIANAS (N4). Reference (b) provides additional information on environmental matters.

3. Historic United States, Chamorro and Japanese sites exist within the Military Training Area. These structures portray the history and culture of Tinian. Willful destruction of these historic sites is a violation of CNMI and U.S. Federal laws, and the Uniform Code of Military Justice. Although these sites are not typically part of any training area, requests for use of these sites will be addressed on a case-by-case basis. The runways within the Military Training Area are considered historic sites and require protection. Use of stakes, nails, or other destructive methods must be avoided unless approved by COMNAVMARIANAS (N4).

4. A continuing effort shall be made to keep the Military Leased Area clear of all trash and other discarded materials. Upon completion of the Tinian deployment, the Unit Commander will survey the training area and ensure trash, waste or hazardous material is properly removed. Upon departure, each unit must ensure the area is as clean or cleaner than it was upon arrival. Additionally, the Tinian dump is <u>not</u> authorized for the disposal of military generated trash, hazardous waste or debris. Units will make arrangements to have such items backhauled to Guam or the unit's home base for proper disposal. Burning of trash is <u>not</u> authorized.

5. Due to numerous environmental and archaeological issues involved in training on Tinian, the CO/OIC of each unit deploying to Tinian will provide a briefing to all troops prior to deploying to Tinian (see enclosure (10)).

6. COMNAVMARIANAS (N4) should be consulted on any activity addressed in the training plan which might have adverse impact to the environment. The following guidance is provided:

a. Hazardous waste/used oil must be removed from Tinian. Each unit will have a spill contingency plan with personnel and equipment to immediately respond to a spill of hazardous materials or fuel. In the event of a spill, the COMNAVMARIANAS Staff Duty Officer at (671) 349-5235/6, will be immediately notified of the location, size, substance spilled and clean-up measures undertaken.

b. There are no toilets in the Military Training Area. Units can utilize Civic Action Team (CAT) holes/slit trenches for limited numbers. Portable toilets should be contracted (via U.S. Fleet and Industrial Supply Center (FISC), Guam) for larger groups or long duration exercises.

c. There are federal and locally listed endangered species in and around the Military Training Area. Do not kill, disturb, harass or eat any wildlife or their nests. Specifically: cows, forest birds, water birds, crabs, sea turtles and bats should be left alone.

d. Solid waste. Remove trash as outlined in reference (b) and paragraph 4 above.

FIRE PREVENTION AND SUPPRESSION

1. Due to the possibility of out of control wildfires during peak dry periods and the remoteness of the training area, units must be prepared to respond to fires in the Military Training Area. (A

a. Background. There are two major fires of concern for military operations on Tinian: aircraft crash, fire and grass/brush fires. Units need to be especially aware of existing conditions on Tinian, such as the time of year (the dry season is approximately December through June), actual moisture content of the vegetation and the ground, and any factors which would increase the likelihood of an unplanned fire.

b. Prevention. In order to minimize the chance of grass and brush fires, open fires and pyrotechnics are limited to the hard surfaced areas at North Field. Their existing runways and taxiways can act as fire breaks and fire access roads, and the vegetation is predominantly tangantangan. The only exception is the use of red smoke and flares to signal an actual emergency.

c. Available Assets. If aircraft crash and fire assets are required, individual units must obtain these services. The 36th Logistics Group, Andersen AFB (36LG AAFB) may be contacted for a P19 crash and fire crew, if available. For other types of fires, Helicopter Combat Support Squadron FIVE (HC-5) may be able to support units with airborne fire bucket capability. Additionally, one 300 and one 750-gallon pump truck belonging to the Tinian Fire Department may provide a back-up fire response, when available. All coordination and costs of these assets are the responsibility of the individual unit. For non-military resources, the unit can expect to be billed by the CNMI Government at an overtime rate.

d. Communications. CO/OICs need to include fire fighting in their communications plan. This includes, but is not limited to, frequencies to be used and radio inoperability, i.e., all players need to be able to communicate on the same frequency.

2. Fire suppression and organization tasking needs to be developed in accordance with the scope of training, the available assets, and the unit's chain of command.

a. Responsibility. In general, the CO/OIC will be responsible for fire prevention and suppression and will act as the on-scene fire operations commander.

b. Notification. All forces on Tinian, via their chain of command, will immediately notify the on-scene fire operations commander. The on-scene fire operations commander will ensure notification of COMNAVMARIANAS and the Tinian Mayor's Office, and coordinate the fire suppression effort. COMNAVMARIANAS will coordinate with the CNMI Government, HC-5 for helo support (if required), Federal Aviation Administration (FAA), Guam Center Radar Approach Control (CERAP) and AAFB for Notices to Airmen (NOTAMs)/Airmen Advisories, as required.

c. Requesting Airborne Fire Fighting. The following should be considered when requesting airborne fire fighting support: ground crews' accessibility to the fire, safety of ground personnel, potential for ground crews to lose control, potential damage to private property/collateral damage, and time of day (HC-5 fire fighting is limited to daylight only).

TROOP BRIEF

1. Do not kill or disturb any wildlife, nest or eggs. Forest birds, water birds, bats, crabs and sea turtles are endangered species. (A

2. Be very careful with fire. Use pyrotechnics only on hard surfaces; a brush fire would destroy animal habitat and historic remains. There is very limited fire fighting capability on the island.

3. We are legally excluded from using the local dump. Remove all trash generated on the island including hazardous waste, construction debris and domestic garbage.

4. Do not collect any historic artifacts; this includes WWII trash or ordnance. Do not mar or disturb any shrine or structure. Do not clear any native vegetation or dig near any structure. Report to COMNAVMARIANAS any previously undiscovered item or structure of possible historic significance.

5. Be very careful not to destroy coral reefs.

6. All fueling and vehicle maintenance activities will be conducted in the village of San Jose. Report any spills of fuel, oil or hazardous materials. Contain as much of spill as possible.

LIBERTY POLICY

1. Liberty may be granted at the discretion of the CO/OIC, and is encouraged.

2. The senior officer present on Tinian is authorized to establish the number of personnel who may be on liberty and the hours within the guidance provided below.

a. Shore Patrol assignment: Recommend assign two Shore Patrol for each 50 persons on liberty.

b. Liberty hours:

Weekdays (M-Th)	1800-2400
Fridays	1800-0200 (maximum)*
Saturdays	1800-0200 (maximum)*
Sundays	1000-2400

* Note: All bars and nightclubs on Tinian are required to secure at 0200.

c. Maximum number in liberty party:

Weekdays (M-Th)	200
Weekends/holidays	400

d. The unit CO/OIC will inform the Mayor's Office of the liberty schedule/policy on the familiarization visit, if possible, so the business community can make appropriate preparations.

e. Shore Patrol shall promptly secure the liberty of any intoxicated personnel and remove them from the village.

f. Shore Patrol will accompany local Public Safety Officers on patrols. Units may be asked to provide gasoline for police vehicles to cover the unprogrammed expense of the greater-than-normal numbers of patrols.

g. Personnel on liberty should be cautioned to avoid trespassing on private property. This is a particularly sensitive issue on Tinian.

h. For information, marijuana is plentiful and local youths have been known to swap marijuana (sometimes counterfeit) for camouflage uniform items, knives, canteens, hats, meals ready to eat (MRE's), etc.

i. After dark, liberty will be restricted to the village area. (A

3. Organized recreational beach parties planned outside the Military Training Area must be coordinated with the Mayor's Office. Unless concurrence of the Mayor's Office is obtained, parties must be restricted to the Military Training Area. (A

ADMINISTRATIVE/LOGISTIC

1. Units should coordinate all contracting support requests through ~~FISC Guam~~ or the 36LG AAFB. (A
COMNAVMARIANAS SUPPLY DEPT (N8)

2. Paydays. Military pay facilities do not exist on Saipan or Tinian. ~~Two banks on Tinian are open several days a week and arrangements may be made for check cashing; however, a service charge of approximately $1.50 per check can be expected. If checks can be issued to military members, commercial aviation transportation is available to take military personnel to Saipan where signed checks and ID can be presented for payment~~.

3. Haircuts. There are no facilities to provide haircuts on Tinian. Deployed units should be prepared to provide their own barbers.

4. Photo Copying Services. Photo copying facilities are not readily available. When a photo copier is available, there is normally a fee for its use.

5. Food. Seasonal fruits and vegetables may be available and include cantaloupe, watermelon, eggplant, tomatoes and green beans. U.S. Department of Agriculture (USDA) inspected meat is available from the Micronesian Development Corporation (MDC) and the Bar K Ranch. Also, milk and some other dairy products may be available. Merchants in San Jose Village can often arrange for regular availability if notified in advance.

6. Beer and Soft Drinks. These items are extremely expensive when purchased by the case. Deploying units should purchase these items at point of embarkation and ship them to Tinian.

7. Fuel. Fuel (gas (MOGAS), aviation gas (AVGAS), and diesel (LSADO)) is available on Tinian in sufficient quantity through the local Mobil distributor. Prior arrangements (60 days in advance) for purchase must be made with FISC Guam. Prior to departure, deploying units should provide FISC Guam ~~(copy to COMNAVMARIANAS)~~ accounting data to prepare a purchase order for fuel. The deployed unit will maintain a daily record of purchases which must be reconciled with the Mobil representative prior to departure from Tinian.

8. Lubricants. All anticipated requirements should be included in the loadout. These items are generally not available on Guam or Tinian. Shipment schedules to Tinian may not meet emergent requirements and military cargo transportation to Tinian is not readily available.

9. Vehicle Parts. Parts for most vehicles and equipment are not normally available on Guam; most requisitions must be forwarded to Okinawa. Experience has shown that parts ordered from Okinawa will not reach the deployed unit until after departure from Tinian. Prior arrangements for a Marine deployed logistics flight originating in Okinawa during the second or third week of the deployment may prove helpful. (R

10. Mail. Mail cannot be sent directly to Tinian deployed units. Mail should be sent to Guam for subsequent delivery via available military aircraft. Close coordination between the deployed unit and COMNAVMARIANAS (N3) is required. Outgoing mail, stamps and money orders are available at the U.S. Post Office on Tinian.

11. Local Payment. In general, any purchase on the local market on Tinian requires cash or traveler's checks. (A

12. COMNAVMARIANAS (N3) is the point of contact for support while deployed on Tinian. ~~Contact can be made as described in enclosure (17). The CNMI Government radio, 8025 KHZ (Channel 4) at the Tinian Dispensary radio is a secondary method of contacting COMNAVMARIANAS if prior arrangements are made.~~ (R

If separate POC's have not been established, N3 can be reached at (671) 339-4286/4187/6399/8054.

ENTRY REQUIREMENTS

1. The Government of the CNMI operates three agencies which control entry of personnel and material into the area. (A

a. CNMI Customs Service. Concerned with the entry of unauthorized materials. No military items should be left on Tinian (sold or traded) without the express written consent of COMNAVMARIANAS. The CNMI is especially sensitive regarding weapons, ammunition and explosives.

b. Quarantine Branch. Concerned no communicable diseases or agricultural pests inadvertently enter the CNMI.

c. Immigration Service. Responsible to ensure no illegal aliens are permitted entry into the CNMI.

2. Historically, most of the checks/inspections have been perfunctory. It is, however, within the agencies' authority to conduct complete and thorough searches, which could become burdensome. Maximum cooperation is essential. (Prior coordination with COMNAVMARIANAS (N3) is recommended.)

3. The above listed authorities have requested the following:

a. Advance notification of arrivals.

b. An officer appointed as liaison/point of contact who will provide/arrange for:

(1) Two copies of vehicle/equipment manifest for items being off-loaded.

(2) A general declaration for any aircraft or ship arriving. (COMNAVMARIANAS can assist with arrival formalities.)

(3) Snake inspection of aircraft and contents prior to departure from Guam. A snake inspection sticker must be applied on all cargo and equipment inspected. The sticker and inspection may be obtained through coordination with the USDA, Animal Damage Control at 635-4400.

4. While no crew list or personnel manifest is required per the provisions of a 1989 Memorandum of Understanding (MOU) on customs and immigration matters, a list of all non-U.S. citizens must be provided to CNMI Immigration officials. Such individuals must be prepared to present a valid passport or U.S. Armed Forces Identification Card. All personnel who disembark may be required to submit a Customs Declaration and may be subject to an

appropriate inspection by Customs officials. It should be noted that local Customs and Immigration officials will not board a vessel or aircraft to perform their duties. A designated crew-member, however, may be required to certify the conditions within the interior of the vessel or aircraft are in compliance with CNMI customs standards or immigration laws.

5. Agriculture (Quarantine) inspectors normally enforce standard USDA regulations which include the following:

a. Garbage may not be imported into Tinian. All box lunch debris or garbage must be disposed of prior to arrival or retained onboard the aircraft or vessel. The Tinian dump is not authorized for disposal of military generated garbage, waste or debris.

b. Fresh food products (meat, vegetables, fruits) may not normally be imported into Tinian without a certificate of origin which proves they are exclusively from U.S. sources. This will normally prohibit food from being removed from a ship for a picnic ashore. The Quarantine Inspector must be contacted and provide his/her concurrence prior to any foodstuffs being taken ashore.

c. Dirt on vehicles and equipment must be removed prior to arrival on Tinian. Additionally, any vehicle or equipment departing Guam for Tinian shall have an inspection by the USDA Animal Damage Control to ensure it is free of brown tree snakes.

6. Failure to comply with the above will result in the immediate termination of the exercise. CNMI Customs officials will be present during exercise commencement to ensure compliance with regulations in paragraph 5 above.

MEDICAL INFORMATION

1. The weather on Tinian is usually moderate with temperatures in the 80's both day and night. Severe sunburn is a constant threat. Deploying commands should take adequate precautions against sunburn, heat stroke and heat exhaustion.

2. Potable water should be chemically treated in accordance with appropriate directives.

3. The dispensary on Tinian is normally available to deployed military units and should be coordinated upon arrival by contacting local medical authorities (MEDEX). A MEDEX is roughly equivalent to a physician's assistant. A civilian medical doctor is only occasionally assigned to Tinian by the CNMI Government.

4. The deployed medical officer may be assigned to the Tinian Dispensary to assist the local MEDEX as a Civic Action Project (CAP). The medical officer should (tactfully) ensure his actions serve to train and enhance the stature of the local civilian medical personnel.

5. The Tinian Dispensary has a limited stock of medicines, books and supplies. Donations of medicines, dressings and other supplies may be made; the medical personnel and people of Tinian will be very appreciative. These donations can be made directly to the Tinian Dispensary after notification to, and concurrence of, the Mayor's Office.

MEDICAL EVACUATION (MEDEVAC)

1. It is highly recommended all units operating on Tinian take their own medical personnel and supplies as support on Tinian and Saipan is extremely limited and may not be up to U.S. standards. Careful consideration should be given prior to having individuals treated at either medical facility. In the event of an accident or other medical emergency, you will need to be able to stabilize an injured person so they may be transported to U.S. Naval Hospital (NAVHOSP), Guam. (R

2. The on-scene commander will need to be prepared to decide what is the best course of action in the case of a medical emergency. Very limited quick reaction assets for air evacuation are stationed on Guam. Response times could be a minimum of 1 hour 30 minutes. HC-5 stands a Search and Rescue (SAR) alert with 15-minute launch times during normal working hours (0700-1630) and one-hour launch times on weekends, holidays, and after hours. During time-critical situations, consideration should be given to commercial air transportation available at Tinian airport. All commercial transportation costs will be born by the individual command.

3. In the event of a medical emergency, units are encouraged to use the following as an order for contact:

a. COMNAVMARIANAS

b. Commander Coast Guard Marianas Section Guam (COMCOGARD MARSEC GU)

c. HC-5

d. NAVHOSP Guam

SEARCH AND RESCUE (SAR)

1. COMCOGARD MARSEC Guam is the local expert for SAR coordination and execution. As such, U.S. Navy resources in the Marianas support the U.S. Coast Guard in SAR efforts. While individual units have the primary responsibility for SAR of their own forces, it is recognized COMCOGARD MARSEC Guam has the expertise and resources to effectively coordinate SAR activities in the local area. (A

2. If SAR support is required for operations on Tinian and individual units do not have the organic assets for support, COMNAVMARIANAS, as overall SAR coordinator for the Area of Responsibility (AOR), will rely on COMCOGARD MARSEC Guam for SAR mission coordination and execution. If SAR support is required, units will contact COMNAVMARIANAS or COMCOGARD MARSEC Guam for support. If it is not possible to make contact expeditiously, then HC-5 or NAVHOSP Guam may be contacted for coordination.

3. Points of Contact

a. COMNAVMARIANAS:

(1) Security and General Emergency (SAGE) Radio (0600(K)-2200(K) daily) - 4815.0/4014.5KHZ (PRI/SEC).

(2) ~~Command Center~~ QUARTERDECK Telephone (24 Hours) - (671) ~~349-5235/6~~. 339-7133

(3) Operations Department (0730(K)-1700(K) M-F) - (671) ~~349-5231/5232/5233.~~ 339-6399/8054/4286

b. COMCOGARD MARSEC Guam, Joint Rescue Sub-Center:

(1) Marine Radio Telephone (24 Hours) - Ch 16 (156.8MHZ).

(2) HF (24 Hours) - 2182KHZ.

(3) HF (2100(Z)-0900(Z)/0900(Z)-2100(Z) daily) - 12242KHZ/6200KHZ.

(4) Command and Rescue Center Telephone (24 Hours) - (671) 339-6100/7100. GOOD.

(5) Administration and Operations (24 Hours) - (671) 339-2001, ext. 115. GOOD.

c. USCGC BASSWOOD and USCGC GALVESTON ISLAND, when underway, monitor same frequencies as COMCOGARD MARSEC Guam and can come up on 243.0 and 381.8MHZ.

d. HC-5:

(1) Duty Radio (0600(K)-2200(K) M-F) and during flight operations - 305.0MHZ.

(2) Duty Phone (24 Hours) - (671) 366-6412.

(3) Operations Department (0730(K)-1700(K) M-F) - (671) 366-~~6423~~. 6419/6422

e. NAVHOSP Guam:

(1) Emergency Room (24 Hours) - (671) 344-~~9232~~. 9314/9340

(2) Search and Rescue Doctor (SARDOC) Beeper (24 Hours) - (671) 472-1290.

Delete

?

COMMUNICATIONS

1. Communications to and from Tinian should normally use military assets and be in accordance with pre-arranged plans. Frequency clearance may be obtained through the Joint Frequency Management Office (JFMO) (N35) at NCTAMS ~~WEST~~PAC, phone (671) 355-5260. DSN 453-0760

2. Communications from Tinian to COMNAVMARIANAS may be accomplished through the various means described below (in order of preference). COMNAVMARIANAS is limited to two tuneable HF transceivers which can be simultaneously monitored.

a. HF Nets. Coordinated through NCTAMS WESTPAC on request. Deploying units should provide a Guam-based liaison for communications and logistics matters.

b. Telephone. Long-distance telephone service is available on Tinian. Deployed units desiring to contact parent commands may place "collect" calls. Occasionally, the local operator will not place collect calls to military numbers. In that event, the only option is to make a paid call using a local subscriber account number. Contact the Micronesian Telecommunications Corporation (MTC) representative on Tinian, who is available to place such a call. He/she will require reimbursement in cash upon completion. Personnel at the Tinian Center may also agree to a similar arrangement. N5?

c. The CNMI Government radio, located at the Tinian Dispensary, may be used if necessary. This transceiver is commercial, non-tuneable channelized equipment intended to be a CNMI administrative net. Stations monitoring this radio during working hours are:

(1) Governor's Office, Saipan.

(2) Governor's Office, Rota.

(3) Governor's Office, Tinian.

(4) COMNAVMARIANAS (if previously arranged).

d. The Channel 4 frequency is 8025 KHZ. Any transmission on this channel should be brief and should be used to pass emergency or other information which will assist in establishing communications on another frequency.

Delete

Delete

e. The Dairy Micronesia Development Corporation (MDC) operates an HF radio with stations on Tinian, Saipan and Guam. In the event no other means exists, then use of this circuit/ equipment may be requested from the General Manager. It should only be used for brief messages as described above.

f. Should it become necessary to hand carry messages or small packages to Guam, contact COMNAVMARIANAS at (671) 349-5235/6 for assistance.

INCIDENT REPORTING

1. This instruction in no way replaces or modifies reporting requirements of higher authority. It does, however, require timely notification of incidents or events which may detract from continuing warm relations with the CNMI.

2. In view of the political sensitivity of the developing Micronesian nations, report to COMNAVMARIANAS when any of the following situations occur:

a. Any incident which indicates a basic conflict exists between the Government of Tinian or the CNMI and the military unit, the U.S. Navy, the military in general or the United States.

b. Any liberty party incident involving any physical contact between military and civilian personnel.

c. Any incident/event resulting in damage to/loss of property owned by the Tinian Government or private citizens.

d. Any injury to military personnel requiring off-island assistance.

e. Any injury/serious illness to civilian personnel while engaged in or resulting from military supervised activities.

f. Any incident which is likely to result in a claim against the U.S. Government for loss, damage or injury.

g. Any incident/event significantly altering or affecting the usefulness of the areas, such as damage caused by fire, earthquake, vandalism, etc.

h. Any spill of fuel or hazardous materials on the ground or in the water. (A

WEAPONS/AMMUNITION

1. Currently no live fire of weapons or demolition is permitted on Tinian. (R

2. Pyrotechnics may be used in the training area, however, their use is restricted to hard paved or cleared areas where the danger of fire to brush areas has been eliminated.

3. Blanks may be used, but units must ensure the areas where they are used are thoroughly picked-up upon completion of the exercise.

4. Refer to reference (d), MTH, Chapters 3 and 4 for amplification.

EXPLOSIVES/EXPLOSIVE ORDNANCE DISPOSAL (EOD)

1. The Navy Explosive Ordnance Disposal Detachment, Guam (EODMU 5 Det) has primary authority and responsibility for the disposal of explosive ordnance in the CNMI. Any discovery of unexploded ordnance should be reported to COMNAVMARIANAS (N3), located on a map, and arrangements made for disposal. In view of the need and the training benefits derived, qualified EOD teams are authorized to dispose of unexploded ordnance when requested and approved by COMNAVMARIANAS. (R

2. Explosives necessary to accomplish EOD tasks should be obtained through respective service sources and transported with the team to Tinian. Explosive material issues from U.S. Naval Activities, Guam are stringently controlled. Issues to Marine units from local stocks require approval of Fleet Marine Force Pacific (FMFPAC) and CINCPACFLT. Assistance of the Guam-based Navy EOD team may be requested through COMNAVMARIANAS (N3).

3. <u>There will be no blasting</u> exercises in any area without prior approval of COMNAVMARIANAS. (R

CIVIC ACTION PROJECT (CAP)

1. Within manpower and operational constraints, exercise units may be tasked to accomplish CAPs requested by the Tinian Government and approved by COMNAVMARIANAS.

2. COMNAVMARIANAS (N4/N5) will coordinate CAPs based on input from the local government and the capabilities of visiting units. Support from the CNMI Government is primarily limited to providing construction materials and obtaining local and environmental permits. To obtain any significant government or commercial material support on Tinian, and to ensure an adequate EA is made, requests must be made several months in advance. If a significant project is to be undertaken, approximately 90 to 120 working days are needed to establish a list of logistic and other necessary support. Deployed units working a CAP will maintain close liaison with cognizant local officials and provide timely status reports to COMNAVMARIANAS.

3. A typical sequence of events leading to CAP completion follows:

a. Exercise units provide COMNAVMARIANAS with a priority listing of training desired (e.g., heavy equipment, electrical, welding, etc.).

b. COMNAVMARIANAS (N4/N5) will work with Tinian officials to develop a prioritized list of projects to be accomplished during the deployment.

c. Representatives from COMNAVMARIANAS and the deploying unit will visit Tinian to review the scope of projects and determine which projects can be accomplished. Tinian officials will be informed of support required of the local government. Representatives of the deploying unit will advise COMNAVMARIANAS (N4) of the materials and equipment they can provide.

d. Projects commence with frequent updates being provided to the Mayor's Office/Director of Public Works/COMNAVMARIANAS. Do not change the scope or intent of the project without prior approval from COMNAVMARIANAS. (R

e. When a project is completed, an After Action Report will be made to COMNAVMARIANAS (N4). (R

f. The Mayor's Office is responsible for obtaining all local building and environmental permits. Units should not start work on projects prior to verification of approved permits by COMNAVMARIANAS. (A

N3

TIMELINE - EXERCISE PLANNING

1. The following is a recommended timeline for exercises involving a company or more. Smaller exercises must have a minimum of 4 weeks notice to COMNAVMARIANAS in order to provide adequate support and coordination. (R

X-120 Deploying units submit CAP proposals to COMNAVMARIANAS (N4/N5) for coordination with CNMI officials.

X-90 Prepare and submit a training scenario for approval by COMNAVMARIANAS. Prepare and submit an EA for approval (enclosures (6) and (8) and reference (b)). PACNAVFACENGCOM requires 60 days to get approval for non-controversial training scenarios. A general EA can be developed and approved in advance. For routine training it is important to ensure these general pre-approved EA's are broad enough to encompass all desired activities. (R

X-60 Develop logistic support requests. FISC Guam Sub Area Petroleum Office requires 60 days ~~notice to ensure~~ fuels are available.

X-30 Briefing by COMNAVMARIANAS Staff in Guam. Discuss training plans for exercise, with emphasis on subjects in enclosure 26.

~~X-30 Finalize training plans for exercise. Require an unclassified version giving times, dates, activities and areas for notification of local officials (see enclosure (24))~~. Delete (R

X-10 COMNAVMARIANAS (N5) will notify the CNMI Military Liaison Office and the Tinian Mayor's Office of intent to exercise on Tinian.

X-3 Reconfirm Final Operational/Environmental brief with COMNAVMARIANAS (N3/N4). (A

X Hold exercise on Tinian.

X + 10 After Action Report. (R

INSERT X-14: Provide COMNAVMARIANAS (N3) with an unclassified training plan incorporating the subjects in enclosure (24).

INITIAL REQUEST FORMAT

1. The following is the format for an initial training request. (A
The initial submission may be either by letter (on official letterhead), FAX or preferably AUTODIN message. — GENADMIN message

a. Unit. Requesting unit.

b. Dates. Inclusive dates to train on Tinian.

c. Objectives. A brief statement outlining the overall objectives of the training.

d. Operations Overview. A brief statement addressing the planned operations.

e. Weapons/Ammunition/Explosives/Pyrotechnics. In general terms, explain what is to be used and how.

f. Personnel. Provide approximate number of personnel going to Tinian.

Replace with Attached form

SAMPLE FORMAL ASSIGNMENT

UNCLAS//N03500// (A

EXER//(NAME)//

MSGID/GENADMIN/COMNAVMARIANAS//

SUBJ/OPAREA ASSIGNMENT - TINIAN//

REF/A/CON/CNM/(DATE)//

REF/B/DOC/CNM N3/(DATE)//

REF/C/DOC/CNM N3/(DATE)//

NARR/REF A IS (EXERCISE NAME) FPC HELD AT COMNAVMARIANAS (CNM) (DATES). REF B IS COMNAVMARIANASINST 3500.3L, SUBJECT: FLEET OPERATING AREAS AND TRAINING FACILITIES MARIANAS AREA. REF C IS COMNAVMARIANASINST 5440.1D, SUBJECT: INSTRUCTIONS TO MILITARY COMMANDERS OF TINIAN DEPLOYED UNITS.//

POC/(COMNAVMAR REP)/N3/-/TEL:DSN 349-5057/TEL:24HRS DSN 349-5235//

RMKS/1. AS DISCUSSED IN REF A, THE TINIAN NORTH FIELD TRAINING AREA IS ASSIGNED FOR YOUR USE, (DATE OF EXERCISE). IAW REFS A, B AND C, A DETAILED TRAINING PLAN MUST BE SUBMITTED TO CNM//N32//. NLT (TWO WEEKS PRIOR TO EXERCISE). A FINAL OPERATIONAL/ ENVIRONMENTAL BRIEFING MUST BE CONDUCTED WITH CNM//N32/N45// PRIOR TO DEPLOYING TO TINIAN.

2. ENSURE ALL PERSONNEL DEPLOYING TO TINIAN ARE THOROUGHLY BRIEFED ON ENVIRONMENTAL/ARCHAEOLOGICAL SENSITIVITIES.

3. GUIDANCE FOR THE CDRS OF TINIAN DEPLOYED UNITS IS CONTAINED IN REF B AND FURTHER AMPLIFIED IN REF C. YOU REVIEW REFS B AND C TO ENSURE COMPLIANCE. ADDITIONALLY, DETAILED CARGO INSPECTION FOR VEHICLES GOING FROM GUAM TO TINIAN BY ANIMAL DAMAGE CONTROL WORKING DOGS IS REQUIRED TO ENSURE BROWN TREE SNAKES ARE NOT TRANSPORTED TO TINIAN.

4. IAW REF C, UPON COMPLETION OF TRAINING, SUBMIT AFTER ACTION REPORT TO COMNAVMARIANAS//N3// NLT 10 WORKING DAYS OF COMPLETION OF TRAINING.//
BT

TRAINING PLAN FORMAT

1. Requesting Unit. Provide complete description of unit and chain of command. (A

2. Planned Operations. Include all activities planned in the Military Training Area with times, dates and location within the area.

3. Weapons, Ammunition and Explosives. Provide statements acknowledging the range rules, including direction of fire, range safety and security for personnel, vehicles and aircraft; pyrotechnics usage; and fire hazard mitigation.

4. Personnel. Provide a list of personnel participating in the exercise including name, rank, rate (or MOS) and position held in unit (i.e., CO, XO, Medical Officer).

5. Aircraft and Drop Zone/Airfield Usage. Provide type of aircraft, activity and flight patterns, times and dates, airfield use, fire fighting requirements and other airfield requirements.

6. Equipment. List all vehicles, heavy equipment, boats and/or fuel burning activities. Identify usage, fuel requirement, routine and emergency maintenance procedures. Address CAPs and permits.

7. Communications. List radios, frequency, call signs and key telephone numbers in training area and at home base.

8. MEDEVAC. Provide real world MEDEVAC and foul weather plan.

9. Logistics. Provide food, water, bed down and resupply plan. Clearance of military customs and anti-snake plan, local coordination.

10. Environmental. Show understanding of environmental concerns within training area: Haul out all trash -- Do not use or allow local residents to put military trash in Tinian dump, acknowledge off-limits areas/historic sites, sewage (CAT holes or portable toilets), protection of reef and wildlife, acknowledge briefing to troops (enclosure ~~(10)~~ (11)), and handling of hazardous materials.

COMNAVMARIANASINST 5440.1D
18 NOV 1996

AFTER ACTION REPORT MESSAGE FORMAT

(A

1. THE FOLLOWING INFO IS SUBMITTED:

   A. DATE(S) OF EXERCISE.

   B. UNITS PARTICIPATING/NUMBER OF PERSONNEL.

   C. AREAS USED.

   D. AIRFIELD USAGE - TYPES OF A/C, NUMBER OF SORTIES.

   E. ORDNANCE EXPENDED.

   F. USE OF CIVILIAN ASSETS/PROPERTY.

   G. SNAKE INSPECTION/CONTROL PROCEDURES USED AND INFO ON SNAKES DETECTED (DATE, TIME, LOCATION, SIZE, SEX AND DISPOSITION).

   H. PROBLEMS ENCOUNTERED.

   I. SUGGESTIONS FOR IMPROVEMENT.//

DECL/(IF APPLICABLE)//
BT

Replace w/ Attached Encl (25)

PUBLIC AFFAIRS

All Public Affairs activities and media inquiries shall be coordinated with COMNAVMARIANAS (~~Code 07~~) at (671) ~~349-5209.~~

Code N01PA 339-2115

DEPARTMENT OF THE NAVY
COMMANDER U.S. NAVAL FORCES, MARIANAS
PSC 489
FPO AP 96536-0051

IN REPLY REFER TO:
COMNAVMARIANASINST 3500.3M
N3

18 AUG 1998

COMNAVMARIANAS INSTRUCTION 3500.3M

Subj: FLEET OPERATING AREAS AND TRAINING FACILITIES - MARIANAS AREA

Ref: (a) COMNAVMARIANASINST 5440.1D
(b) CINCPACFLTINST 3624.1F

Encl: (1) COMNAVMARIANAS Surface/Air Operating Areas
(2) COMNAVMARIANAS Fleet Training Facilities
(3) Farallon De Medinilla Target Complex
(4) Map of Tinian Exclusive Military Use Area/Leased Area
(5) Map of Tinian Constrained Areas
(6) Orote Point Training Area
(7) COMNAVMARIANAS Fleet Training Services
(8) OPAREAS and/or Services Request Format
(9) Farallon De Medinilla Utilization Request Form
(10) Tinian Military Training Area After Action Report Format
(11) Operations at Northwest Field

1. Purpose. To promulgate information concerning training services, areas and facilities available in the Marianas area for military training and to prescribe requesting procedures.

2. Cancellation. COMNAVMARIANASINST 3500.3L. This instruction has been revised in its entirety.

3. Background. COMNAVMARIANAS is the controlling and scheduling authority for Navy controlled training areas and services available in the Marianas area and will coordinate fleet unit requests for use of Air Force training assets as may be available. COMNAVMARIANAS, as Commander in Chief U.S. Pacific Command Representative Guam/Commonwealth of the Northern Mariana Islands/Federated States of Micronesia/Republic of Palau (USCINCPAC REP GUAM/CNMI/FSM/ROP), also coordinates joint service utilization of training areas and facilities as well as de-conflicting exercises in the planning phase prior to such execution in Micronesia.

4. Discussion/Action

a. Facilities. COMNAVMARIANAS maintains a shore bombardment range, submarine and Anti-Submarine Warfare (ASW) operating areas and military land maneuver training areas on Guam and certain islands of the CNMI. Enclosures (1) through (6) provide details/ maps on these areas.

b. Services. Ground unit deployment, electronic counter measure training, shore bombardment, torpedo firing, aircraft radar services and laser operations can be accommodated. A complete listing of services are provided in enclosures (2) and (7), and the format for obtaining services is provided in enclosure (8).

c. Safety

(1) All exercises are to be conducted under applicable Fleet Exercise Procedures (FXP), STAR's or service directives. The pre-exercise briefing will include safety precautions appropriate to the scheduled exercises and the specific area limitations.

(2) The Officer-in-Charge of the Exercise (OCE) is responsible for the safety of exercise units and will ensure non-exercise traffic transiting the area is well clear during firing exercises.

(3) Units will remain within their assigned areas to provide maximum safety and preclude interference with other units. Surface Ship Safety Lanes (SSSL) 1 through 5 have been established for the safe transit of operating areas by surface ships (see Marianas Air and Surface Training Areas Charts, DMA 81025).

(4) Units requesting a gunnery exercise area will be assigned a specific area within Airspace Warning Area (W-517) or the entire Airspace Restricted Area (R-7201), as appropriate, to preclude interference with other surface units and civilian or military aircraft.

(5) COMNAVMARIANAS will initiate requests for the issuance of Airman Advisories, Notices to Airman (NOTAM), Marine Safety Broadcasts and Notices to Mariners (HYDROPACS), as required.

(6) Small fishing boats frequently fish the waters around Farallon De Medinilla (FDM) Target Island. Surface units will circumnavigate the island prior to commencing gunnery exercises and aviation units will conduct a clearing pass at or below 1000 feet above ground level (FT AGL) prior to commencing firing/ bombing operations.

d. Non-Combatant Evacuation Operations (NEO) and Hostage Recovery Training Support. NEO exercises are frequently carried out on Guam in conjunction with other special/unconventional warfare exercises. These exercises frequently request player personnel support from Guam area commands for simulated evacuees. The following procedures will be followed for all NEO training in the COMNAVMARIANAS Area of Responsibility (AOR):

(1) All personnel will be volunteers. Area commands will not draft personnel to meet desired number of player personnel for evacuation.

(2) NEO exercises will be scheduled to allow for adequate organizing and briefing of volunteers. Short notice exercises may be held, but expect reduced number of volunteer personnel.

(3) All players will be briefed completely on the exercise scenario. The briefing will include force levels to be used and levels of resistance the players may use in return.

(4) Use of force and physical contact will be held to a minimum consistent with safety, goals of exercises and common sense.

(5) Participants may drop out of the exercise at any time.

(6) COMNAVMARIANAS will be briefed in detail prior to approving NEO exercises in the COMNAVMARIANAS AOR. A formal debriefing is also mandatory.

(7) An officer controller will be present at and during all evolutions involving volunteers.

e. Reports/Requests

(1) Requests for Operating Areas (OPAREAS) or services should be submitted no later than 45 days prior to the desired time to allow preparation of NOTAMS and HYDROPACS, as applicable. Enclosure (8) provides request format.

(2) Requests for use of the Tinian Military Training Area must be submitted to COMNAVMARIANAS a minimum of 90 days in advance of an exercise per reference (a). A training scenario must accompany the request. Contact COMNAVMARIANAS ACOS Facilities/Environment (N4) for assistance with environmental assessment requirements.

(3) Exercise units will advise COMNAVMARIANAS of exercise cancellation by the most rapid/expeditious means available. Telephonic advisement will be followed by a message or letter. The reason for exercise cancellation will be included if Operating Security (OPSEC) permits.

(4) Exercise units will submit a "Farallon De Medinilla Utilization Report" upon completion of operations to COMNAVMARIANAS ACOS Operations (N3) per reference (b). Enclosure (9) provides format for request.

(5) Upon completion of exercises involving either the Tinian Military Training Area or Orote Point Training Area, exercise units will submit an After Action/Lessons Learned Report to COMNAVMARIANAS N3. Enclosure (10) provides format for both areas.

(6) COMNAVMARIANAS will be kept informed of all exercises to be conducted in the training areas assigned.

(7) Units planning operations in the Northwest Field area must comply with the environmental restrictions outlined in enclosure (11).

(8) Special Unconventional Warfare Exercises and Training. COMNAVMARIANAS will be briefed as to concept, methods of employment, local support desired, rules of engagement and safety requirements prior to approval of special warfare exercises to be conducted in COMNAVMARIANAS AOR.

(9) Report control symbol for all reports cited herein is assigned in CINCPACFLT 3624-1.

B. B. SCOTT
Chief of Staff

Distribution:
USCINCPAC REP GUAM/CNMI/FSM/
ROP//COMNAVMARIANASINST 5216.1R
Lists I, II, III and IV

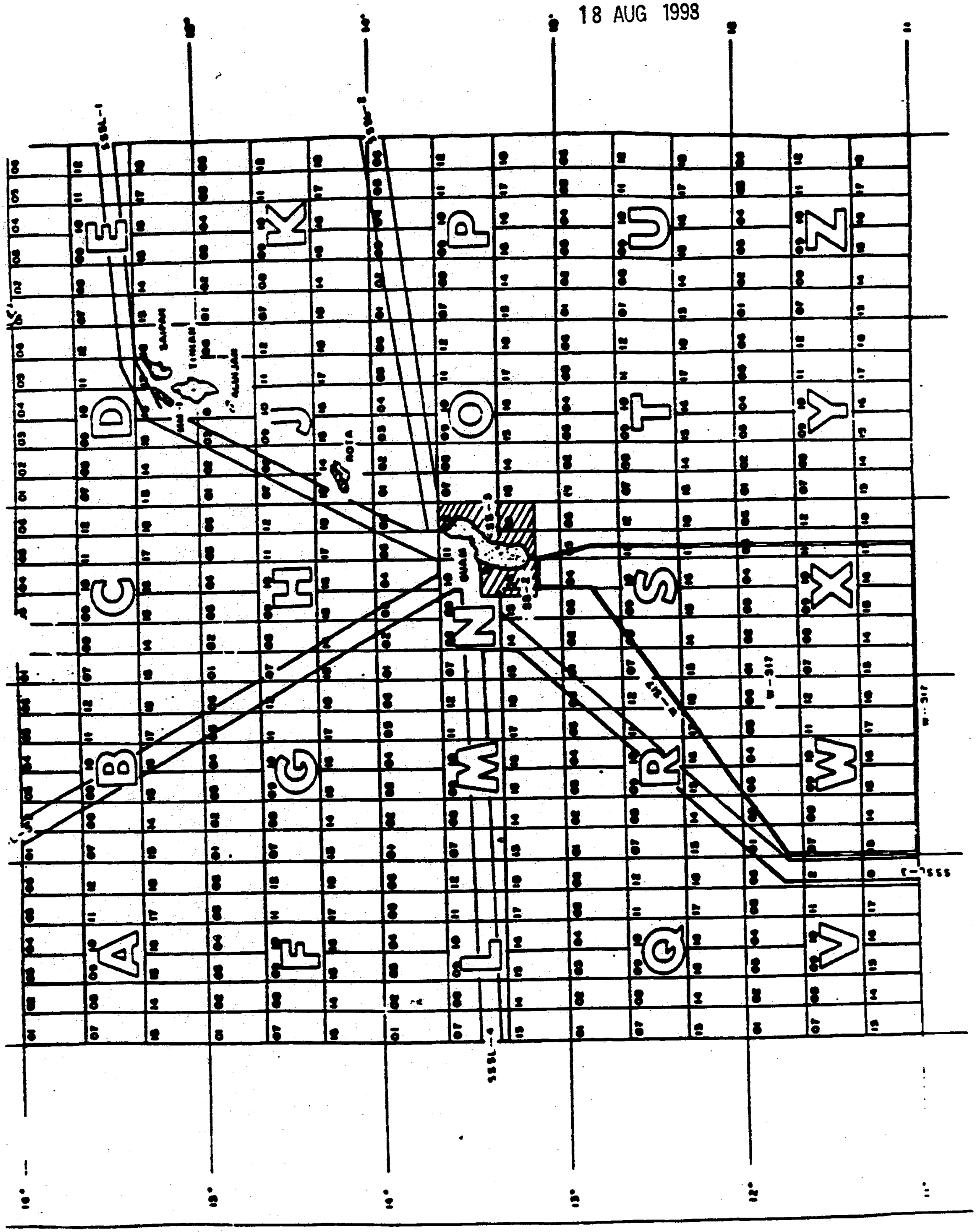
Copy to:
CNO
USCINCPAC
COMSEVENTHFLT
COMSUBGRU SEVEN
COMNAVSURFPAC
COMSUBPAC

COMNAVAIRPAC
COMFAIRWESTPAC
COMFLETRAGRU WESTPAC
FAA GUAM
COMNAVOCEANCOM BAY ST LOUIS MS

Stocked:
COMNAVMARIANAS (N1)

18 AUG 1998

COMNAVMARIANAS SURFACE/AIR OPERATING AREAS



COMNAVMARIANAS FLEET TRAINING FACILITIES

1. Shore Bombardment, Strafing, Aerial Bombing Area. The Shore Bombardment, Strafing and Aerial Bombing range is enclosed within Airspace Restricted Area R-7201 which is a three nautical mile radius circle around the island of Farallon De Medinilla located at 16-01N 146-04.5E. This area is available for all surface, shore, aerial strategic and tactical bombardment support exercises. No ordnance, live or inert, will be delivered within an area 400 meters from the north end of FDM, this area is a no fire safe zone.

2. Special Subsurface Areas. The areas within the following coordinates are available for subsurface operations.

a. SS-1: 14-07N 145-07.5E, 14-08N 145-07E, 14-09.5N 145-07E, 14-13.5N 145-13E, 14-13.5N 145-15.8E, 14-11.9N 145-15.8E, thence southwest along the western coast of Rota to point of commencement.

b. SS-2: From a point where longitude 114-45E intersects the northern coast of Guam, north to latitude 13-40N, then east to longitude 145E, south to latitude 13-10N, west to longitude 144-45E, north to intersect the southern coast of Guam, thence along the eastern coast of Guam to the point of origin.

c. SS-3: From a point where longitude 144-51.5E intersects the northern coast of Guam, north to latitude 13-40N, then east to longitude 144-5E, north to intersect the southern coast of Guam, thence along the eastern coast of Guam to the point of origin.

3. Air to Air, Surface to Surface, Air to Surface and Surface to Air Gunnery/Missile Exercise Area. Surface and aerial gunnery/missile exercises may be conducted within Airspace Warning Area W-517 which is contained within the following coordinates: 13-10N 144-30E, 13-10N 144-42E, 12-50N 144-45E, 11N 144-45E, 11N 143E, 11-45N 143E, 12-50N 144-30E.

4. Small Arms Firing Range. COMNAVMARIANAS maintains an armory, small arms firing range and a Small Arms Marksmanship Instructor (SAMI) available to fleet units.

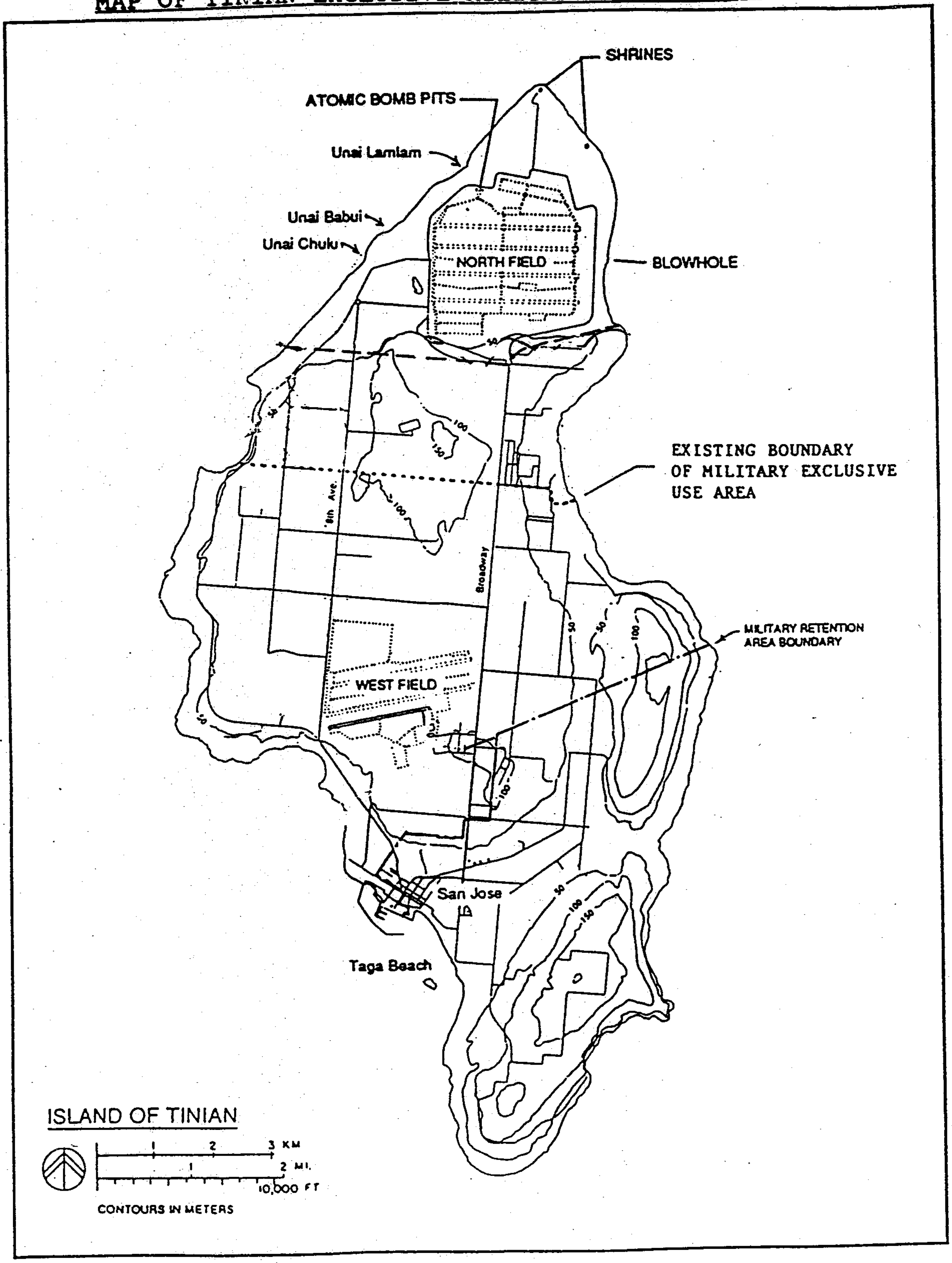
5. Military Training Area. A military training area is located on the northern end of the island of Tinian. The area primarily consists of an abandoned airfield with several historic Japanese structures from World War II. Most of the area is flat with heavy growth of underbrush; however, training sites and drop zone should require only minimal clearing. Runway 1 (northern most 8500' runway), although listed as closed, is cleared periodically

and has been used during past training evolutions for C-130 JA/ATT operations. Roads and tarmac areas are overgrown in some areas but permit ready access to most of the training area. Lake Hagoi, located west of the runways, and all structures are off limits to exercise activity and must not be disturbed. Reference (a) contains instructions to Military Commanders for use of this area. Maps of the island of Tinian are available through the Federal Mapping Agency, stock number W94ZXTINIAN, and through the U.S. Department of Interior.

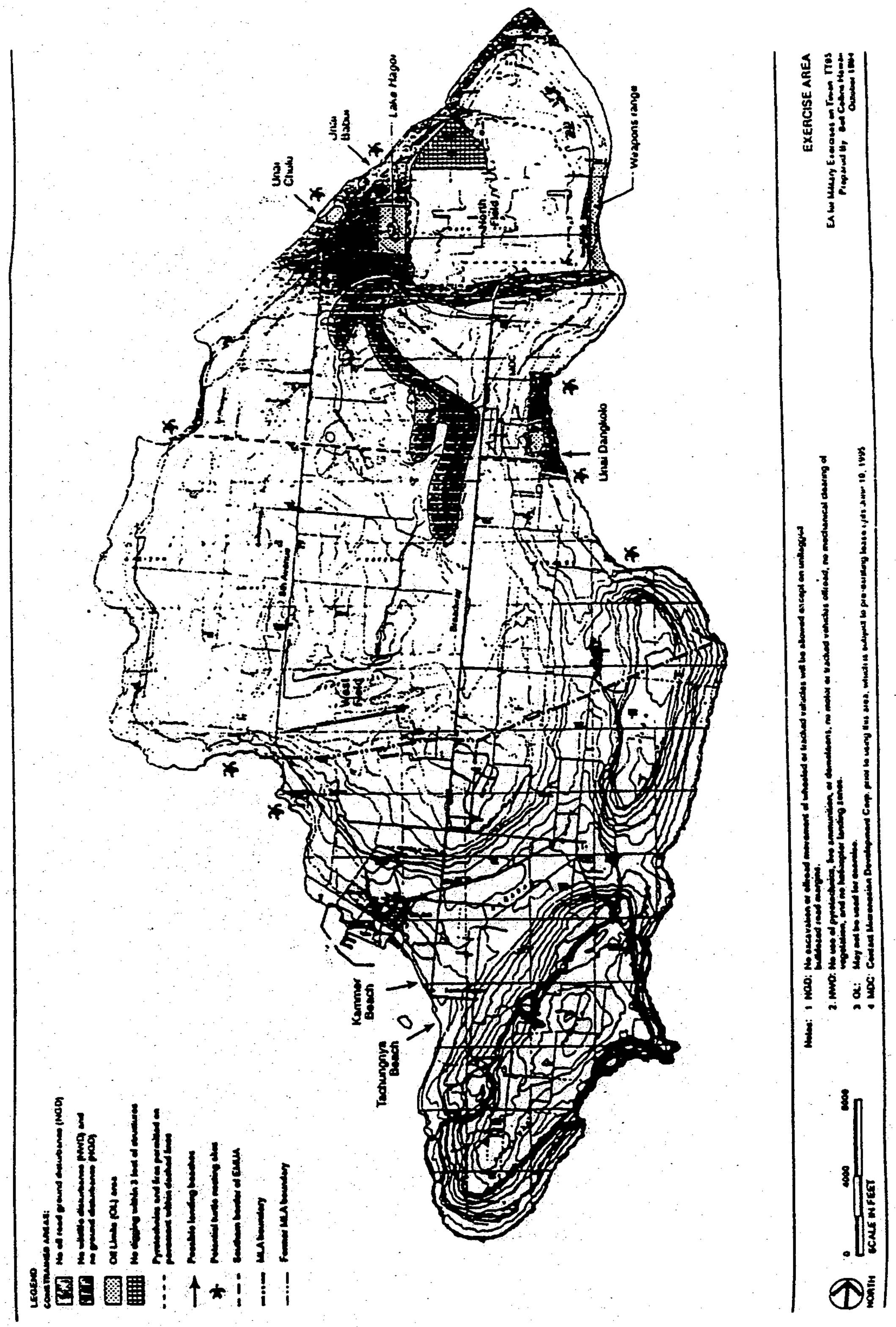
FARALLON DE MEDINILLA TARGET COMPLEX

TARGET NUMBER	GRID POST (SEE PG 3)	HEIGHT (IN METERS)	DESCRIPTION	TARGET USE/PURPOSE	ORDNANCE RESTRICTION
1	98296951	3	Rock Outcropping, Southern	NGFS Point Target	None
2	98506974 to 98617003	40	Truck Convoy #1	CAS; strafing	None (Aircraft only)
3	98537029	10	Rock Outcropping	NGFS Point Target	None
4	98737037 to 98847039	50	POL Storage (Connex; dumpster)	CAS; strafing	None (Aircraft only)
5	98867041 to 99167075	50 to 65	Airstrip (1500 x 150')	CAS	None
6	98797049	Zero	Beach staging area	NGFS Point Target	None
7	98837063 98997059	45 to 60	Vehicle Park	CAS	Inert Ordnance (Aircraft only)
8	99187068	70	Bunker (Connex Box)	NGFS Point Target	NGFS only
9	99157088	60	Bunker (Connex Box)	NGFS Point Target	NGFS only
10	99047088 99127104	15 to 40	Truck Convoy #2	CAS; strafing	Inert Ordnance (Aircraft only)
11	98897089 99187068 99387097	5 to 50	400 yard square	NGFS Area Target	NGFS only
12	99327108 (Center)	50 (Center)	Bullseye marked by large microwave antenna(Aircraft only)	CAS	Inert Ordnance (Aircraft only)
13	99317	2	Bunker in Cove (Rock)	NGFS Counterbattery	

MAP OF TINIAN EXCLUSIVE MILITARY USE AREA/LEASED AREA



MAP OF TINIAN CONSTRAINED AREAS



OROTE POINT TRAINING AREA

1. Description. The Orote Point Training Area is located on the western end of Orote Peninsula, Guam (see map) and extends from the west end of the Orote airfield (closed) to the tip of the peninsula. The south side of the peninsula is an ecological reserve (see below for boundaries) and is not part of the training area. A number of historic sites also exist (see map) that are not part of the training area.

2. Orote Peninsula Ecological Reserve Area (ERA). An ERA is defined as a biological or physical area in which current natural conditions are maintained insofar as possible. Their conditions are ordinarily achieved by allowing natural physical and biological processes to prevail without human intervention.

a. The Orote Peninsula ERA consists of approximately 163 acres covering both land and water areas along the Southern cliffs.

b. The Territorial Unit (TU), from the upper edge of the cliff edge to the mean low water line, is approximately 30 acres. The TU supports scattered stands of remnant native limestone forest. The TU consists of the cliff face only. Climbing is allowed so long as the cliff face is not disturbed.

c. The Marine Unit (MU), from the mean low water line to the 20 fathom contour, covers approximately 133 acres of submerged area. The MU supports a relatively undisturbed coral reef supporting healthy and diverse populations of reef community fish and invertebrates. Boating and swimming are allowed so long as the reef is not disturbed.

d. Boundaries. 13-26-41.25N/144-37-00.05E. Follows along the top of the cliff line in a southeasterly direction to the next point at 13-25-41.00N/144-38-10.80E. Then from the top of the cliff to the bottom of the cliff, to a water depth of 20 fathoms (120 ft) on a line to 13-25-36.80N/144-38-05.00E. Then follows along the 20 fathom contour to 13-26-42.50N/144-36-53.00E. Then to the bottom of the cliff line at water edge at 13-26-42.35N/144-37-00.00E. Then from the bottom of the cliff to the top of the cliff at the beginning point.

3. Historic Sites. (See Chart 81054, enclosures (4) and (5)). The following historic small sites are located on the western end, Apra Harbor side, of Orote peninsula. These four sites are off-limits for exercise play. They will not be damaged or disturbed in any way, nor will anything be removed from them.

a. Orote Point Archaeological Site. Adjacent to the ERA on the northeast side. This site consists of a cave rock shelter approximately six feet above sea level. It has no latte stones, but has an extensive midden around its east entrance.

b. Spanish Well. This shallow water well lies east of the archaeologic site and consists of a shallow well and surrounding rock wall. The well is approximately four feet deep (filled with debris) and 10 feet across.

c. Spanish Steps. Consisting of the hand carved steps up to the top of the cliff face.

d. Fort Santiago Site. Located near the ammunition wharf close to Adotgan Point. This site consists of the remains of the first Spanish fort built on Guam.

4. Helicopter Operations. Helicopters may land at any of the following sites:

a. In the large field in front on the Jungle Warfare Building.

b. At the Ammunition Wharf helo pad.

c. On the abandoned Orote Point runway complex. Area must be confirmed clear of obstructions, people and vehicles prior to use.

5. Orote Point Ammunition Wharf. The Ammunition Wharf and all support facilities are off-limits to exercise players. Ammunition loading/off-loading may, at times, require closing the training area for safety or security purposes.

6. Rifle and Pistol Range. A small rifle range and separate pistol range are available for use. (Use must be approved by COMNAVMARIANAS).

7. Scheduling and Control. The Orote Point Training Area is controlled by COMNAVMARIANAS. Scheduling is coordinated by COMNAVMARIANAS N3. Close coordination will be maintained by COMNAVMARIANAS N3 to ensure conflicts do not arise and training requirements are met.

COMNAVMARIANAS FLEET TRAINING SERVICES

1. Shore Bombardment, Strafing and Aerial Bombing. Farallon De Medinilla (FDM), Airspace Restricted Area R-7201, is available for strafing, aerial bombing, direct and indirect Naval Shore Fire Support (NSFS) training. When not manned, user assumes responsibility for on scene safety. COMNAVMARIANAS does not provide spotter services. The user must arrange and provide spotter services if desired. Access to FDM is only via helicopter.

2. Anti-Submarine Torpedo Firing. Anti-submarine torpedo firing is authorized within the COMNAVMARIANAS operating areas. However, a torpedo retriever (TR) is not available.

3. Small Arms Training. COMNAVMARIANAS maintains a small arms range and has a Small Arms Marksmanship Instructor available to fleet units. Thirty days lead time is desired for range/instructor requests.

4. Tinian Military Training Area

a. The North Field area of Tinian is designed as a military training area for training involving the deployment of personnel and equipment. No utilities are available in the training area. Runway 1 (northern most runway) is listed as closed, but may be used during exercises at the discretion of the Exercise Commander with prior approval and coordination through COMNAVMARIANAS. Fire truck and crash crew to support North Field flight operations is not available on the island but may be requested through Andersen AFB. All Temporary Additional Duty (TAD) costs for crash crew services will be funded by the requesting activity.

b. The island has a civilian airfield (West Tinian) with a 5,333 feet runway located north of San Jose Village. Additional information may be obtained from the Flight Information Publication (FLIP) En Route Supplement.

OPAREAS AND/OR SERVICES REQUEST FORMAT

FM (REQUESTING UNIT)
TO COMNAVMARIANAS GU//N3//
(CLASSIFICATION) //N03500//
MSGID/GENADMIN/(REQUESTING UNIT)//
SUBJ/OPAREAS AND/OR SERVICES REQUEST//
REF/A/DOC/COMNAVMARIANASINST 3500.3M/18AUG98//
AMPN/REF A IS FLEET OPERATING AREAS AND TRAINING FACILITIES - MARIANAS AREA INSTRUCTION//
RMKS/1. PER REF A, REQ FOL OPAREA (OR SERVICES):
A. AREA (OR SERVICES) DESIRED
B. DATE/TIME DESIRED (INCLUDE ALTERNATE)
C. EXERCISE (IF APPLICABLE)
D. OCE AND UNIT PARTICIPATING
E. COMMENTS/REMARKS//
DECL (IF APPLICABLE)//

FARALLON DE MEDINILLA UTILIZATION REQUEST FORM

FM (EXERCISE UNIT)
TO COMNAVMARIANAS GU//N3//
(CLASSIFICATION) //N03500//
SUBJ/FDM UTILIZATION REPORT (RCS 3624)//
REF/A/DOC/COMNAVMARIANASINST 3500.3M/18AUG98//
AMPN/REF A IS FLEET OPERATING AREAS AND TRAINING FACILITIES - MARIANAS AREA INSTRUCTION.//
RMKS/1. PER REF A, FOL INFO IS SUBMITTED:

A. LOCATION - FARALLON DE MEDINILLA (FDM) (R-7201)
B. DATE(S)
C. HOURS SKED
D. HOURS UTILIZED
E. HOURS CNX
F. REASON CNX
G. COMMAND
H. UNIT
I. NUMBER/TYPE AIRCRAFT/SHIP
J. ORDNANCE EXPENDED

2. COMMENTS.//
DECL/IF APPLICABLE//

TINIAN MILITARY TRAINING AREA AFTER ACTION REPORT FORMAT

FM (EXERCISE UNIT)
TO COMNAVMARIANAS GU//N3//
INFO (AS REQUESTED)
UNCLAS //N03500//
SUBJ/TINIAN AFTER ACTION REPORT//
REF/A/DOC/COMNAVMARIANASINST 3500.3M/18AUG98//
AMPN/REF A IS FLEET OPERATING AREAS AND TRAINING FACILITIES - MARIANAS AREA INSTRUCTION.//
RMKS/1. PER REF A, FOL INFO IS SUBMITTED:

A. DATE(S) OF EXERCISE
B. UNITS PARTICIPATING/NUMBER OF PERSONNEL
C. AREAS USED
D. AIRFIELD USAGE - TYPES OF A/C, NUMBER OF SORTIES
E. ORDNANCE EXPENDED
F. USE OF CIVILIAN ASSETS/PROPERTY
G. PROBLEMS ENCOUNTERED
H. SUGGESTIONS FOR IMPROVEMENT//

DECL/(IF APPLICABLE)

OPERATIONS AT NORTHWEST FIELD

1. Flying operations involving overflights or landings by fixed wing or helicopter aircraft are prohibited on Northwest Field except on the south runway (06R/24L). Approaches/departures to the south runway at Northwest Field are restricted to straight in/straight out aligned on the runway centerline extended a minimum of W NM from the runway threshold. Overflights of Northwest Field land areas north of the south runway (06R/24L) below 1,500 feet MSL are prohibited. A map of the restricted area can be found on the next page. All flying (overflights, landings, etc.) and ground operations in the vicinity of Northwest Field will be coordinated/scheduled 60 days prior with 36 Air Base Wing Management who will in turn notify the Environmental Management Office (Natural Resources) for endangered species clearance.

2. Other limitations: Flying is prohibited in the vicinity (1 NM radius, 600' MSL) of the Detachment 5 Radar Facility.

DEPARTMENT OF THE NAVY
COMMANDER, U.S. NAVAL FORCES MARIANAS
PSC 455, BOX 152
FPO AP 96540-1000

IN REPLY REFER TO
COMNAVMARIANASINST 5090.10A
N45
14 FEB 2005

COMNAVMARIANAS INSTRUCTION 5090.10A

Subj: BROWN TREE SNAKE CONTROL AND INTERDICTION PLAN

Ref. (a) Executive Order 13112, Invasive Species
(b) OPNAVINST 5090.1B
(c) COMNAVMARIANASINST 3500.4

Encl: (1) Brown Tree Snake Control and Interdiction Plan

1. Purpose. To outline specific responsibilities and establish policy for coordination and procedures governing the control and interdiction of brown tree snakes on Navy installations on Guam and during military training within the Commander, U.S. Naval Forces Marianas (COMNAVMARIANAS) Area of Responsibility (AOR).

2. Cancellation. COMNAVMARIANASINST 5090.10. This instruction has been changed in its entirety.

3. Scope. This instruction provides guidance and direction to prevent the dispersal of brown tree snakes from Guam to other locales via military sea and air shipments of personnel, equipment, and cargo. Its provisions are applicable to all activities in the COMNAVMARIANAS AOR who directly or indirectly have responsibility for military sea and air shipments. This instruction issues a revised Brown Tree Snake Control and Interdiction Plan that is to be followed during the planning and execution of any movement of military sea and air shipments, including personnel. This instruction applies to Guam Installation Commanders, Major Exercise Commanders, Training Unit Commanders, and all military Flight Crews.

4. Background. Per reference (a), COMNAVMARIANAS is responsible for not causing or promoting the introduction or spread of invasive species in the United States or elsewhere. The brown tree snake is an alien species to the United States, including Guam, whose introduction has caused significant economic and environmental harm; consequently, it is classified as an invasive species. Per reference (b), the Navy is required to ensure military readiness and sustainability while complying with natural resources protection laws, and conserving and managing natural resources in the United States, its territories, and possessions. This dual dynamic of stewardship and readiness is essential for the long-term maintenance of

military and natural resources sustainability. Per reference (c), COMNAVMARIANAS is the controlling and scheduling authority for Navy-owned and controlled training areas and services in the Mariana Islands. The dispersal of brown tree snakes from Guam to other locales is a serious economic and environmental threat. Preventing dispersal of brown tree snakes in military sea and air cargo is a priority for COMNAVMARIANAS.

5. Action

a. The sponsoring office for this order, the Assistant Chief of Staff, Facilities and Environmental (ACOS N4) is responsible for environmental oversight of all actions, including military training, within the COMNAVMARIANAS AOR. The ACOS N4 is responsible for environmental evaluation of potential environmental impacts, determining the measures necessary to protect the environment and preserving the long-term maintenance of military and natural resources sustainability. The ACOS N4 will advise the Commander of any changes in the handling and movement of military sea and air shipment cargo, and any changes in military training constraints necessary to prevent the dispersal of brown tree snakes in military sea and air shipments. The ACOS N4 will work in close coordination with the Assistant Chief of Staff, Operations (ACOS N3).

b. The ACOS N3 is responsible for scheduling and oversight of supplies and port services and operations, and for the scheduling and oversight of training. The ACOS N3 will accomplish all specified requirements described herein.

c. The Assistant Chief of Staff, Ordnance Operations (ACOS N2) is responsible for preparing and staging munitions for shipment from Guam. The ACOS N2 will accomplish all specified requirements described herein.

d. Regional supported activities, including but not limited to, DRMO Guam, NMCB DET Guam, and MSCO Guam will:

(1) Review the Brown Tree Snake Control and Interdiction Plan and identify and incorporate into local plans all necessary control and interdiction measures, and fully cooperate with federal authorities during observations and inspections of equipment and cargo being prepared and staged for shipment from Guam.

(2) Ensure that personnel assigned to preparation and handling of equipment and cargo scheduled for shipment from Guam are knowledgeable and adhere to the information contained in the

Brown Tree Snake Control and Interdiction Plan and directives pertaining to inspection of outbound equipment and cargo.

(3) Comply with the mandatory regulations and direction contained in the Brown Tree Snake Control and Interdiction Plan when preparing equipment and cargo for shipment from Guam.

e. Commanding Officers/Officers-in-Charge of training units will:

(1) Review the Brown Tree Snake Control and Interdiction Plan and identify and incorporate into training plans all necessary control and interdiction measures, and fully cooperate with federal authorities during observations and inspections of equipment and cargo being prepared and staged for shipment from Guam.

(2) Ensure that personnel assigned to preparation and handling of equipment and cargo scheduled for shipment from Guam are knowledgeable and adhere to the information contained in the Brown Tree Snake Control and Interdiction Plan and directives pertaining to inspection of outbound equipment and cargo.

(3) Comply with the mandatory regulations and direction contained in the Brown Tree Snake Control and Interdiction Plan when preparing equipment and cargo for shipment from Guam.

6. Applicability. This order applies to all commands, organizations, units, and activities authorized use of Navy lands and facilities, training areas, and ranges controlled by COMNAVMARIANAS.

7. Certification. Reviewed and approved this date.

R. A. McNAUGHT
Chief of Staff

Distribution:
USPACOM REP GUAM/CNMI/FSM/ROP//COMNAVMARIANASINST 5216.1V
Lists I through IV

Stocked:
COMNAVMARIANAS (N1)

14 FEB 2005

BROWN TREE SNAKE CONTROL AND INTERDICTION PLAN

Prepared by:
Commander U.S. Naval Forces Marianas
Facilities & Environment, N45

August 2004

This Page Blank

Table of Contents

ACRONYMS and ABBREVIATIONS

AAFB	Andersen Air Force Base
AMSS	AAFB Mobility Support Squadron
APHIS	Animal and Plant Health Inspection Service
BTS	Brown Tree Snake
CECG	Combined Exercise Command Group
CESG	Combined Exercise Support Group
CNMI	Commonwealth of the Northern Mariana Islands
COMNAVMARIANAS	Commander, Naval Forces Marianas
GDAWR	Guam Division of Aquatic and Wildlife Resources
DLNR	Department of Land and Natural Resources
DOD	U.S. Department of Defense
DOI	U.S. Department of Interior
FISC	Fleet Industrial Supply Center
GovGuam	Government of Guam
HDOA	Hawaii Department of Agriculture
MI	Military Inspector
MILVAN	Military (cargo) Van
MOA	Memorandum of Agreement
PHNSY	Pearl Harbor Naval Shipyard
PM	Pest Management (USAF)
PMRF	Pacific Missile Range Facility
USAF	United States Air Force
USAG-HI	United States Army Garrison, Hawaii
USARPAC	United States Army, Pacific
USCOMPAC	Commander, U.S. Pacific Command
USCOMPAC REP	USCOMPAC Representative
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS/CSU	U.S. Geological Survey/Colorado State University, Brown Treesnake Project
USGS/RRT	U.S. Geological Survey, Rapid Response Team
WACSA	USDA-WS Approved Cargo Staging Area
WS	(USDA) Wildlife Services

BROWN TREE SNAKE
CONTROL AND INTERDICTION PLAN

I. INTRODUCTION

Purpose

Control and interdiction of the brown tree snake (*Boiga irregularis*), hereafter referred to as BTS, is absolutely essential to prevent the dispersal of BTS from Guam to other locales via military sea and air shipments of personnel, equipment and cargo. The control and interdiction protocols are practiced on a daily basis by military organizations permanently stationed in Guam. The purpose of this plan is to disseminate these procedures to resident and transient organizations, and to emphasize the threat and need to prevent BTS movement from Guam to other areas at risk during military training activities. These preventive practices are particularly crucial during shipments to the Commonwealth of the Northern Mariana Islands (CNMI), Hawaii, and other locations where the BTS has no natural population controls. Therefore, the primary objectives of BTS control and interdiction are to reduce the ongoing and potential threats to human health and safety, biological resources, and impacts to island economies.

The Brown Tree Snake Threat

The BTS is a native species of Indonesia, New Guinea, the Solomon Islands, and Australia that was inadvertently introduced in Guam sometime between the mid-1940s and early 1950s. Since its introduction, the population of BTS has expanded to encompass the entire island's rural and urban areas. The BTS has caused or has been a major factor in the extirpation of most of Guam's native terrestrial vertebrates, including lizards and 9 of 11 endemic/native forest and water birds. In addition, the BTS has caused more than a thousand power outages, preyed on poultry and household pets, and has bitten numerous children.

High densities of snakes occur throughout Guam, and in areas where cargo is loaded for transport by air and sea. BTS characteristics such as being able to survive for long periods of time without food, and habitually seeking out small dark places as refugia, work synergistically to give a higher probability for successfully transporting BTS to other islands/regions. Due to the possibility of sperm storage, a single female BTS can potentially start a population. The potential spread of BTS from Guam via cargo movements is a serious concern due to Guam's role as a trans-Pacific shipping hub and the delicate environments of islands that receive cargo.[1] BTS sightings have been recorded in locations ranging from - Oahu in Hawaii, Tinian, Rota, and Saipan in the CNMI, Marshall Islands, Okinawa, Diego Garcia, Wake Island, Spain, Alaska and Texas. There is no documentation supporting any established populations of BTS in any of these locations. However, detecting BTS populations at low densities is extremely difficult.

[1] USDA et al.1996. *Environmental Assessment for Brown Tree Snake Control Activities on Guam.*

II. FEDERAL AUTHORITY AND DIRECTION

1990: Federal funding for BTS interdiction and control initiated.

1990: U.S. Congress incorporated specific direction into the Nonindigenous Aquatic Nuisance Prevention and Control Act regarding the control of BTS in coordination with regional, territorial, state, and local entities in Guam and other areas where the species is established outside of its historic range.

1993: A 5 year Memorandum of Agreement (MOA) between U.S. Department of Agriculture (USDA)[2], the U.S Department of the Interior (DOI), the U.S. Department of Defense (DOD), the Government of Guam (GovGuam) and the State of Hawaii to coordinate BTS research and establish the USDA Animal Damage Control program.

1996: The Commonwealth of the Northern Mariana Islands (CNMI) added to the 5 year MOA.

1999: Department of Transportation and the Department of Commerce added to 5 year MOA.

1999: President Clinton signed Executive Order 13112, "Invasive Species"[3]. The executive order directed federal agencies to (1) prevent, detect, and respond to control populations of invasive species; (2) to monitor invasive species populations; (3) to provide for restoration of native species and habitation in ecosystems that have been invaded; (4) to conduct research and develop technologies to prevent introduction and to control invasive species; and, (5) to promote public education on invasive species.

III. DOD BTS ACTIONS IN THE MARIANA ISLANDS

BTS contamination can occur during any cargo shipment or personnel scenario. COMNAVMARIANAS and Commanding Officer, 36th Air Base Wing, Andersen Air Force Base, are responsible for carrying out a viable plan to meet a full spectrum of potential BTS cargo contamination at Guam's military ports. COMNAVMARIANAS and 36th ABW are fully supported in these actions by the USDA Wildlife Services (WS).

Other cooperative agencies that support COMNAVMARIANAS and 36th ABW BTS control and interdiction efforts include DOI, U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey/Colorado State University Brown Treesnake Project (USGS/CSU), the Guam Department of Agriculture's Division of Aquatic and Wildlife Resources (GDAWR), the CNMI Department of Land and Natural Resources (DLNR), and the State of Hawaii Department of Agriculture (HDOA).

[2] In 1997, USDA Animal Damage Control (ADC) became the USDA Animal and Plant Health Inspection Services (APHIS) Wildlife Services (WS), and is the office presently responsible for integrated wildlife damage management.

[3] "Invasive species" means a species not native to an ecosystem that does or is likely to cause economic or environmental harm or harm to human health.

The COMNAVMARIANAS BTS Control and Interdiction Plan has been implemented and evaluated during major inter-island exercises, as well as numerous small scale operations and daily operations. The control and interdiction procedures were reevaluated as part of a Commander, U.S. Pacific Command (USCOMPAC) Final Environmental Impact Statement that assessed potential impacts of all military training exercises throughout the Mariana Islands. The lessons learned from these major exercises and the results of other environmental evaluations have been incorporated in this plan. COMNAVMARIANAS sponsors annual reviews of BTS control and interdiction protocols with federal, territorial and commonwealth agencies to evaluate additional lessons learned and new technologies that may be adopted in the Mariana Islands.

IV. RESPONSIBILITIES

The following categorized responsibilities provide a foundation for action by certain agencies or individuals involved with Guam military training exercises and BTS control/interdiction programs. Due to turnover experienced by all military units, the responsibilities relating to BTS threat awareness instruction will often be repetitious to ensure that all persons training in the Mariana Islands are fully knowledgeable of individual and command responsibilities.

A. Guam Installation Commanders

COMNAVMARIANAS and Commander, 36th Air Base Wing are responsible for the conduct of BTS control and interdiction on Navy and USAF installations, respectively, and supported daily by the Guam WS permanent staff assigned to COMNAVMARIANAS and Andersen Air Force Base. The installation commanders are responsible to keep WS informed of activities that will require their support. Specific command responsibilities are as follows:

1. Fully cooperate with WS to conduct measures necessary to reduce the BTS snake population at port and cargo facilities through an integrated approach consisting of technical assistance and lethal and non-lethal control methods such as exclusion, habitat modification, capture and prey base reduction.

2. Plan, direct, and coordinate all cargo handling procedures for cargo departing Guam with consideration for the on-going threat of the pan-Pacific spread of BTS.

3. Consult with WS to determine the necessity to establish USDA-WS approved cargo staging areas (WACSA).

4. Direct cargo handlers and/or managers to work closely with WS personnel to establish and maintain an effective cargo and equipment BTS inspection process.

5. Publish and distribute the BTS Emergency Response Protocol. Prominently display contact information and telephone numbers to report BTS sightings (see Table 1).

6. Conduct information briefings for both permanently assigned and transient personnel. Explain the potential for impacts if BTS were transported from Guam in military vehicles, cargo and equipment. Explain individual responsibilities if and when a BTS or any other snake species is sighted (kill/capture/immediately report to WS). Other snake species can be dangerous.

7. Clearly display BTS identification and information posters in tent cities, barracks and work sites. Use the BTS Awareness instructional videotapes and printed materials, requesting WS participation and/or demonstrations at the briefings when their workloads permit. Provide information cards to personnel as a reminder of the BTS threat and responsibilities for immediate action.

8. For major exercises, include BTS control and interdiction procedures in the exercise plan's Environmental Awareness Annex. Include in the annex, a copy of the information cards to be distributed to training personnel that will define applicable environmental protective measures, including the BTS protocol.

9. In consultation with WS, direct the sites to be used for tent cities and staging areas for vehicle, cargo pallets and containers, and other equipment.

10. Provide vehicle washing areas and high-pressure wash equipment when needed.

11. Designate areas to be used for inspecting vehicles after they have been cleaned and prior to movement to WACSAs or immediate loading aboard aircraft and/or ships.

12. Provide area lighting at WS approved designated inspection and staging areas.

13. Assist WS to facilitate the mandatory 100 percent inspection of all outbound cargo by detector dog teams.

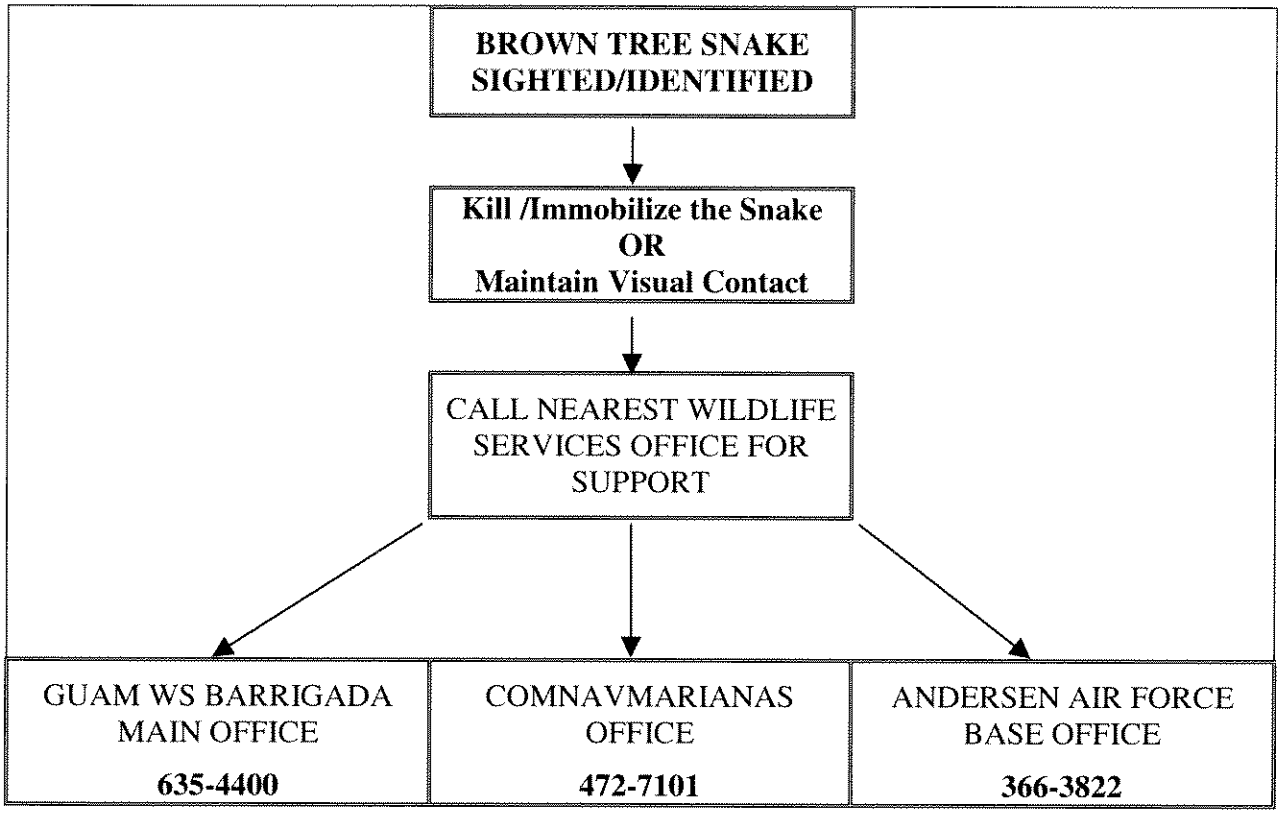
14. For major exercises, assign members of the base environmental staff with experience in conducting BTS protocol as members of the Combined Exercise Command Group (CECG) and the Combined Exercise Support Group (CESG).

15. Provide personnel and logistic support to augment BTS protocol activities as needed.

16. For major exercises and in coordination with WS, enhance rodent control measures and grounds maintenance practices that reduce the potential for BTS activity/presence in areas selected for vehicle and cargo staging.

17. During day-to-day cargo inspections, the installation commander may authorize WS to stop any cargo carrier from departing Guam with any cargo or equipment suspected to harbor BTS.

Table 1: BTS Emergency Response Procedures for Guam Cargo Stations



NOTE: Cellular phone numbers will be provided to exercise units during field exercises to ensure WS can be contacted at any hour.

B. Major Exercise Commanders

The CECG and CESG conducting major exercises are tasked with a variety of responsibilities to support the exercise force. Logistics coordination in response to command direction is the responsibility of the CESG. Early coordination with WS is required to incorporate BTS control and interdiction requirements into the exercise logistic support plans. In regard to BTS control and interdiction, the CECG/CESG will:

1. Work with the Installation Commander and WS when necessary to establish a WACSA for personal and unit equipment, and vehicle staging.
2. Work with the AAFB commander and WS to develop an aircraft parking plan that will minimize potential exposure of aircraft to BTS.
3. Supervise the BTS control and interdiction process by providing environmental monitors as needed.
4. Schedule and monitor BTS control and interdiction briefings for all training units upon arrival.
5. Identify to WS the logistics staff personnel who will be responsible for cargo handling operations and BTS response.
6. Provide WS the authority to stop any cargo carrier from departing Guam with any cargo or equipment suspected to harbor BTS.

C. Training Unit Commanders

Regardless of the size of training exercises, commanders of resident and transient organizations will request support from the Installation Commander (and/or the CECG and CESG) when tasked with establishing tent cities, staging areas, and areas for inspecting personnel, vehicles and cargo prior to shipment from Guam (see Section E below for a listing of WS assistance and service that are provided to training units). The commanders of training units will:

1. Ensure that installation staff or CESG conduct BTS control and interdiction information briefings for exercise personnel.

2. Distribute BTS information packets that include the Emergency Response Protocols in case of actual or suspected snake sightings.

3. Coordinate with the on-site commanders to obtain wash down facilities and inspection areas. 36th ABW may provide portable high-pressure washers and a cleaning area. Future plans include repair of a 36 Transportation Squadron vehicle washing area.

4. Identify key personnel responsible for cargo staging, handling and inspection to the installation commander/CESG and ensure their cooperation with WS personnel.

5. Provide additional information to cargo handlers to increase their levels of BTS awareness. Cargo handlers are the first-line of defense against BTS in military cargo. Request assistance from WS to review the following:

    a. History of BTS on Guam, the threat to the environment, action taken to control and interdict BTS, and the goals of existing programs. (Use the USDA video).

    b. A description of implementation efforts on base.

c. A demonstration by the WS detector dog team.

d. A live BTS to enhance immediate recognition.

e. A review of proper methods to kill or capture the snake.

f. Information cards.

6. Supervise the equipment and vehicle cleaning and inspection prior to moving items to the staging area for WS inspections.

7. Provide WS complete access to staged cargo and equipment, opening any containers as requested for a WS internal inspection.

8. Designate personnel as inspectors to assist during WS and cargo handling personnel during personnel, vehicle, cargo and equipment cleaning and inspection.

9. Ensure that all ships and aircraft departing from Guam for overseas and airports are inspected by WS.

10. Prior to breaking camp and off-island departure, ensure that personal belongings, tents and canvas used/staged in bivouac areas have been inspected for BTS presence by WS. Ensure that all personnel conduct inspections of their individual equipment (hand-carried/back-packed/sea-bags). Request WS assistance prior to breaking camp.

D. Flight Crews

Supporting aircraft may be staged at the AAFB parking apron. Supporting aircraft will not be staged overnight at Orote airfield. When idle, the doors of the aircraft will be closed so that BTS cannot enter the aircraft interior. During pre-flight inspections, flight crews should be alert for potential BTS on aircraft. Request WS assistance as needed.

E. USDA APHIS Wildlife Services Support in Guam

USDA APHIS field operations in Guam are conducted by Wildlife Services (WS) staff consisting of Wildlife Biologists, WS Specialists, and snake detector dogs. Logistic support is available to Guam from the WS staff in Yakima, Washington, who make and store equipment and snake traps.

WS BTS control and interdiction efforts are conducted at all commercial and DOD ports for day-to-day cargo shipments. In support of military exercises, WS inspection and containment efforts are enhanced, and WS will:

1. Conduct a 100 percent canine inspection of all outbound aircraft and surface cargo.

2. Identify, purchase, operate, and maintain BTS control tools such as snake handling equipment, snake traps, and snake barriers. Barrier fencing is used to erect a WACSA at a port of embarkation on Guam (to keep snakes out of inspected cargo) and a containment area (to keep any snakes in) at the port of debarkation on Tinian. Other tools may be used as needed to accommodate special circumstances and situations.

3. Determine snake-trapping strategies by topographical features and proximity to cargo staging, handling, or processing areas. The BTS trap is a modified minnow trap with a mouse as an attractant within an inner chamber that is inaccessible to snakes. The trap is routinely restocked with food and moisture source for the mouse. The self-setting traps have one-way entrances on either end and are designed for multiple captures.

4. Assign WS personnel and detector dog teams 24 hours/7-days per week during deployment and post-exercise redeployment activities.

5. Use handheld spotlights to walk the perimeter at night to detect and capture BTS, and use detector dog teams to inspect shipments trucked into staging area.

To ensure effective communication with exercise participants, WS will rely on a close working relationship with military cargo managers, appropriate installation commanders, and training unit commanders, and the military commanders keeping WS informed of ongoing and future activities.

USDA WS may be contacted one of three offices on Guam: Andersen AFB Office (366-3822), Barrigada Heights District Office (635-4400), and COMNAVMARIANAS Office (472-7101). The supervisory office in Honolulu can be reached at (808) 861-8576. Cell phone numbers will be published prior to major exercises to ensure WS personnel on Guam and Tinian can be reached 24 hours a day

F. USGS/Colorado State University, Brown Treesnake Project (USGS/CSU)

The U.S. Geological Survey/CSU's Brown Treesnake Project may provide technical assistance to WS. BTS specialists in USGS/CSU may be called upon to provide technical assistance on barrier deployment and construction, trapping efficacy, population levels, special problems with visual or trap-capture of small snakes in dense vegetation, etc. The USGS-Rapid Response Team (RRT) can be requested by local government agencies to respond to any snake sightings outside of Guam.

V. CONTROL, CLEANING, AND INSPECTION PROCEDURES

The possibility of the inadvertent importation of the BTS to other areas of the world is always present whenever military units embark from Guam. BTS is a nocturnal snake that will seek shelter during the day in any area that offers shade, including CONEX boxes, MILVANS, commercial shipping containers, crates, pallets, and personal gear, as well as aboard aircraft, ships, and wheeled or tracked vehicles. The snake can hide in extremely confined spaces. The BTS has the ability to go without food for extended periods and to survive long voyages or flights undetected. Military and commercial air- and sea-ports have recorded several instances of a live BTS arriving from Guam. Therefore, BTS control and interdiction responsibilities have high priority.

A. BTS Control Measures at COMNAVMARIANAS and AAFB Cargo Points

WS personnel will provide support to the military on a routine basis as well as throughout any training exercises that involve the shipment of military personnel and associated cargo off-island via ship (Apra Harbor) and/or aircraft (Andersen AFB). This support is identified in Section II. D above. Ensuring that the BTS protocol is accomplished and that there are no delays in off-island shipment will require full cooperation from the units being inspected prior to embarkation.

Permanent Staging Areas. Permanent staging areas provided by COMNAVMARIANAS and 36th ABW for sea and air cargo are surrounded by chain link fencing with lighting. These areas are extensively patrolled for BTS but are **not** WS approved cargo staging areas. COMNAVMARIANAS uses Sierra Wharf and warehouse facilities at the former Fleet Industrial Supply Center (FISC). At AAFB, the primary staging area is the 634th Air Mobility Support Squadron (AMSS) warehouse (see Figure 1). Cargo is inspected at these sites daily. These facilities are primarily used for day-to-day cargo staging, but may be used for cargo related to a training exercise.

Temporary USDA-WS Approved Cargo Staging Area (WACSA). When needed to support an influx of training materials and equipment, WS will assist military personnel to select the site for a WACSA for cargo that will be embarked from Guam. In addition to establishing a WACSA at or near a permanent staging area, other paved areas could be suitable.

WACSA will be established when there will be a delay between BTS cargo inspection and movement to the loading point for aircraft or ship embarkation. The WACSA would be used to keep BTS from contaminating inspected cargo and to establish a controlled staging area for snake surveillance and trapping. The necessity to use a WACSA as part of the overall embarkation process will be reviewed during major exercise planning conferences so that the steps and additional time may be included in embarkation plans. The need to use either permanent staging areas or a WACSA at other paved surfaces with low potential for BTS presence will be determined during pre-deployment conferences with WS assistance.

The WS developed WACSA is a barrier constructed with angled sections of weather shade netting on re-bar and PVC pipe supports, weighted along the bottom edge with water snakes and sandbags. The number of entry and exit points is minimized and the barriers at the entrances are designed to lead any BTS toward a trap. The advantage of the temporary barrier is portability and a means to readily support fixed wing operations at main airfields, helicopter operations at landing zones, and ship offloads in port. A temporary snake barrier at AAFB Main or the FISC would be erected 3-5 days prior to the exercise. Snake traps will be placed on the fencing and/or along the forest perimeter. WS personnel will be responsible for trap and portable fence line maintenance, including trap cleaning and the care of mice used as an attractant.

442.0106/004-7 r4.3.00 2

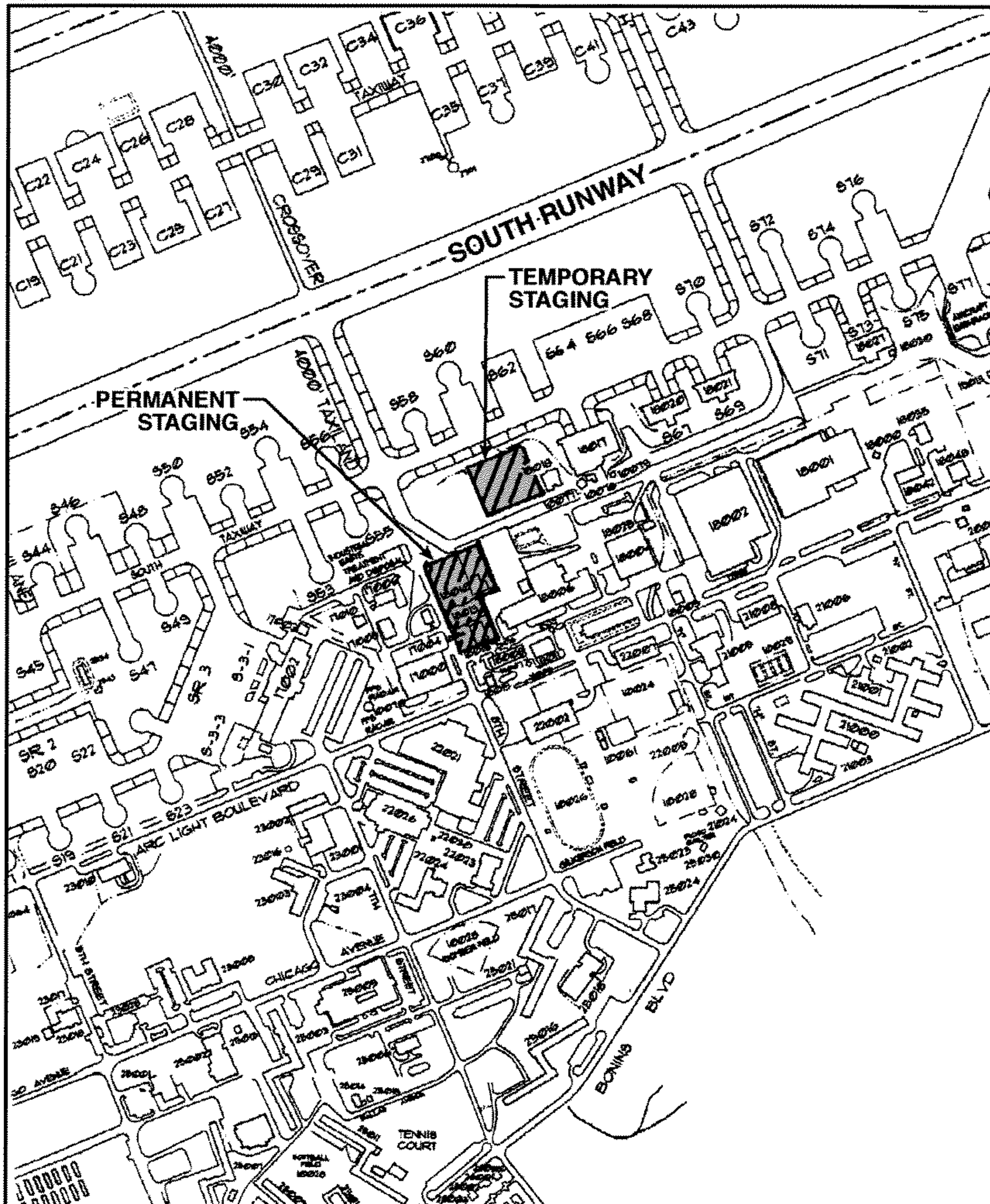


Figure 1
ANDERSEN AIR FORCE BASE
CARGO STAGING AREAS
BTS Control and Interdiction Plan
Belt Collins Hawaii, April 2000

Snake Trapping. Snake trapping is conducted prior to construction of the WACSA on Guam. The time necessary to initiate the effort depends on the selected WACSA site and the nature of the exercise. If the WACSA will be established at AAFB Main and the FISC, snake-trapping activities are already being conducted. If an area elsewhere on Guam, such as Northwest Field, Ordnance Annex, or Orote Point is going to be used, WS will initiate snake trapping thirty days prior to the exercise. Once the WACSA is erected, WS will conduct nightly spotlight searches in the area of the fence to augment area snake trapping.

Detector Dog Teams. WS will use snake detector dogs to inspect outbound cargo and aircraft. The snake detector dog teams (one team equals one dog and handler) will be made available as necessary 24-hours a day, seven days a week.

B. BTS Control Measures at COMNAVMARIANAS and AAFB Tent Cities

Site Selection. WS will be consulted to recommend areas of low BTS risk to be considered as Tent City (bivouac) sites.

Trapping and Searching. WS may elect to activate and monitor brown tree snake traps surrounding the immediate vicinity of tent cities. WS Detector dog teams will periodically walk through the area while troops are being staged prior to departure from Guam. Particular attention to BTS control measures is needed while breaking camp and re-packing tents and equipment susceptible to BTS infestation during bivouac and field training.

C. Cleaning Procedures

Responsibility. Prior to staging in a WACSA and embarkation aboard an aircraft or ship, each training unit will be responsible for cleaning its vehicles and equipment. For vehicles and equipment considered to be high-risk, additional procedures may be required such as high-pressure washing, steam-cleaning, fumigation, or other methods suggested by WS. These additional efforts will supplement any inspection conducted by cargo handlers, unit personnel and WS.

Cleaning Facilities and Equipment. AAFB and COMNAVMARIANAS will provide cleaning areas. If cleaning equipment is unavailable or if the exercise scenario would increase the risk of snake infestation of vehicles, the training units may be tasked with augmenting or providing all necessary cleaning equipment and supplies. To request installation support, training units may contact the following units:

For Andersen Air Force Base: Call Vehicle Operations at 366-2239, 24 hours, 7 days per week.

For COMNAVMARIANAS: Call the COMNAVMARIANAS Area Training Officer (Code N3) 339-6141.

D. Inspection Procedures on Guam

General. The inspection procedure is a joint military/WS effort. It includes individual user and cargo handler attention when packing materials for air and sea embarkation, and a subsequent thorough, systematic inspection of cargo, equipment, and vehicles by WS. To maintain open lines of communication among all involved, DOD will provide WS the names of military contacts at the shipping or air terminals, and WS will keep the military points-of-contact informed of their BTS inspection activities.

WS inspections are required for all outbound cargo. This includes inspections of equipment belonging to units stationed on Guam, and equipment that is transported to Guam by transient units from CONUS, Hawaii, or Japan for subsequent exercise support. Upon completion of the exercise, another inspection is required for equipment that will be cleaned, packed, and embarked for movement to home installations off-island.

Inspecting Personal Equipment. Military commanders are responsible for ensuring that all personal gear, hand-carried equipment and supplies, and tent canvas are visually inspected by military personnel as it is repacked when breaking camp. To facilitate the inspection, personal equipment and tent canvas will be laid out for WS detector dog inspection prior to palletizing or loading into shipping containers.

Inspecting Outbound Cargo. The decisions are based on the nature of the training exercise and volume of cargo to be transported from Guam to an off-island location. The objectives are to minimize the timeline necessary between cleaning and embarking equipment, and to minimize the use of a WACSA without degrading BTS control and interdiction protocols. The military commander and WS cooperate in making these decisions.

Inspecting Transports. The WS Detector Dog Teams may be tasked to inspect accessible transport craft (ship, barge, and/or airplane) prior to departure from Guam.

Inspecting Heavy Equipment and Vehicles. This equipment is often used to support field maneuvers prior to movement to the port of embarkation. WS Detector Dog Teams will inspect all heavy equipment and vehicles after they have been thoroughly cleaned.

Snake Detected or Suspected. If the detector dogs alert to a possible BTS on a vehicle, pallet, or at the threshold of a locked container, the suspected equipment will not be moved. A second detector dog team may be brought on-scene to confirm the first dog alerting to BTS presence. If the BTS is not discovered, the affected military unit will break out the cargo to allow BTS detection and elimination. If the BTS is not immediately found, WS will intensify its search and may activate additional traps in the vicinity of the affected shipment.

All outbound cargo is to be cleaned, inspected and immediately loaded onto a vessel or aircraft. If there is a delay between inspection and loading, cargo may be subject to WS reinspection or be placed in an approved WS cargo staging area. WS will decide on the proper course of action. WS may determine that any ship, barge, boat or aircraft that was inspected and then unattended may require another inspection prior to departure. Cargo, vehicles, and equipment held within a WACSA for an extended period (such as during the night when snakes are active) may be subject to additional inspection prior to loading for departure.

Schedule and Plan Modifications. WS plans its personnel and detector dog team assignments based on published exercise plans, arrival and departure schedules. Sites to be used as WACSA at ports of embarkation and debarkation are selected in advance and activated prior to the exercise commencing. Relocating established WACSA might not be feasible. However, given reasonable time to react, WS may alter its personnel and detector dog team schedules and assigned cargo and vehicle inspection sites. Since the BTS protocols take precedence when executing tactical troop and cargo movements from Guam, the arrival and departure schedules and points-of-contact will be verified by the military so that WS support will be on-hand when expected.

Inspection Verification Process for Tinian Shipments. WS personnel will identify inspected items within Guam containment areas by affixing a stamp and/or tag to cargo or cargo manifest denoting the words "Snake-Inspected" together with date and time the inspection occurred.

WS will be especially watchful to ensure that airdrop cargo for Tinian has been thoroughly inspected and is tagged for identification by CNMI Customs Inspectors.

E. Inspection Procedures on Tinian

Military exercises may involve personnel, cargo, and equipment movement between Guam and Tinian, CNMI. Similar staging and inspection processes for Tinian may be established at other island training sites.

1. Prior to a training exercise commencing on Tinian, WS personnel will identify, purchase, and make arrangements with DOD to transport BTS control and interdiction tools and equipment such as temporary snake barrier components, snake capturing equipment, and lighting. WS personnel will train volunteering wildlife and/or customs officials to assist with BTS interdiction measures

2. Supporting cargo that is shipped to Tinian from Guam in advance of the training exercise is subject to the routine cargo inspection process conducted daily by WS. A WACSA-type barrier may be used at the Tinian harbor, and the cargo will be checked by CNMI Quarantine Inspectors to ensure that BTS inspection was conducted on Guam and the stickers/tags then removed.

3. Prior to arrival of the first military cargo from Guam to Tinian, WS will review the BTS protocol and necessary actions with the on-scene federal and CNMI wildlife and/or quarantine officials. Exercise planning will include designating the following: responsible logistics personnel, cargo offloading and staging areas, and cargo drop zones to be used that will require BTS control measures. WS will conduct BTS surveillance during nighttime cargo offloading, staging, and release of inbound traffic from Guam. WS will coordinate spotlight searches of staging areas, fence lines, and any tree lines/forest areas in proximity to runways/taxiways that are designated as drop zones. These areas will be targeted during inbound and exiting traffic times.

4. The majority of personnel, cargo, and equipment that deploy from Guam to Tinian are air-transported to North Field (preferred) or the West Tinian Airport as part of the military exercise. Prior to arrival, sections of angled weather shading will be used to establish a containment area for offloaded personnel and cargo. The portable barrier will be erected and maintained about five days prior to the first shipment. Prior to the arrival of exercise personnel and cargo, snake traps with a mouse attractant, food and moisture source will be installed in the forest adjacent to the barrier. Snake traps inside the barrier will be a passive design.

5. WS will maintain the BTS traps at the containment area throughout the duration of the training exercise. Some traps will be installed near parachute drop zones and near take-off zones. Additional BTS traps shall be made available for contingency plans and in case BTS sightings occur in the exercise area.

6. An anti-coagulant toxicant (contained within a tamper proof bait box) will be used in and around brown tree snake trapping areas and near cargo containment/temporary snake barriers to reduce local rat populations. Removal of rats reduces the potential damage they inflict to traps and barrier material.

7. CNMI DLNR may provide Snake Detector Dog Teams from Saipan on short notice if BTS presence is suspected.

8. When shipments reach Tinian, CNMI Quarantine Inspectors may check for the BTS inspection stamp/tag that verifies that the inspection process was conducted on Guam. If there is no tag on cargo that originated in Guam, the cargo may be reloaded aboard the aircraft/ship and returned to Guam. The inspection stamp/tags will be removed prior to the cargo being moved out of the containment area or drop zone. It is important that the tags be removed to avoid any confusion when the equipment and vehicles are returned to Guam at the end of the exercise, and subsequently re-inspected prior to transient unit departures to home installations.

9. WS will maintain a log of all cargo, vehicle, equipment, and craft that are inspected and will monitor the time between inspection and movement. CNMI-DLNR staff may request copies of inspection logs and cargo manifests. WS and CNMI DLNR will continue to support inspection and surveillance at Tinian's air and sea ports of entry and exit until military forces have departed and the exercise is formally terminated.

VI. GUIDELINES FOR BTS SIGHTINGS

Emergency Response Procedures are published for COMNAVMARIANAS and Andersen Air Force Base to contact Guam WS immediately (see Table 1). Similar procedures have also been identified for publication at military bases in Hawaii, in case BTS are sighted or suspected in returning shipments. These procedures to obtain immediate support from Hawaii Department of Agriculture and WS are found in Enclosure (2).

A. Immediate Action

1. **Make every attempt to kill or to capture the snake**. Do not delay. The cost and difficulty of trying to locate an escaped BTS coupled with the potentially significant ecological impacts of

each snake justifies the killing or capturing of the snake immediately. If it is not possible to kill or capture the snake, maintain visual contact.

- A BTS can be captured by pinning it down with one's boot heel, a stick or rifle butt, or anything heavy. A sharp blow to the snake's head with the butt of a (unloaded) rifle or boot heel should be fatal.

- A bucket or heavy box can be used to capture a snake on a flat surface. Place the container over the head of the snake leaving enough space for the snake to crawl completely underneath the container. Then weight it down to confine the BTS. If bagging a stunned or pinned-down snake, grab it directly behind its head.

- Keep any dead or captured snake available for positive identification by WS or an Environmental Monitor.

2. **Exercise caution.** When threatened, a BTS will coil back into a strike position, flatten its head, and lunge to bite. Small grooved fangs located in the rear of the mouth enable the mild venom to trickle into the bite while the snake constricts. A normal defensive strike from a BTS will not allow the rear fangs to penetrate the skin and will usually result in minor punctures similar to pinpricks. When wearing battle dress uniforms (BDU) and field boots, a bite from a BTS will not penetrate clothing or footwear. Use caution with all snakes. There is the chance, although unlikely, that other, more dangerous, snakes could be encountered.

B. BTS Sighting on Tinian or Other CNMI Sites

Tinian is a BTS-free island, therefore, killing or capturing a sighted BTS is critical. Reaction to a BTS sighting on Tinian and subsequent incident reporting procedures are the same as described above for sightings on Guam. Staff response during major military training exercises on Tinian may include representatives of CNMI Division of Fish and Wildlife, WS, and/or Navy environmental monitor staffs. All are equipped with cellular phones. The latter will have radio/telephone communication with the CESG.

Exercise caution, safety and discretion. The priority action becomes killing, capturing, or containing the BTS. Report the incident, including the same information as needed for Guam BTS sightings.

The telephone numbers to call are:

CNMI Fish and Wildlife Saipan office:	(670) 664-6011/6000
CNMI Emergency Management Office:	(670) 322-9528/9
CNMI Fish and Wildlife Tinian office:	(670) 433-9298
USGS-RRT:	(671) 777-4477

USDA APHIS WS Guam District Office:	(671) 635-4400
USDA APHIS WS AAFB:	(671) 366-3822
USDA APHIS WS COMNAVMARIANAS	(671) 472-7101

CNMI will dispatch investigating personnel and detector dog team assistance. The WS and Navy Environmental Monitors/CESG will also be notified (via cellular phone numbers provided prior to the exercise).

C. Notifications for BTS Sightings on Guam

When a BTS is sighted, the immediate action is to kill or immobilize the snake so that it cannot escape. The person involved will then collect information of the incident that will describe the circumstances of the sighting, and remain on scene to act as primary POC to other responders. WS may call upon the person who discovered the snake to collect additional information.

1. When a BTS is sighted, killed and/or captured on Guam, or a BTS is suspected to be in a specific area, immediately contact the local area WS office, COMNAVMARIANAS and/or Commander. 36th ABW. The caller will provide the following information regarding BTS presence and will be given instructions regarding follow-on action:

- Caller:
- Military Organization:
- Sighting Location:
- Status: (Snake Killed/Captured/Contained/Loose)
- Date and Time of Sighting:
- Initial Response Action Underway at the Scene:

2. The telephone numbers to call during business hours are:

USDA APHIS WS Guam District Office:	(671) 635-4400
USDA APHIS WS AAFB:	(671) 366-3822
USDA APHIS WS COMNAVMARIANAS	(671) 472-7101

(WS is on call 24 hours per day, and WS field personnel are equipped with cellular telephones. The telephone numbers will be published prior to military exercises).

3. During major exercises, the unit and/or COMNAVMARIANAS will contact the CESG, who will alert exercise personnel needed to respond and the COMNAVMARIANAS Quarterdeck at (671) 339-7133. Cellular telephone numbers will be published prior to major exercises for contact with command Environmental Monitors in the field.

Once notified of a sighting and circumstances, WS will dispatch personnel and/or BTS Detector Dog Teams to the scene. Military personnel will cooperate fully with WS and their inspection of the area, and may provide any assistance needed to locate and capture a BTS.

D. Post-Training Exercise Snake Sighted in Hawaii

The Emergency Response Protocols established for snake sightings at Navy and Marine, Air Force, and Army installations on Oahu are attached as Enclosure (2). The principal state agency that must be informed is the Hawaii Department of Agriculture (HDOA), Plant Quarantine Branch at (808) 586-7378 or 586-PEST.

VII. REFERENCES

Brown Tree Snake Control Committee, Aquatic Nuisance Species Task Force. June 1996. *Brown Tree Snake Control Plan.*

Commander, Amphibious Group One Naval Message 040925Z December 1999, "USS Ogden and USS Rushmore Guam Equipment Washdown 7-13 Nov 99, Consolidated After Action Report of Lessons Learned."

Commander, U.S. Navy Marianas. October 1996. "Brown Tree Snake (BTS) Control/ Interdiction Plan for Military Training Exercises."

United States Department of Agriculture – Animal and Plant Health Inspection Services – Wildlife Services, Program Aid No. 1636, October 1998. "No Escape from Guam: Stopping the Spread of the Brown Tree Snake."

United States Department of Agriculture – Animal and Plant Health Inspection Services – Wildlife Services – National Wildlife Research Center, et al. July 1998. "1998 Brown Tree Snake Research Symposium."

United States Department of Agriculture. June 1996. *Environmental Assessment for Brown Tree Snake Control Activities on Guam.*

United States Department of Interior, Office of Insular Affairs. September 1999. *Integrated Pest Management Approaches to Preventing the Dispersal of the Brown Tree Snake and Controlling Snakes in Other Situations.*

United States Pacific Command. June 1999. Final Environmental Impact Statement, Military Training in the Mariana Islands.

14 FEB 2005

HAWAII EMERGENCY RESPONSE PROTOCOLS

U.S. NAVY

SNAKE SIGHTED ON NAVY PROPERTY

Kill or Immobilize the Snake

Maintain Visual Contact

If Sighting is in or around the Pearl Harbor Naval Complex

Navy Housing, Naval Station, Pearl Harbor Naval Shipyard, Fleet Industrial Supply Center, Naval Intermediate Maintenance Facility, Public Works Center

COMPACFLT, PACDIV, Inactive Ships, and all Navy Commands in the Area:

CALL NAVAL STATION SECURITY POLICE at

471-7114

If Sighting is outside the Pearl Harbor Naval Complex

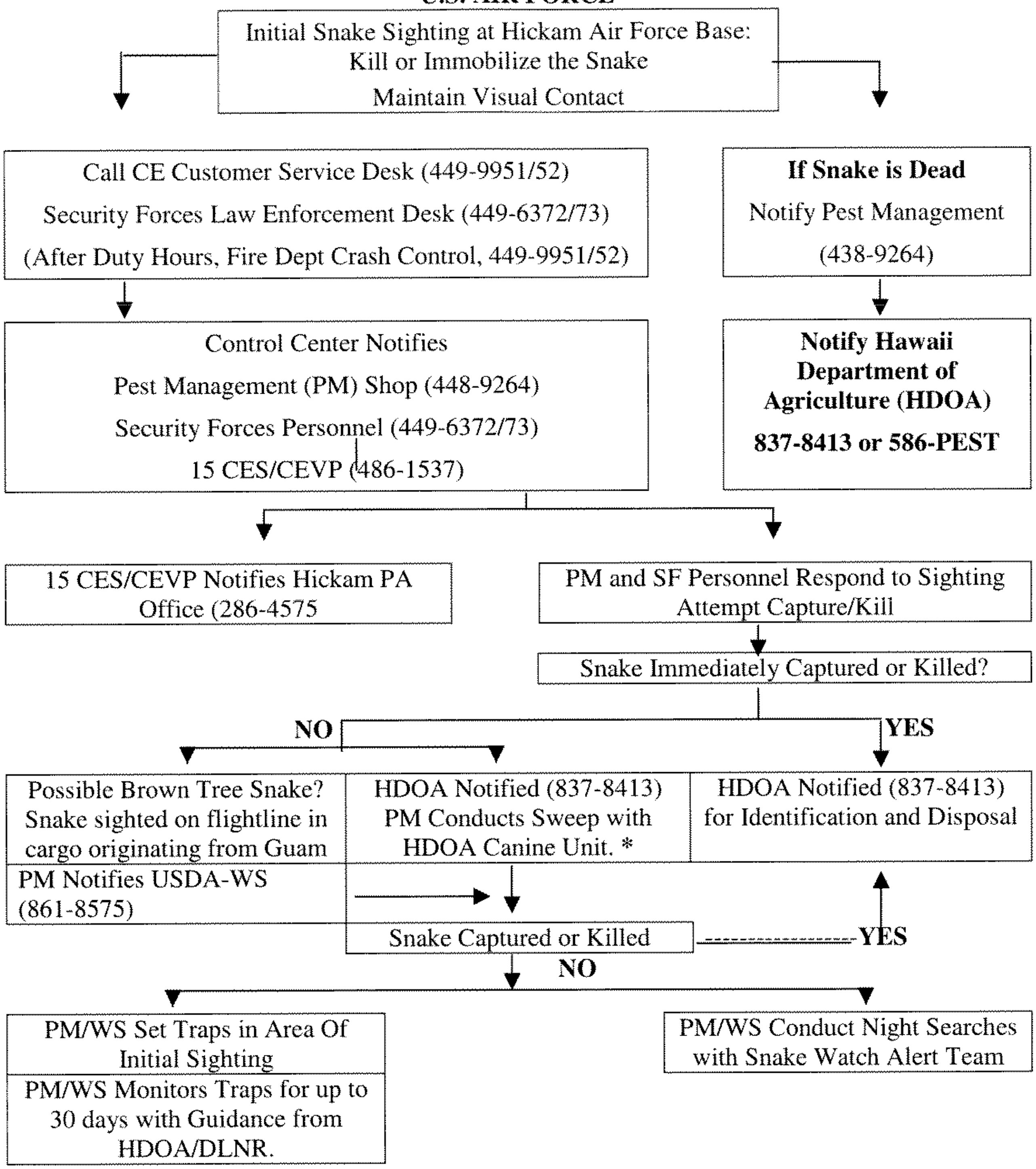
CALL SECURITY POLICE IN THAT AREA

Pacific Missile Range Facility, Kauai	Naval Magazine, Lualualei	Naval Computer and Telecommunications Master Station	Naval Security Group Activity, Kunia
471-6523 471-4185	668-7114 471-5141	653-0000 653-0234	655-3200 655-3205

Area Security Police will provide first response to sighting and inform NAVSTA dispatch at 71-7114 and the Department of Agriculture at 586-7378. First responders will collect information on the snake sighting, if it was killed or captured, and act as the primary POC to others responding to the scene. Security Police are trained in snake response equipment and techniques.

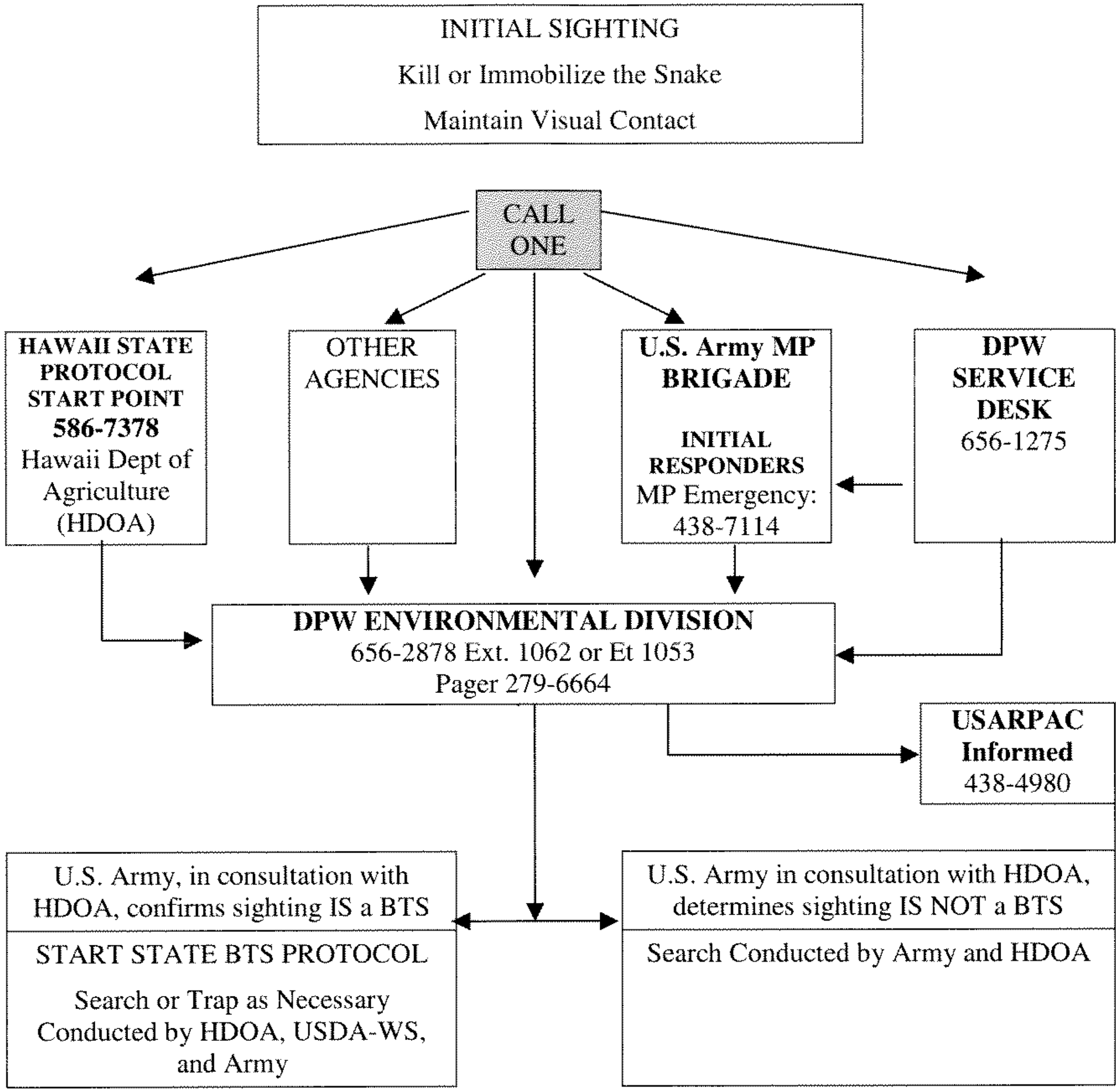
All civilian and military personnel will be briefed on BTS and trained to respond and comply with reporting procedures. The videotape "The Silent Invader" will be shown as part of this training. Training should be recurring. BTS posters will be displayed in buildings to remind personnel of the danger. The reporting number should be changed to the number for that area. For more information, contact the COMNAVBASE Pearl Harbor Regional Conservation Coordinator, at 471-0326, or Environmental Protection Specialist at 471-1171, extension 233. Alternate number is 471-1171, extension 225 (pager number 361-4864).

U.S. AIR FORCE



Notify J431, USCOMPAC at 477-0850 if State and WS activate Emergency Response Team.

UNITED STATES ARMY GARRISON-HAWAII



If State and WS Emergency Response Team are dispatched to military installations, notify J421, USCOMPAC at 477-0850.

MARINE CORPS BASE HAWAII, KANEOHE BAY

Initial Snake Sighting
Kill or Immobilize if Possible
Maintain Visual Contact

↓

Call:
Military Police (MP) 257-2123
Environmental Dept 257-6920 Ext 226 or 230
AFTER DUTY HOURS:
Military Police 257-2123
Command Deck (Officer of the Day) 257-1824
Environmental Dept 569-8494-pager

→ **If Snake is Dead:**
Notify Environmental Dept
257-6920 Ext 226 or 230

↓

MPs and Env Dept Respond to Sighting
Confirm, Identify
Attempt to Kill or Capture

↓

SNAKE CAPTURED OR KILLED?

YES → Notify: HDOA 586-PEST
I.D. and Disposal
Env. Dept 569-8484
PAO 257-8841

NO ↓

HDOA Notified (586-PEST)
MP and Env. Dept Conduct Sweep
With HDOA Canine Unit

↓

SNAKE CAPTURED OR KILLED? (Yes → Notify box above)

↓ NO

Env. Dept/USDA Wildlife Services Set Traps in Area of Initial Sighting and Conduct Night Searches

Environmental Dept. POCs:
Lance Bookless-Natural Resources Mgr
Gordon Olayvar-Wildlife Technician

↓

Env. Dept/WS Monitors Trap for up to 30 days with Guidance from HDOA/DLNR

DEPARTMENT OF THE NAVY
COMMANDER, U.S. NAVAL FORCES MARIANAS
PSC 455, BOX 152
FPO AP 96540-1000

IN REPLY REFER TO
COMNAVMARIANASINST 3502.1
N3
25 Apr 05

COMNAVMARIANAS INSTRUCTION 3502.1

Subj: STANDARD OPERATING PROCEDURES AND REGULATIONS FOR RESTRICTED AREA 7201 AND FARALLON DE MEDINILLA (FDM) LASER BOMBING RANGE

Ref: (a) COMNAVMARIANASINST 3500.4 - MARIANAS TRAINING HANDBOOK
(b) OPNAVINST 5100.27/MCO 5104.1B - NAVY LASER HAZARDS CONTROL PROGRAM

Encl: (1) Laser Safety Survey Report of Farallon De Medinilla
(2) COMNAVMAR Training Area Request
(3) Laser Operation Request Requirements
(4) Farallon De Medinilla After Action Report
(5) Farallon De Medinilla Range Users Manual

1. Purpose. To promulgate information concerning training services, areas and facilities available in the R-7201/Farallon De Medinilla (FDM) bombing range, establish laser standard operating procedures, and to prescribe requesting procedures for its use.

2. Cancellation. COMNAVMARIANASINST 3502. This instruction is a complete revision and shall be read in its entirety.

3. Background. COMNAVMARIANAS is the controlling and scheduling authority for Navy owned and controlled training areas in the Mariana Islands. COMNAVMARIANAS schedules the training in the restricted area and bombing range on the island of FDM.

4. Discussion. COMNAVMARIANAS maintains the bombing range on FDM in accordance with environmental agreements with the Commonwealth of the Northern Mariana Islands (CNMI). Information about this agreement can be found in reference (a).

5. Action.

a. U.S. Naval Forces, Marianas Regional Program Director for Operations is responsible for scheduling and coordinating with local agencies all training on FDM. The ACOS Operations will ensure the maintenance of FDM on an annual basis.

b. Per reference (b), the Area Training Officer will be designated the Technical Laser Safety Officer (TLSO) and will comply with all requirements. He will be responsible for oversight and approval of all laser operations in R-7201 and on FDM. The TLSO will personally inspect FDM to the extent practicable at least annually.

c. The Regional Program Director of Environmental is responsible for the oversight of environmental compliance for training on FDM.

d. Commanding Officers/Officers-in-Charge of training units will:

(1) Conduct training in accordance with appropriate service directives, orders, standards, and procedures. This will include ensuring that unit personnel comply with the contents of this instruction and its references.

(2) Ensure all reports and requests for training are submitted within the timelines prescribed within this instruction.

(3) Commanders of training units are encouraged to submit recommendations concerning improvements or changes to this instruction via email to the Area Training Officer at n31@guam.navy.mil.

6. Applicability. This order applies to all commands, organizations, units, and activities authorized use of R-7201, FDM, and airspace controlled by COMNAVMARIANAS.

R. A. MCNAUGHT
Chief of Staff

Distribution:
USPACOM REP GUAM/CNMI/FSM/ROP//COMNAVMARIANASINST 5216.1V
Lists I, II, and III

Stocked:
COMNAVMARIANAS (N1)

CORONA DIVISION, NSWC

LASER RANGE SAFETY SURVEY REPORT

of

FARALLON DE MEDINILLA U.S. NAVAL FORCES MARIANAS, GUAM

PREPARED FOR: COMNAVAIRPAC (N8M)

26 April 2004

Prepared by:
Brian Sabino (TLSO, RLSS)

LASER SAFETY SURVEY REPORT
U.S. NAVAL FORCES MARIANAS GUAM

1. INTRODUCTION

1.1 The on-site laser safety survey was performed on the Farallon De Medinilla (FDM) laser range during 26 April 2004.

1.2 The next laser site safety survey for the FDM laser range should be completed by 31 May 2007.

1.3 The FDM laser range is under the control of the Commander U.S. Naval Forces, Marianas (COMNAVMARIANAS).

2. DISCLAIMER AND LIMITATIONS

2.1 The safe lasing profiles discussed in this report are not to be construed as mandated aircraft flight paths, but rather as boundary limits at a given location that distinguish between safe and unsafe laser use conditions.

2.2 This evaluation addresses only those systems approved for general training scenarios by the Navy Laser Safety Review Board (LSRB). A separate evaluation should be done on a case-by-case basis by the Range Laser Safety Specialist (RLSS) on laser systems used in non-traditional modes, research & development applications, and prototype systems.

2.3 Force-on-force scenarios are not evaluated in this report and should only be allowed with the express consent of the range Laser Systems Safety Officer (LSSO) using safety measures established by the LSRB.

2.4 Data for this report were sourced from multiple documents. All coordinates shown in this report are referenced to the World Geodetic System of 1984 (WGS 84) datum.

2.5 Bearings used to define the Laser Hazard Danger Zones (LHDZs) are referenced to Magnetic North.

3. SOURCE DOCUMENTS/REFERENCES

3.1 The Geodetic (Latitude/Longitude - LAT/LONG) grid coordinates used to describe the range, target area, point targets and firing locations were taken from the following documents:

3.1.1 Laser Safety Survey Report of Farallon De Medinilla (FDM) U.S. Naval Forces Marianas, Guam (Dec 2001).

3.1.2 Farallon De Medinilla Range Training Land Use, Marianas Training Handbook, Belt Collins Hawaii, June 2000.

3.1.3 Map of FARALLON DE MEDINILLA (WGS 84, 1:10,000 scale, 10 meter contour interval).

3.1.4 COMNAVMARIANAS INSTRUCTION 3502, 09 April 2002.

3.1.5 COMNAVMARIANAS INSTRUCTION 3500.3M, 18 August 1998.

3.2 The Nominal Ocular Hazard Distances (NOHD), Optical Densities (OD), and other laser weapon systems parameters were taken from MIL-HDBK-828 of 15 April 1993, and LSRB minutes.

4. Description

4.1 **Location**. FDM is part of the Commonwealth of the Northern Marianas Islands (CNMI) located approximately 175 miles northeast of Guam. The closest island to FDM is Anatahan located approximately 45 miles to the northwest. FDM is approximately 1.7 miles (2.8 km long) and 0.3 (450 m) wide and consists of a hilly plateau with cliffs dropping as much as 328 ft to the ocean on all sides. The target area consists of naval gunfire target, strafing targets, inert bombing targets, and live bombing targets. FDM is located within a 3-mile safety radius designated as Navy Restricted Area R-7201.

4.1.1 FDM contains two laser target areas (LTAs).

4.1.1.1 LTA 1 is located at the center of FDM, just south of the No Bomb Line. The targets within LTA 1 consist of multiple 50-foot connex boxes painted non-glossy white, shown in Figure 4.1.1. The boundaries for LTA 1 are listed in Table 4.1.1.


Figure 4.1.1.1 – LTA 1 Targets

Table 4.1.1.1 – LTA 1

MGRS			Geodetic
55Q	CT	99357 71592	16 01 19.0N, 146 03 33.4E
55Q	CT	99548 71531	16 01 17.1N, 146 03 39.8E
55Q	CT	99057 70770	16 00 52.2N, 146 03 23.4E
55Q	CT	98891 70844	16 00 54.6N, 146 03 17.8E

4.1.1.2 LTA 2 is located at the southern end of FDM. The targets consist of connex boxes painted non-glossy white. Targets include a high altitude laser target (LB 6) used for live bombing, and live strafe targets (LST 1, LST 2, and LST 3) located north of LB 6. These targets are designated for aerial use only. The coordinates are listed in Table 4.1.1.2.

Table 4.1.1.2 – LTA 2

MGRS			Geodetic
55Q	CT	98472 69695	16 00 17.2N, 146 03 03.9E
55Q	CT	98362 69740	16 00 18.6N, 146 03 00.2E
55Q	CT	98582 70264	16 00 35.7N, 146 03 07.5E
55Q	CT	98570 70498	16 00 43.3N, 146 03 07.1E
55Q	CT	98737 70519	16 00 44.0N, 146 03 00.4E
55Q	CT	98656 70131	16 00 31.4N, 146 03 10.0E

4.2 **Ground-Based Firing Lines.** There is one Firing Line (FL) location on FDM. The FL coordinates are listed in Table 4.2. FL 1 is used by ground-based laser systems against visible targets within LTA 1.

Table 4.2 – Firing Line 1

FL	MGRS			Geodetic
FL 1	55Q	CT	99788 71915	16 01 29.6N, 146 03 47.8E
	55Q	CT	99619 72160	16 01 37.6N, 146 03 42.1E

4.3 **Aerial Lasing**. There are two LTAs and that are established to support aviation laser systems, as specified in Appendix B provided that the pilot adheres to the approved laser flight profiles contained in Appendix C.

5. Survey

Mr. Brian Sabino performed the physical site inspection of FDM during 26 April 2004. Mr. Sabino is from the Naval Surface Warfare Center, Corona Division, Systems Engineering Directorate (SE41) in Corona, CA. Mr. Sabino is a Technical Laser Safety Officer (TLSO) and an RLSS. QM1 Robert Rennie from COMNAVMARIANAS participated in pre-survey discussions.

5.1 The following areas of concern were noted and should be considered by the range Laser Systems Safety Officer (LSSO).

5.1.1 The range safety officer has not taken the appropriate TLSO and RLSS training.

5.1.2 FDM offers little to no backstops and target elevations are between 50 ft and 200 ft MSL.

5.1.3 The areas around FDM are used by local fishing boats.

6. Evaluation

6.1 **Ground Lasing**. The ground systems used are limited to a 5 mrad buffer angle.

6.1.1 Ground laser systems should be tripod mounted and elevation limited to avoid lasing the horizon.

6.1.2 Ground lasing is limited to a maximum allowable Nominal Ocular Hazard Distance (NOHD) of 6 km if the system does not meet the maximum allowable buffer. (Note: The Navy/Marine Corps uses the NOHD for 7 x 50mm optics).

6.2 **Aerial Laser Targets**. The aerial systems used are limited to a 5 mrad buffer angle.

6.3 Appendix A contains the ground Laser Hazard Danger Zones (LHDZs).

6.4 Appendix B contains the airborne LHDZs.

6.5 Appendix C contains airborne-laser profiles.

6.6 Appendix D contains all LTA, PT, and FP coordinates in UTM, Geodetic, and MGRS formats.

6.7 If standing water, glass, or any other reflective materials becomes present within or near any of the established LTAs, then it will be the responsibility of the training facility LSSO to either suspend the exercise or ensure personnel are not within the NOHD of the system in use.

7. Results

7.1 **Ground Lasing.** Ground lasing designation is only permitted on the LTA shown in Appendix A provided that the user operates the laser within the lateral limits referenced and within the LTA. Table 7.1 shows the available lateral limits (magnetic north) for the LTA contained in Appendix A.

Table 7.1 – Laser Target Areas with Appropriate Lateral Limits

FL	LTA	Allowable Type System	Lateral Limits (Magnetic)
FL 1	1	Ground	203° clockwise to 227°

7.2 **Aerial Lasing.** Aerial lasing designation is permitted on the targets referenced in Appendix B provided that the pilot adheres to the approved laser flight profiles contained in Appendix C. Table 7.2 shows the available flight headings for the targets. The LHDZ for the targets are also contained in Appendix B.

Table 7.2 – Laser Target Areas with Appropriate Headings

Targets	Heading (Magnetic)	Number of Different Laser Flight Profiles
LTA 1	32° clockwise to 212°	1
LTA 2	32° clockwise to 212°	1

8. Recommendations

8.1 COMNAVMARIANAS has a laser safety program that is in compliance with OPNAVINST 5100.27/MCO 5104.1B.

8.1.1 All laser systems used on FDM are to be used only against targets located within the designated LTAs described in section 4.

8.1.2 All laser operators should meet the following minimum requirements:

8.1.2.1 Have received the appropriate laser range briefing from the training facility LSSO before use of any laser exercise.

8.1.2.2 Are familiar in detail with the FDM Laser Safety Program and adhere to the procedures established therein.

8.1.2.3 Are in constant communication with range safety/control during laser operations.

8.1.2.4 Fire ground lasers only after positive identification of the approved targets.

8.1.2.5 Fire aerial lasers only after positive identification of the target ensuring that the LTA and LHDZs are clear of unauthorized personnel.

8.2 The following are suggested general laser safety guidelines that apply to laser personnel during laser exercises:

8.2.1 Prior to laser operations, pilots should make a cold pass to ensure that the LTA and corresponding LHDZ are clear of unauthorized personnel.

8.2.2 The training facility LSSO should ensure that all personnel in the vicinity of the laser range remain outside the LTAs and LHDZs during laser operations and/or wear the appropriate eye and skin protection.

8.2.3 The range safety officer should notify the CNMI Emergency Management Office (EMO) Operations Section of any live-fire operations. EMO informs the local fishing vessels of the exercises via VHF and SSB.

8.2.4 COMNAVMARIANAS should provide administrative control measures to ensure a clear range up to 6 nmi beyond FDM on run-in heading for extended (low-altitude) aerial LHDZ laser operations.

8.3 The COMNAVMARIANAS range safety officer should take the appropriate training to become certified as a TLSO and RLSS.

8.4 The LSSO should post visible markings that indicate the extreme boundaries of the LTAs.

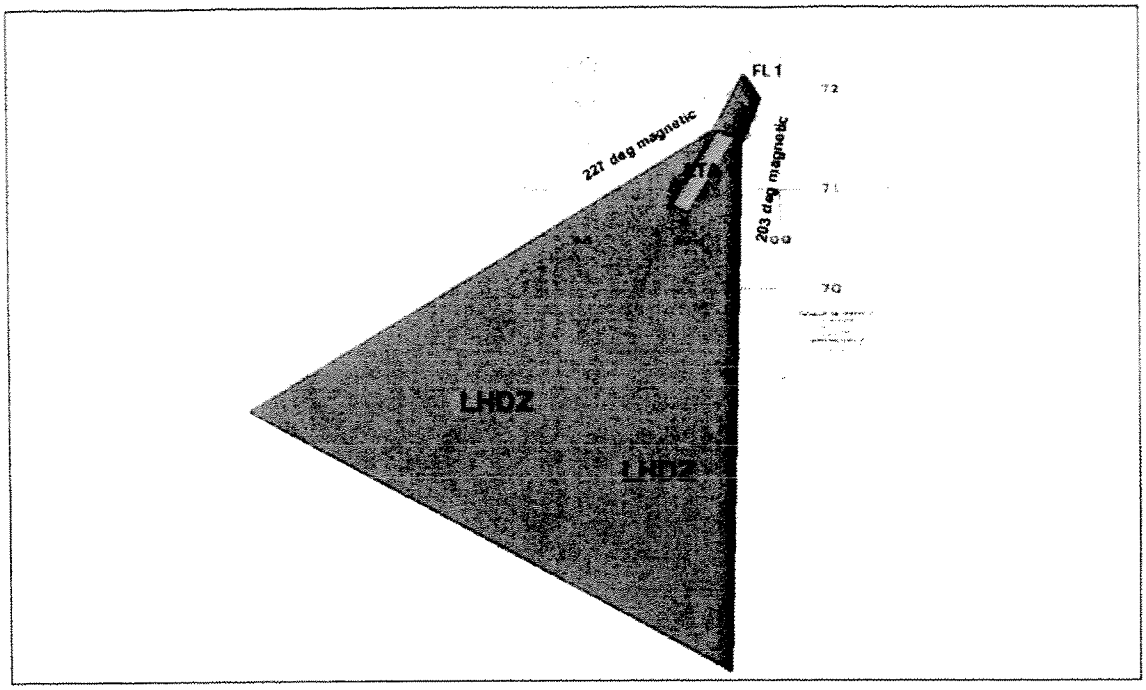
8.5 When ground positions are laser designating for aircraft, there should be an aircraft exclusion cone that is centered on the heading of the laser position on the target. The exclusionary zone recommended by the Joint Close Air Support Manual 3-09.3 requires a 20°-safety cone around the FP extending back from the target to the FP. In situations where the aircraft is approaching from a heading that is behind the FP, the pilot should offset when the aircraft is near the FP.

Appendix A

Ground-Based Laser Systems Laser Target Areas

Laser Hazard Danger Zones

LASER RANGE SAFETY SURVEY REPORT
U.S. NAVAL FORCES MARIANAS GUAM



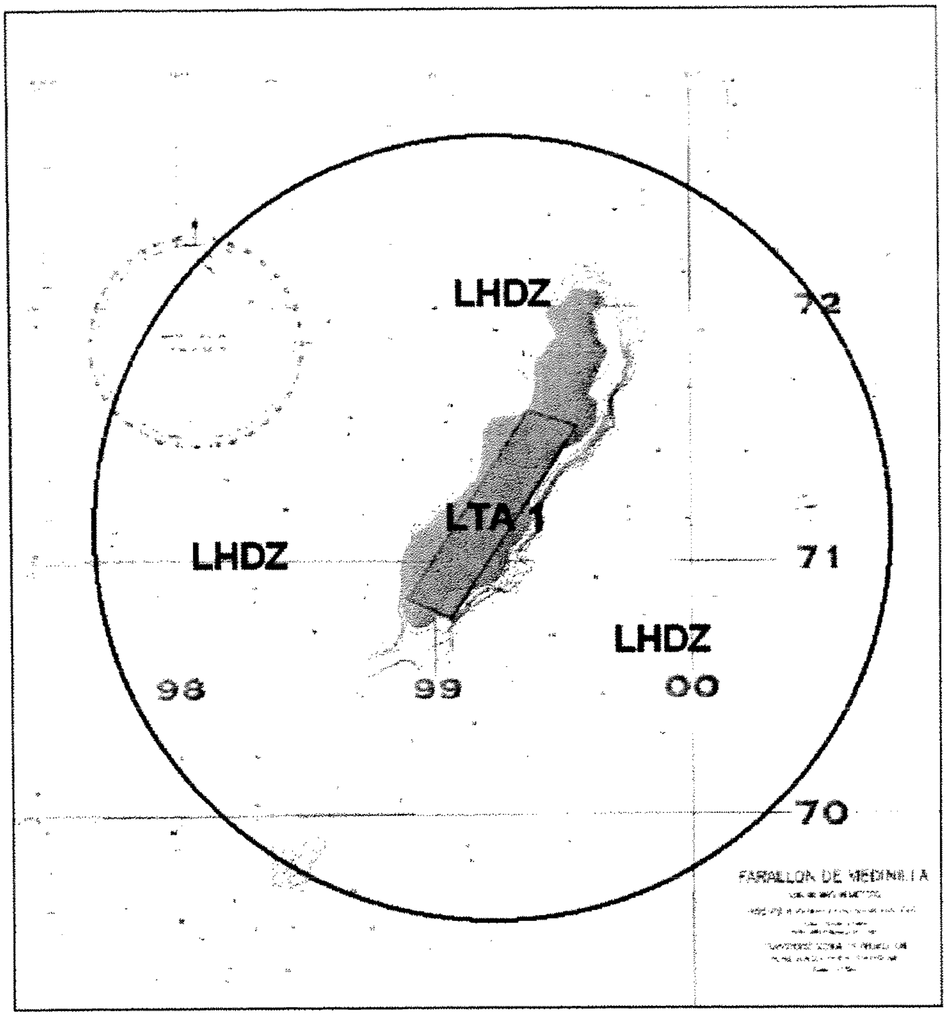
LTA	**FL**	**Maximum Allowable Buffer**	**Max Allowable NOHD if buffer not met**	**Allowable Type System**	**Lateral Limits (magnetic)**
1	1	5 mrad	6 km	Ground	203° clockwise to 227°
LTA Coordinates (LAT/LONG)		16 01 19.0N, 146 03 33.4E to 16 01 17.1N, 146 03 39.8E to 16 00 52.2N, 146 03 23.4E to 16 00 54.6N, 146 03 17.8E			
FL Coordinates (LAT/LONG)		16 01 29.6N, 146 03 47.8E 16 01 37.6N, 146 03 42.1E			

Appendix B

Airborne Laser Systems

Laser Hazard Danger Zones

LASER RANGE SAFETY SURVEY REPORT
U.S. NAVAL FORCES MARIANAS GUAM



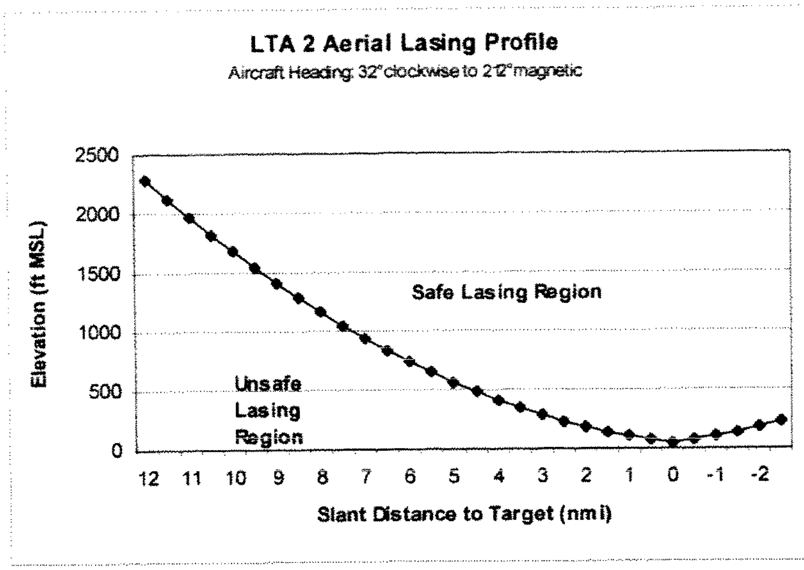
LTA 1	Figure B-1	Magnetic Heading: 32° clockwise to 212°
Scale: 1 grid = 1 km	Coordinates: 16 01 19.0N, 146 03 33.4E to 16 01 17.1N, 146 03 39.8E to 16 00 52.2N, 146 03 23.4E to 16 00 54.6N, 146 03 17.8E	Maximum Buffer Angle: 5 mrad

Appendix C

Airborne Laser Systems

Safe Lasing Profiles

LASER RANGE SAFETY SURVEY REPORT
U.S. NAVAL FORCES MARIANAS GUAM



Slant Distance (nmi)	Altitude (feet)	Slant Distance (nmi)	Altitude (feet)
12.0	2289	4.5	489
11.5	2128	4.0	416
11.0	1973	3.5	349
10.5	1823	3.0	287
10.0	1680	2.5	232
9.5	1542	2.0	182
9.0	1411	1.5	138
8.5	1285	1.0	100
8.0	1165	0.5	68
7.5	1051	0.0	42
7.0	942	-0.5	68
6.5	840	-1.0	100
6.0	743	-1.5	138
5.5	653	-2.0	182
5.0	568	-2.5	232

Appendix D

Laser Target Area Coordinates

Firing Line Coordinates

Table D-1 FDM LTA Coordinates

LTA	Zone	Easting	Northing	Geodetic	MGRS
LTA 1	55Q	399357	1771592	16 01 19.0N, 146 03 33.4E	55QCT9935771592
LTA 1	55Q	399548	1771531	16 01 17.1N, 146 03 39.8E	55QCT9954871531
LTA 1	55Q	399057	1770770	16 00 52.2N, 146 03 23.4E	55QCT9905770770
LTA 1	55Q	398891	1770844	16 00 54.6N, 146 03 17.8E	55QCT9889170844
LTA 2	55Q	398472	1769695	16 00 17.2N, 146 03 03.9E	55QCT9847269695
LTA 2	55Q	398362	1769740	16 00 18.6N, 146 03 00.2E	55QCT9836269740
LTA 2	55Q	398582	1770264	16 00 35.7N, 146 03 07.5E	55QCT9858270264
LTA 2	55Q	398570	1770498	16 00 43.3N, 146 03 07.1E	55QCT9857070498
LTA 2	55Q	398737	1770519	16 00 44.0N, 146 03 00.4E	55QCT9873770519
LTA 2	55Q	398656	1770131	16 00 31.4N, 146 03 10.0E	55QCT9865670131

Table D-2 FDM FL Coordinates

PT	Zone	Easting	Northing	Geodetic	MGRS
FL 1	55Q	399788	1771915	16 01 29.6N, 146 03 47.8E	55QCT9978871915
	55Q	399619	1772160	16 01 37.6N, 146 03 42.1E	55QCT9961972160

COMNAVMAR TRAINING AREA REQUEST

DATE OF REQUEST:	
NAME / RATE / RANK OF PERSON SUBMITTING REQUEST:	
POC NAME AND NUMBER:	
OCE / PARTICIPATING UNIT:	
SUPPORTING UNIT:	
REQUESTED DATE (S) / TIME (S):	
LOCATION REQUESTED:	
TYPE OF TRAINING:	
TYPE/NUMBER OF WEAPONS:	
ALTITUDE:	
NUMBER OF PERSONNEL:	
TYPE/NUMBER OF AIRCRAFT:	
SHIPS IN EVENT:	
NUMBER OF SORTIES:	
REMARKS:	
COMNAVMAR N31 USE ONLY	
EMO NOTIFICATION:	
SPECIAL USE AIRSPACE REQUEST:	
USCG APPROVAL REQUIRED:	
NOTMAR MSG DTG:	
OTHER APPROVAL: (UNDET/WATER SPACE/ENVIRONMENTAL)	
PERSONNEL TAKING REQUEST:	
REMARKS:	

LASER OPERATION REQUEST REQUIREMENTS

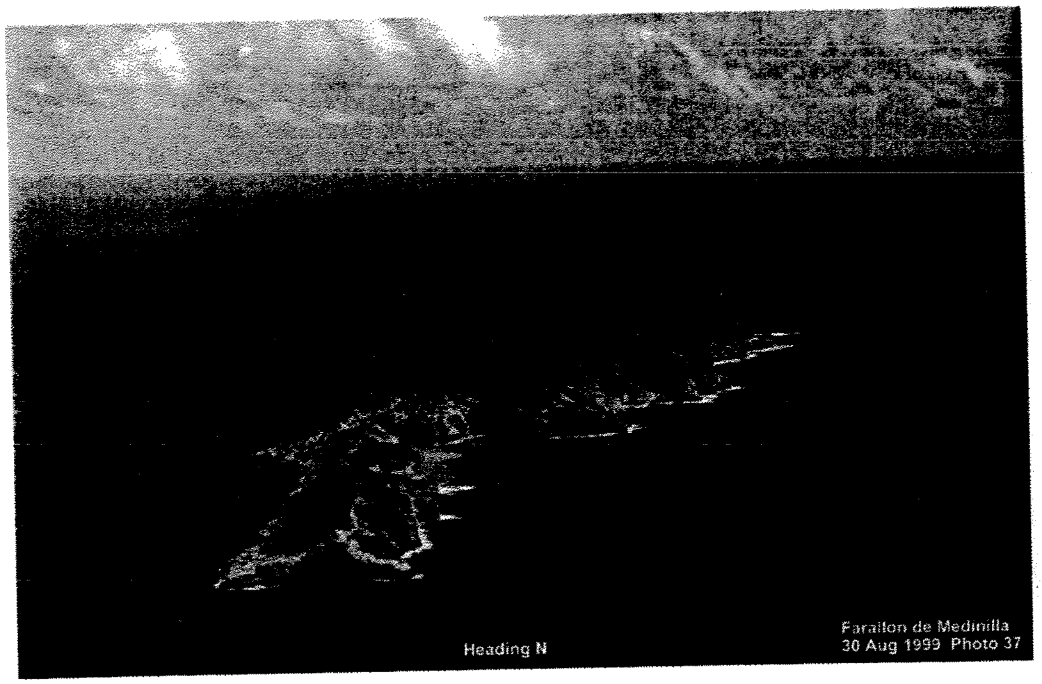
The command requesting use of the laser range shall include the following in the remarks section of enclosure (2).

1) Name and date of qualification of the command LSSO.
2) Laser devices to be used.
3) Laser device firing points.
4) Targets to be used/target area to be used.
5) Ground personnel locations (if applicable).
6) Laser eye protection to be used (if applicable).
7) Aircraft run-in headings (if applicable).
8) Laser mode(s)/tactics to be employed (e.g. force-on force, designation, range finding, offset lasing, etc).
9) Types of surveillance to be used to ensure a clear range.
10) Radio frequencies and standardized terminology for communication where appropriate.
11) Any amplifying information necessary.

FARALLON DE MEDINILLA AFTER ACTION REPORT

FM (EXERCISE UNIT)
TO COMNAVMARIANAS GU//N3//
(CLASSIFICATION) //N03500//
MSGID/GENADMIN/(REQUESTING UNIT)//
SUBJ/FDM AFTER ACTION REPORT//
REF/A/DOC/COMNAVMARIANAS/3502.1/28FEB05/
AMPN/REF A IS RESTRICTED AREA 7201 FARALLON DE MEDINILLA RANGE INSTRUCTION//
REMARKS/1. FOL SUBMITTED IAW REF A:
A. LOCATION - FARALLON DE MEDINILLA (FDM) (R-7201)
B. DATE(S)
C. HOURS SKED
D. HOURS UTILIZED
E. HOURS CANX (IF APPLICABLE)
F. REASON CANX (IF APPLICABLE)
G. COMMAND
H. UNIT
I. NUMBER/TYPE AIRCRAFT/SHIP
J. ORDNANCE EXPENDED (NUMBER AND TYPE PER DAY)
K. TARGETS USED AND DISPOSITIION
L. LOCATION AND AMOUNT OF ORDNANCE IMPACTING SURROUNDING WATER
M. COORDINATES AND AMOUNT OF ORDNANCE JETTISONED FOR EMERGENCY DISPOSAL
N. NUMBER AND TYPE OBSERVED WILDLIFE CASUALTIES
2. COMMENTS.//
DECL (IF APPLICABLE)//

FARALLON DE MEDINILLA (FDM) Range Users Manual



R-7201 And ATCAAs 1-5

Guam and the Commonwealth of the Northern Mariana Islands

COMNAVMARIANASINST 3502.1

TABLE OF CONTENTS

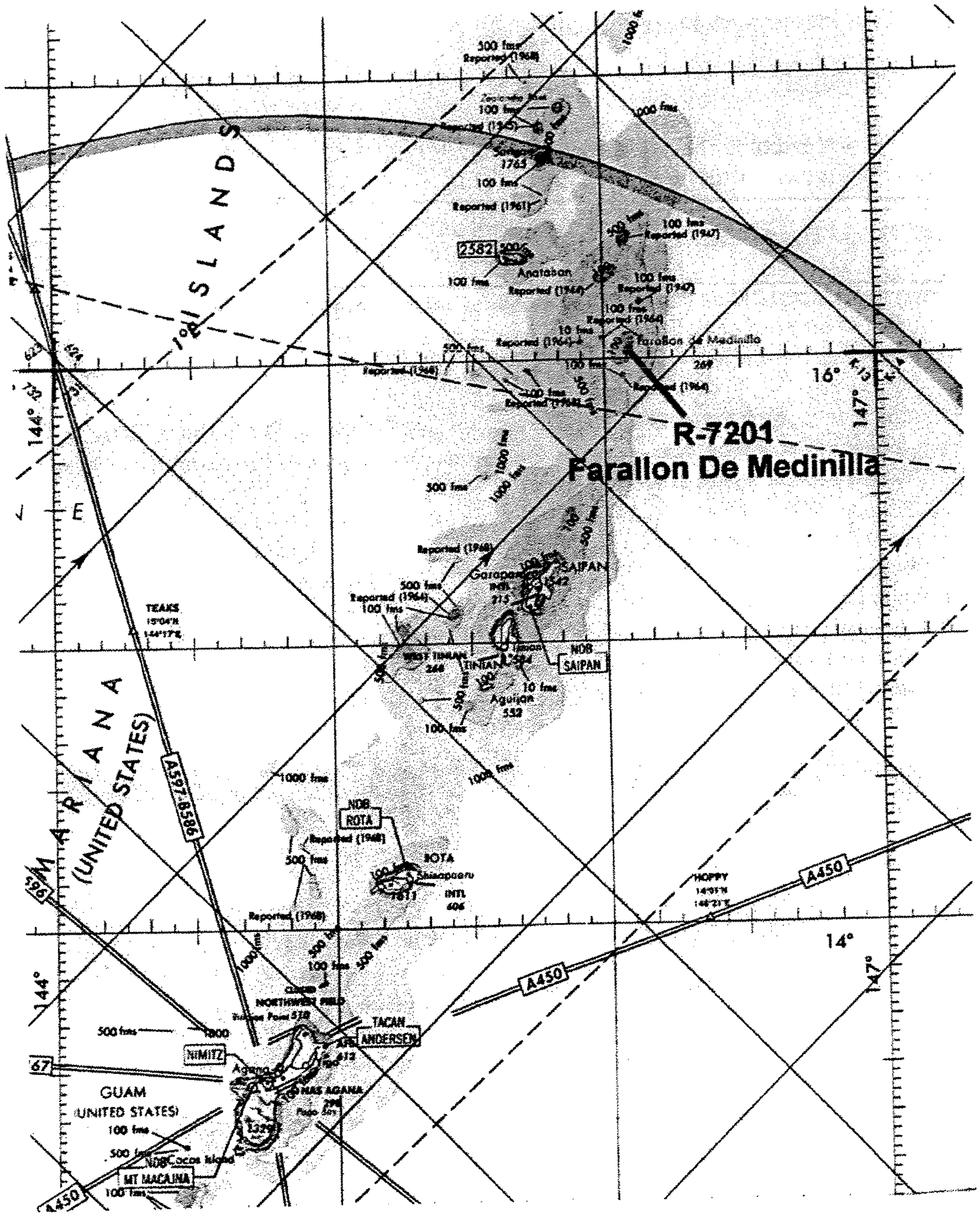


Figure 1.1
Marianas Islands
Extract from JNC-56

1.1 Overview and Description

1.1.1 Location

Farallon de Medinilla (FDM) is approximately 1.7 miles (2.8 kilometers) long and 0.3 miles (450 meters) wide, and is located at 16.01 N 146.03 E. (See Figure 1.1, page 3)

1.1.2 Land Resources

Since 1971, The US has leased the uninhabited island Farallon De Medinilla (FDM) for the express purpose of military activity including aerial bombardment and naval gunfire. The 206-acre (83-hectare) island and its 3-mile safety radius is designated as Navy Restricted Area 7201, with the restrictions applying to both air and sea traffic. FDM is the only air-to-ground and naval gunfire surface target range in the Marianas Islands. Reference (a) is the Marianas Training Handbook, and details the environmental constraints upon training in R-7201 and on FDM.

The island is currently used as a live and inert fire training range. FDM has been a bombing range for more than 30 years and contains an abundance of UXO (unexploded ordnance), including highly sensitive cluster bombs. Only explosive qualified military personnel with COMNAVMARIANAS authorization are allowed on the island due to the extensive amount of UXO present. On an event necessary basis, approval for ground operations may be requested through the COMNAVMARIANAS Operations Department. In accordance with ref (a), all aircraft, personnel, and equipment originating from Guam and landing on FDM must be undergo brown tree snake inspection procedures prior to departing Guam. Procedures concerning the use of ground lasers are listed in section 1.4.2.

1.1.3 Restricted Area 7201

Restricted Area 7201 (R-7201) is centered on FDM and is defined by the island and a Surface Danger Zone (SDZ) encompassing a 3-mile (4.8-kilometer) radius from the center of the island. Four types of ordnance delivery are performed in R-7201 (TACAIR/helicopter, strategic bombardment, naval surface fire support (NSFS), and small arms). **All ordnance delivery shall be in the designated impact areas on the island. Impacts outside these areas and in the water shall be reported to COMNAVMARIANAS Operations Department as soon as possible.** No commercial boaters are authorized access to this area.

WARNING

Regardless of the posted limits and pre-training public notices, fishing and boating within the 3-mile radius may occur, and surveillance of the island and Surface Danger Zone SDZ prior to live-fire training to ensure that the area is clear is MANDATORY.

WARNING

Laser operation hazard areas may extend beyond R-7201. Extra care in clearing these extended areas must be used by exercising units before commencing laser operations.

1.1.3.1 TACAIR/Helicopter Bombardment

Navy and Marine Corps fighter/attack aircraft operating from transiting aircraft carriers and air capable ships practice routine interdiction, strike, and Close Air Support (CAS) at FDM. Navy and Marine Corps helicopters also conduct missile and gunnery exercises. Other service tactical aircraft and helicopters also use FDM for similar readiness training. Authorized munitions are found in section 1.2.5. The amount and types of ordnance are established and audited by COMNAVMARIANAS (CNM) Operations (N3) and Environmental (N45). The types of ordnance are restricted to protect vegetation habitat and faunal species. Surveillance shall be conducted prior to any ordnance evolution to ensure that the area is clear of near-shore marine species. **Ordnance is prohibited from hitting water to the greatest extent possible. All ordnance observed impacting the water around FDM shall be reported to CNM N3 as soon as possible.**

FDM may be used by NSWU (Naval Special Warfare Unit) and Marine Forward Air Controllers (FAC) with EOD training to conduct TACP (Tactical Air Control Party) training for delivery of precision-guided munitions. The Special Use Area is the only authorized area for TACP training. Ground laser procedures and limitations are found in section 1.4.2. Permission for ground access to the island must be requested from COMNAVMARIANAS Operations Department.

1.1.3.2 Strategic Bombardment

The USAF Air Combat Command (ACC) bomber wings use FDM for global power-projection training missions. B-52, B-1 and B-2 bombers may conduct various altitude bombing runs after coordination with COMNAVMARIANAS, dropping conventional 500-, 750-, and 2000-pound (227-, 340-, and 907-kilogram) bombs (both live and inert), precision-guided munitions, and mines. Authorized munitions are found in section 1.2.5. The amount and types of ordnance are established and audited by COMNAVMARIANAS (CNM) Operations (N3) and Environmental (N45). Public notifications include establishing a 10-mile safety radius during the hours of training and publishing Notices to Airmen (NOTAM) and Notices to Mariners (NOTMAR). **Ordnance is prohibited from hitting water to the greatest extent possible. All ordnance observed impacting the water around FDM shall be reported to CNM Operations Department (N3) as soon as possible.**

1.1.3.3 Naval Surface Fire Support (NSFS)

U.S. Navy ships fire 5-inch (127-millimeter) and 76 mm deck–mounted guns from the west of the island to shore. Range ordnance includes high explosive, point-detonating rounds with mechanical and variable time-fuses. Illumination rounds may be used to light the impact area so that strikes may be observed and adjusted by spotters either aboard ship or airborne but should be fired as to avoid fire hazards on the island. These activities may be conducted during Pacific transits, or as a phase of joint/combined exercises. Ordnance and annual expenditures are established and audited by COMNAVMARIANAS N3 and N45. (Section 1.2.7) **Ordnance is prohibited from hitting water to the greatest extent possible. All ordnance observed impacting the water around FDM shall be reported to CNM Operations Department (N3) as soon as possible.**

1.1.3.4 Small Arms

Navy SEALS and other DoD special warfare units may use FDM for small arms practice. Typical use involves small arms fire from offshore to the island. Authorized munitions are found in section 1.2.5. No landing or on-island operations are allowed without express approval of COMNAVMAIRANAS Operations Department (N3). **Ordnance is prohibited from hitting water to the greatest extent possible. All ordnance observed impacting the water around FDM shall be reported to CNM Operations Department (N3) as soon as possible.**

1.2 Operations on FDM

NOTE

All procedures and guidance delineated in this instruction are minimum requirements. Any more restrictive exercising unit SOP or instruction shall be controlling.

1.2.1 FDM Special Use Area and Impact Areas

FDM is divided into several areas, as depicted in Figure 1-2. There is one Special Use Area – a NO-FIRE area at the northern end of the island for TACP/FAC use. The island has four designated impact areas: three that are authorized for air-to ground live and/or inert ordnance operations and one non-contiguous area for naval gunfire support and off-shore small arms. All other portions of the island are NO-FIRE. Coordinates below are referenced to WGS-84 datum.

NOTE

Other than designated impact areas, no other areas are approved for ordnance. Any ordnance expenditure shall be in accordance with the guidance below.

1.2.1.1 The Special Use Area. Reserved for TACP/FAC and Personnel Recovery (PR) use and consists of the area of the island north of the line defined in Table 1.2.1.1. In accordance with ref (a) all aircraft, personnel, and equipment originating from Guam and landing in the special use area must be undergo brown tree snake inspection procedures prior to departing Guam. The Special Use Area is a NO-FIRE ZONE.

N 16° 01' 23.80"	E 146° 03' 35.89"
N 16° 01' 23.32"	E 146° 03' 50.26"

Table 1.2.1.1 – Special Use Area

1.2.1.1.1 Helicopter Landing Zone (LZ). A helicopter landing zone (LZ) is located in the vicinity of N16° 01' 26.29" / E146° 03' 48.19". Hazards to helicopter landings include birds, vegetation, and uneven terrain. Any personnel inserted into the Special Use Area shall be accompanied by EOD personnel. In accordance with ref (a) all aircraft, personnel, and equipment originating from Guam and landing in the special use area must be undergo brown tree snake inspection procedures prior to departing Guam. Coordination for using the Special Use Area shall be through COMNAVMARIANAS Operations Department (N3).

1.2.1.2 Impact Area 1. This area contains high fidelity target structures, and is used for inert ordnance exclusively. The coordinates are listed in Table 1.2.1.2. Impact Area 1 is for INERT ORDNANCE ONLY. **Any live ordnance dropped into Impact Area 1 shall be reported to COMNAVMARIANAS Operations Department (N3) as soon as possible.**

N 16° 01' 19.44"	E 146° 03' 36.59"
N 16° 01' 18.59"	E 146° 03' 45.05"
N 16° 01' 09.63"	E 146° 03' 30.45"
N 16° 01' 06.61"	E 146° 03' 36.78"

Table 1.2.1.2 – Impact Area 1

1.2.1.3 Impact Area 2. This area is used for live ordnance and strategic bombing. The coordinates are listed in Table 1.2.1.3. Impact Area 2 may be used for both live and inert ordnance.

N 16° 01' 09.63"	E 146° 03' 30.45"
N 16° 01' 06.61"	E 146° 03' 36.78"
N 16° 00' 53.98"	E 146° 03' 28.02"
N 16° 00' 57.21"	E 146° 03' 22.66"

Table 1.2.1.3 – Impact Area 2

1.2.1.4 Impact Area 3. This area is south of the land bridge and is used for live and inert ordnance. It consists of the area of the island south of the line defined in Table 1.2.1.4. **Ordnance is prohibited from impacting the land bridge to the greatest extent possible. All ordnance observed impacting the land bridge shall be reported to CNM Operations Department (N3) as soon as possible.**

N 16° 00' 45.42"	E 146° 03' 15.52"
N 16° 00' 45.17"	E 146° 03' 16.57"

Table 1.2.1.4 – Impact Area 3

1.2.1.5 Impact Area 4. This area consists of a series of non-contiguous point targets, which are reserved for Naval Surface Fire Support (NSFS) and small arms training. These targets are located along the western side of FDM. Approximate locations are listed below in Table 1.2.1.5.

N 16° 01' 14.41"	E 146° 03' 30.10"
N 16° 01' 12.83"	E 146° 03' 30.05"
N 16° 01' 11.60"	E 146° 03' 31.65"
N 16° 00' 44.45"	E 146° 03' 10.78"
N 16° 00' 27.01"	E 146° 03' 10.30"
N 16° 00' 22.28"	E 146° 03' 06.88"
N 16° 00' 21.78"	E 146° 03' 04.01"
N 16° 00' 19.86"	E 146° 03' 03.22"

Table 1.2.1.2 –NSFS Point Targets

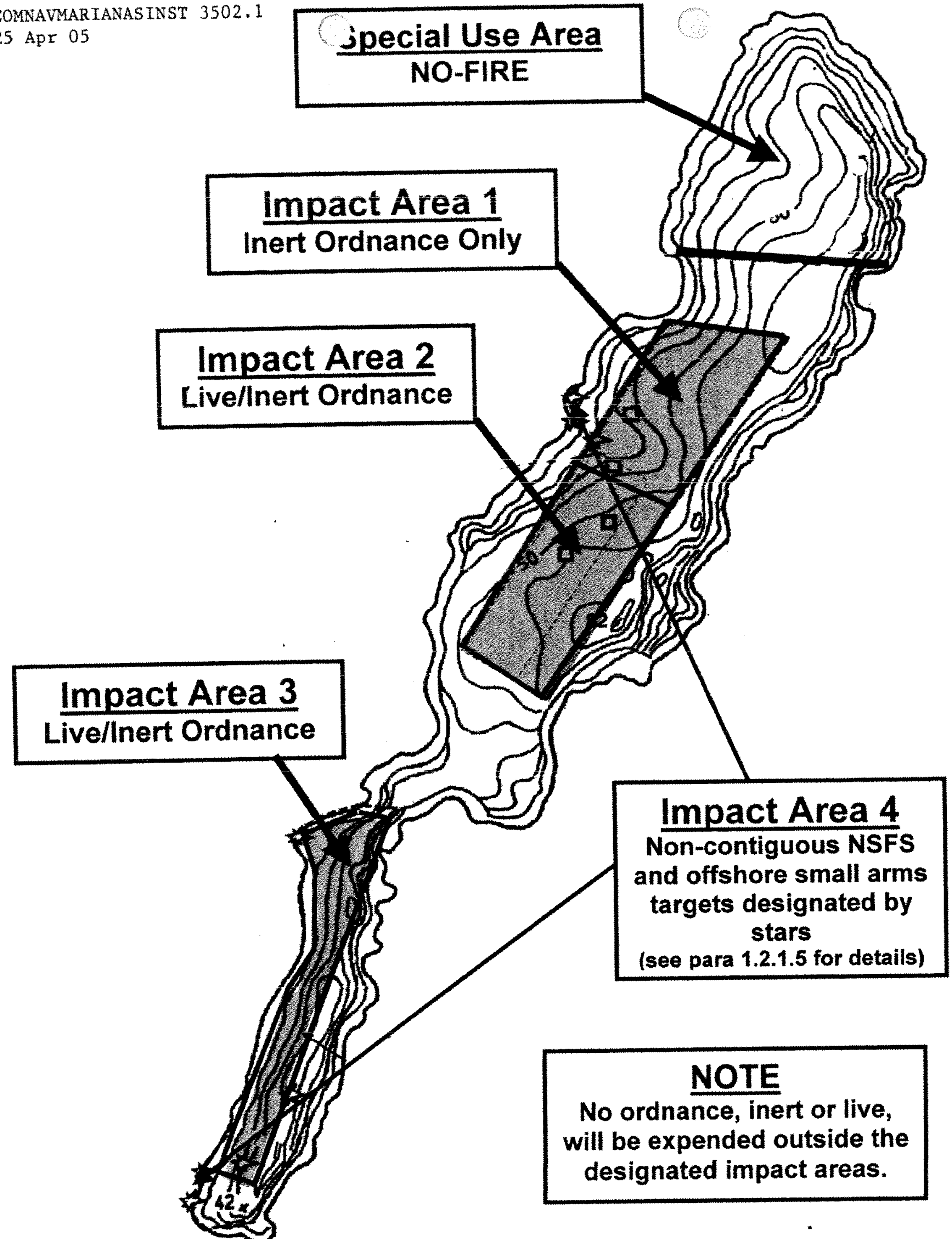

Special Use Area
NO-FIRE
Impact Area 1
Inert Ordnance Only
Impact Area 2
Live/Inert Ordnance
Impact Area 3
Live/Inert Ordnance
Impact Area 4
Non-contiguous NSFS and offshore small arms targets designated by stars
(see para 1.2.1.5 for details)
NOTE
No ordnance, inert or live, will be expended outside the designated impact areas.

Figure 1-2

1.2.2 Communications

R-7201 is an uncontrolled range. All units using FDM will monitor the assigned ATCAA common frequency. Prior to entry into ATCAA 3, a call will be made to de-conflict ATCAA 3 airspace IAW ATCAA procedures. Units operating without an established ATCAA, and with sole use of R-7201 may utilize a discrete frequency.

WARNING

Prior to delivering ordnance, a call will be made on GUARD (243.0 MHz) declaring the target "hot" with evolution duration.

In the event of radio failure (NORDO), weapons deliveries for that unit or aircraft will cease. Weapons delivery for that unit or aircraft may resume ONLY when radio communications have been regained.

1.2.3 Range Clearance

FDM is an uncontrolled range. Each participating aircraft must make a clearance pass for positive target identification and range clearance prior to ordnance release. Clearance passes must be made at 1,000 feet AGL or the minimum safe operating altitude of the aircraft, whichever is higher. All flights MUST ensure the target and surrounding water are clear of unauthorized personnel, vessels or marine life (turtles, marine mammals) prior to expending ordnance. Clearing passes are not required if the range was visually cleared within the last 10 minutes by aircraft exiting R-7201 or a TACP/ FAC is on FDM and can effectively ensure the target area and surrounding water are clear. The TACP/ FAC must be in two-way radio contact with the aircraft using the range. Clearance procedures for laser operations are in section 1.4.

WARNINGS

Regardless of the posted limits and pre-training public notices, fishing and boating within the 3-mile radius may occur, and surveillance of the island and SDZ prior to live-fire training to ensure that the area is clear is MANDATORY.

Laser operation hazard areas may extend beyond R-7201. Extra care in clearing these extended areas must be used by exercising units before commencing laser operations.

Other than designated impact areas, no other areas are approved for ordnance. Any ordnance expenditure shall be in accordance with the guidance in section 1.2.1.

1.2.4 Impact Areas

1.2.4.1 Impact Area 1. This area consists of manufactured targets simulating SAM sites, AAA sites, and command bunkers. Only inert free-fall ordnance is authorized in order to preserve the target complex. Forward firing ordnance is restricted to 25mm TP and TP tracer and below. **Live ordnance is NOT authorized.**

1.2.4.2 Impact Area 2. This area is used primarily for strategic bombing. All conventional live and inert free-fall and forward firing ordnance is authorized except for cluster, fuel air and incendiary munitions.

1.2.4.3 Impact Area 3. All conventional live and inert free-fall and forward firing ordnance is authorized except for cluster, fuel air and incendiary munitions.

1.2.4.4 Impact Area 4. This area is a non-contiguous area that includes various targets on the western side of the island used for surface fire support/small arms. Live gunfire is authorized in these areas.

1.2.5 Authorized Ordnance in R-7201

WARNINGS

Absolutely NO depleted uranium rounds, or any ordnance containing nuclear material, will be expended on R-7201.

Cluster bombs, fuel-air explosives, or incendiary devices are not authorized for use on R-7201.

NOTE

Target illumination flares, chaff and self-protection flares are authorized within the entirety of R-7201, but should be used in such a way as to avoid fire hazards on the island.

1.2.5.1 Ordnance Limitations. On FDM ordnance limitations are controlled by environmental agreements as delineated in reference (a). These expenditures are tracked and audited by CNM N3 and N45. The types and expenditures of ordnance allowed on FDM are delineated in Table 1.2.5.1

Tactical Air to Ground	
Missiles	80 annually
Rockets, 2.75 inch	400 annually
Rockets, 5 inch	400 annually
Rockets, other	40 annually
Conventional Bombs (250-500lb)	1400 annually
Conventional Bombs (1000-2000lb)	1240 annually
Inert Bombs	1380 annually
Strategic	
Live Conventional/Inert Bombs (500, 750, 2000lb)	612 monthly
Naval Surface Fire Support (HEPD/HECVT)	
5 inch	1040 annually
76mm	400 annually
Small Arms	
7.62mm	11,700
.50 caliber	600
40mm	2600
AT-4/other shoulder fired missile	40 (10 per quarter)

Table 1.2.5.1 Allowed Ordnance Expenditures

1.2.6 R-7201 Weapons Delivery Procedures and Restrictions

Surface fired ordnance shall be delivered from positions west of the island only. All units must plan to ensure all ordnance lands within the designated impact areas.

A dedicated mission safety observer must be assigned to each flight. The airborne safety observer may carry ordnance when necessary to fulfill a training commitment. The safety observer will retain ultimate responsibility for target area procedures throughout the course of the flight. The following criteria applies:

a. The safety observer must have 2-way radio communications with all strike elements.
b. The safety observer must have a positive ID of the target and visual contact with each strike element prior to delivery.
c. The safety observer will positively clear each element to drop after confirming ID of the target.
d. The safety observer has abort authority and responsibility.
e. The safety observer may swap roles with the element leader while the observer completes his live drop runs after the strike elements have completed their live drop runs.

For TACP/CAS missions, a qualified FAC shall act as safety observer. **Strike Leaders and Mission Commanders are accountable for the safety of ordnance deliveries.**

1.2.7 Targets and Locations

Impact Area 1 contains targets simulating SAM sites, AAA batteries, and command bunkers. CNM N3 will provide detailed pictures of the targets and locations upon request. These pictures will be included with the range instruction on compact disc. Units damaging or destroying targets shall indicate the target location and damage in the remarks section of their after action report (see section 1.2.8).

1.2.8 After Action Reports

The submission of an after action report is **required NLT 10 days** after the completion of an evolution. This information is closely tracked by civilian environmental authorities in the CNMI, and is necessary for the continued use of FDM. The after action report and necessary information is found in enclosure (4).

1.3 Scheduling

- Scheduling Authority: COMNAVMARIANAS
  FPO AP 96540
  DSN: 339-6399
- Scheduling Activity: COMNAVMARIANAS N3
- Scheduling POC: N31@guam.navy.mil, DSN 339-6399/4157
  N3@guam.navy.mil, DSN 339-4670
  Fax: (671) 339-6277

Commercial: (671) 339-6399/4157

1.3.1 R-7201 (FDM) Scheduling Procedures

All usage of R-7201 must be scheduled through COMNAVMARIANAS Operations Department (N3) via the CNM Area Training Officer (N31). Range use requests must arrive a minimum of 45 days prior to any large or extended exercise and 15 days for small scale exercises. This can be accomplished by e-mail or fax using the format provided in enclosure (2). Units desiring to use an ATCAA concurrent with R-7201 shall include this in their request. CNM N31 will coordinate with the FAA, Coast Guard, and the Commonwealth of Northern Marianas Islands (CNMI) for issue of all Notice to Airmen (NOTAM), Notice to Mariners (NOTMAR), and other public notices. Additional procedures for requesting laser use on FDM are found in section 1.4.4.

NOTE

The U.S. Navy reserves the right to schedule, for its use, any or all ranges under its operation. While USN range reservations are usually made 45 days in advance, short-notice requests will be evaluated for priority on a case-by-case basis. As such, units scheduled for use of these ranges may have range periods withdrawn with little or no advance warning.

1.3.2 FDM Maintenance

FDM will periodically be unavailable due to maintenance upkeep requirements. Questions concerning availability should be directed to CNM N31.

1.4 Laser Standard Operating Procedures

1.4.1 Air Operations

Laser operations on FDM shall be conducted in accordance with reference (b), enclosure (1) and this instruction. Laser Target Area (LTA) 1 is located within Impact Areas 1 and 2, and is specified in enclosure (1), paragraph 4.1.1.1. LTA 2 is located within Impact Area 3 and is specified in enclosure (1), paragraph 4.1.1.2.

Laser operations may be conducted on FDM provided that the laser system and profile are specified in enclosure (1) or authorized by the Range Technical Laser Safety Officer (TLSO) prior to scheduling. All LSRB approved aircraft mounted laser systems with a maximum buffer angle of 5 mrads are approved for use on FDM.

WARNING

Lasers shall not be directed above the apparent horizon or at non-laser targets.

The following laser safety procedures shall be adhered to:

- Observers viewing laser operations are not allowed to use optical aids unless laser protective eyewear is worn.
- Aircraft using laser-guided ordnance against ground laser designated targets shall approach the target from behind and on either side of the laser operator at an angle between 15 and 30 degrees along the laser line.
- All personnel in a Laser Hazard Zone, both in the air and on the ground, shall wear laser protective eyewear.
- Laser flight profiles in enclosure (1) depict minimum altitudes for specified run-in headings. Laser operations on run-in headings, other than those specified in enclosure (1), are not authorized.
- Laser hazard zones depicted in this instruction are based on the heading of the laser, and not the heading of the aircraft.

FDM is an uncontrolled range. All laser events shall have a qualified Laser System Safety Officer (LSSO), in accordance with reference (b), assigned to the range target area by the exercising unit. The LSSO's authority extends to the control of any act, apparent intention or condition that they deem unsafe, either in the air or on the ground within the target area.

Laser operations are not authorized until the LSSO has determined the target area is clear of potential laser hazards and people, and:

- Two-way communications between all safety personnel and the exercising unit are in place and maintained.
- A laser log identifying time, date, targets, firing points, and personnel present during all laser firings is maintained.
- In the event of a Laser Radiation Incident, notify the Range TLSO as soon as possible.
- Unit personnel are briefed on the lateral limits of the target areas.
- Only qualified personnel shall operate the laser systems.
- The target must be visually identified prior to lasing.

WARNING

FDM is a remote, unsurveilled range. Exercising units will assume responsibility for range clearance and safe laser operations. Extra care must be taken during range clearance to ensure FDM is clear of reflective surfaces, particularly standing water.

The depicted altitudes in enclosure (1), Appendix C are the minimum altitudes for the specific run-in headings. Laser operations on run-in headings other than those specified are not authorized.
Personnel within a laser hazard zone shall wear eye protection of the proper wavelength and optical density.
Lasers shall not be directed above the horizon.
The exercising unit will conduct a pre-brief prior to laser operations. The brief will include as a minimum:
Maps depicting the targets and/or target areas and their laser hazard zone.
Drawings or photographs (if available) of the targets to be utilized.
Run-in headings and flight profiles to be used in airborne laser operations.
Prior to any laser operations, exercising units will make a cold pass to ensure LTA and corresponding LHDZ are clear of unauthorized personnel or vessels.

1.4.2 Ground Laser Operations

Ground laser operations shall be conducted in accordance with enclosure (1), and this instruction.

The authorized firing line (FL) is located at the northern end of Special Use Area 1 . The coordinates of the FL are listed in enclosure (1), paragraph 4.2.

WARNINGS

Lasers shall not be directed above the apparent horizon or at non-laser targets.

Observers viewing laser operations shall not use optical aids unless laser protective eyewear is worn.

Two-way communications will be maintained between ground personnel and aircraft at all times during laser operations.

Prior to any laser operations, exercising units will make a cold pass to ensure LTA and corresponding LHDZ are clear of unauthorized personnel or vessels.

All LSRB approved ground laser systems with maximum buffer angles as shown in Enclosure (1), Appendix A are approved for use on FDM.

1.4.3 Range Maintenance

COMNAVMARIANAS will maintain the FDM range. All targets placed on the FDM range will be inspected by the COMNAVMARIANAS TLSO prior to placement on FDM. FDM will be inspected annually by the TLSO, accompanied by EOD, and as required by reference (b), to ensure compliance with laser safety directives. All targets found to be unsafe or unfit for laser operations will be removed.

COMNAVMARIANAS TLSO will maintain inspection records, laser logs, and all additional documentation necessary for a range safety compliance program in accordance with reference (b) and current applicable instructions.

1.4.4 Laser Operation Scheduling Procedures

Commands requesting the use of lasers on FDM should include the contents of enclosure (3) with the range request, enclosure (2). (See section 1.3.1)

The TLSO for FDM will review the data provided in enclosure (2), and:

- Ensure requesting unit has a certified LSSO coordinating the test/training operation.
- Provide the local range instruction/standard operating procedure to the LSSO of the requesting unit.
- Review proposed laser range operations plan or test plan to ensure compliance with current certification and local regulations and SOP's.
- Ensure a laser safety inspection has been conducted.

The command requesting use of the laser range shall:

- Review this range instruction and reference (a), the Marianas Training Handbook.

- Ensure all personnel involved in operations receive an appropriate pre-mission brief to include:

  - Authorized tactics, firing positions, firing fans, and aircraft run-in headings (as appropriate).
  - Drawings, photographs, descriptions or grid points of authorized targets.
  - Communication procedures that include specific frequencies, controlling authorities, and standardized terminology.
  - Acquisition, identification, and tracking procedures for targets are established prior to laser activation.
  - Missile/ordnance mode of operation (as appropriate for live fire operations).
  - Requirements for beam termination.
  - Control measures to minimize the risk of unauthorized aircraft or vessels entering the range area.
  - Type of eye protection to be worn.
  - Potential hazards posed by the laser system and the target area, and specific procedures to avoid these hazards (as appropriate).

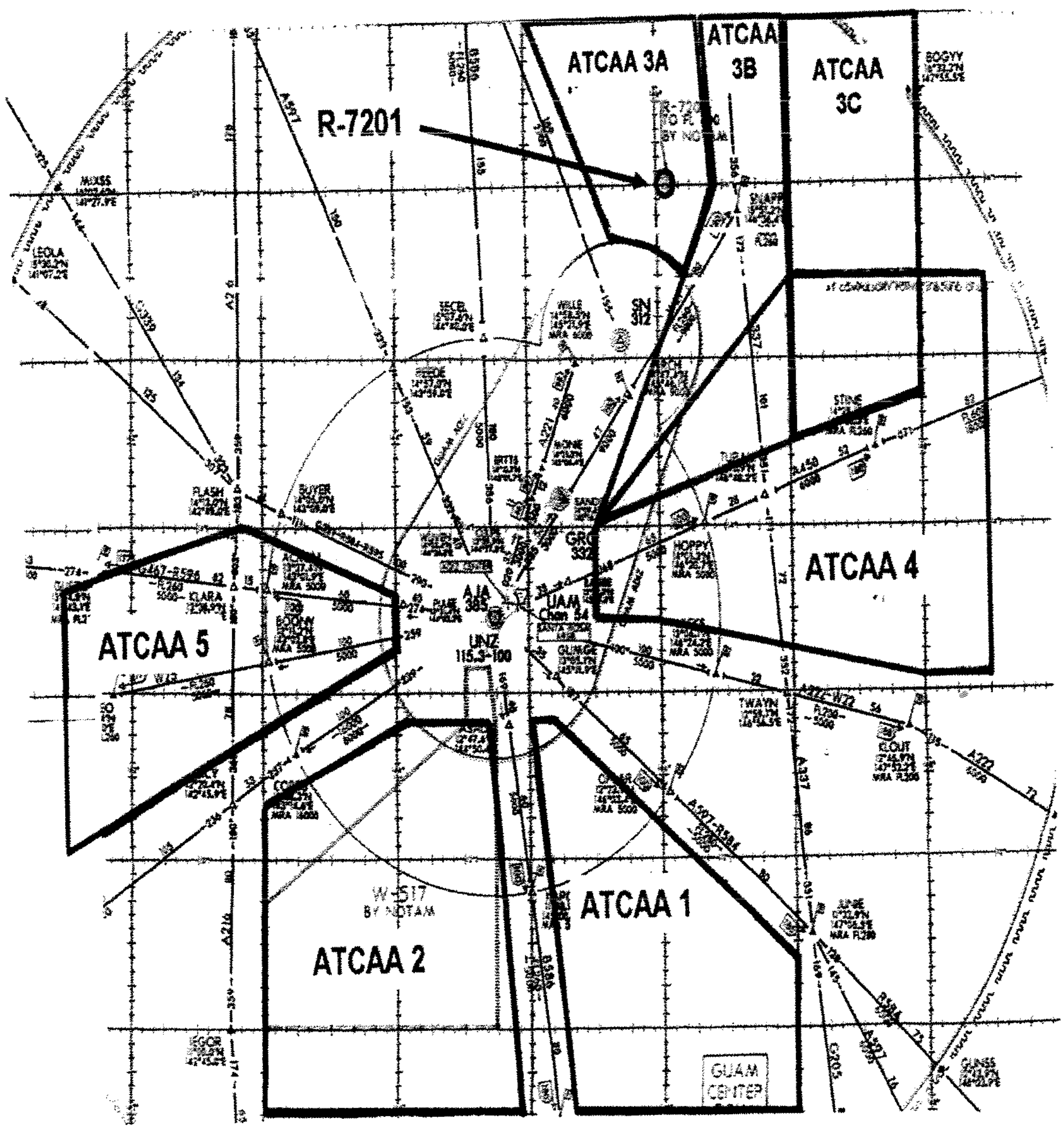
- Ensure appropriate laser eye protection is provided to all personnel within the laser hazard zone.

- Ensure all aspects of the FDM range instruction/ laser standard operating procedures are adhered to during the operation/ exercise/ test.

- Ensure only tactics authorized within the scope of the range certification (see encl. (1)), and only LSRB-approved laser systems are used for the operation/ exercise/ test.

Air Traffic Control Alert Area (ATCAA)

COMNAVMAR in conjunction with Guam ATC can establish any or all of five Air Traffic Control Alert Areas (ATCAAs) (see figure below) for military aircraft use and deconfliction. ATCAAs 1-5 are unattended, non-instrumented training ranges utilized for air-to-air and air-to-surface operations. ATCAA 3 is further divided into ATCAAs 3A, 3B and 3C, which may be activated individually or as a group. The ATCAAs define vertical/lateral limits, assigned by ATC, for the purpose of providing air traffic separation between the activities being conducted within the ATCAA and other IFR air traffic. Military aircraft within ATCAAs 1-5 operate under MARSA procedures.



Appendix A

ATCAA Establishment

CNM N31 will coordinate with the FAA to establish ATCAAs at the request of a training unit. Requesting units should not contact the FAA directly. Geographic coordinates have been historically preset, but can be tailored for individual needs. Requests for ATCAA establishments should be included with the R-7201 range request, enclosure (2). Historical geographic coordinates may be obtained from CNM N31 by email or phone. (See section 1.3.1)

Applicable Charts

See Operational Navigation Charts (ONC) J-14 and K-13 and Tactical Pilotage Charts (TPC) J-14C and K-13B.

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser 456K/9U157914
23 June 2009

Mr. James Lecky, Director
Office of Protected Resources
National Oceanic and Atmospheric Administration
National Marine Fisheries Service (NMFS)

Dear Mr. Lecky:

The Navy submitted a Biological Assessment (BA) on May 27, 2009 and a request for a Letter of Authorization (LOA) on July 9, 2008 in support of the Mariana Islands Range Complex (MIRC) Environmental Impact Statement. As a result of comments on the DEIS, the Navy has refined its analysis since these submittals, including some changes to the preferred alternative. Those changes are summarized below:

(1) Additional tables summarizing sonar source parameters and explosive source modeling results;
(2) Additional Analysis of HELLFIRE missiles and Joint Direct Attack Munitions (JDAMs) use within W-517;
(3) Live ordnance drops in W-517 and BOMBEX operating procedures and mitigation measures;
(4) Additional analysis of humpback whale exposures;
(5) Analysis of results for MIRC Portable Underwater Tracking Range (PUTR) sound sources;
(6) Revisions of some preliminary effects determinations from the original BA submittal; and
(7) Updated take authorization language and language correction for March 18, 2009 Federal Register Notice.

To assist in your efforts to review these changes, we have prepared an addendum for the May 27, 2009 BA submittal and update number three for the July 9, 2008 LOA request. Navy requests for NMFS to utilize this updated information when preparing their biological opinion and rules.

My staff point of contact for the Endangered Species Act is Dr. Kelly Brock, who can be reached at 703-604-5420 or via email at Kelly.Brock@navy.mil and for the Marine Mammal Protection Act is Ms. Linda Petitpas, who can be reached at 703-604-1233 or via email at linda.petitpas@navy.mil.

Commander, Pacific Fleet's point of contact for this matter is Ms. Julie Rivers, who can be reached at (808) 472-1407 or julie.rivers@navy.mil.

Sincerely,

Ronald E. Tickle
Head, Operational Environmental
Readiness and Planning Branch
Environmental Readiness Division
(OPNAV N45)

Enclosure:
(1) Biological Assessment Addendum for Mariana Islands Range Complex - June 2009.
(2) Update Number Three to the Letter of Authorization Application - June 2009

Copy to (w/o enclosures):
DASN (E)
OPNAV N43
CPF N01CE

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0902
17 Jul 09

Mr. Patrick Leonard
Field Office Supervisor
U.S. Fish and Wildlife Service
Pacific Islands Field Office
[illegible]
[illegible]

Dear Mr. Leonard:

SUBJECT: REQUEST FOR FORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE MARIANA ISLANDS RANGE COMPLEX [CONSULTATION #2007-1-0347]

The Department of the Navy for the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau proposes to support and conduct current and emerging training and research, development, testing and evaluation activities (RDT&E) and upgrade or modernize capabilities to enhance and sustain military training and testing in the Mariana Islands Range Complex (MIRC). Enclosed for your review is a Biological Assessment (BA) to initiate formal consultation under Section 7(a)(2) of the Endangered Species Act (ESA).

Informal consultation for this project began with the Navy's transmittal of the Federal Register document to the U. S. Fish and Wildlife Service (USFWS) Pacific Islands Field Office (PIFO) announcing the Notice of Intent and public scoping meetings for the MIRC Environmental Impact Statement (EIS)/Overseas EIS in June 2007 and subsequent meetings between the Navy (represented by NAVFACPAC and PACFLT personnel) and the PIFO in July of 2007. The Navy appreciates the technical assistance provided by PIFO personnel throughout the informal phase of this consultation.

As required by section 7 of the ESA, the Navy considered the potential impacts of training and RDT&E within the MIRC on listed species and critical habitats in drafting the BA and determined that:

1. The proposed action will not affect the following ESA-listed species: *Serianthes nelsonii*, *Nesogenes rotensis*, *Osmoxylon mariannense*, Guam Micronesian

kingfisher, Guam rail, and the Rota bridled white-eye.

2. Although critical habitats have been designated on both Guam (for the Mariana fruit bat, Mariana crow, and Micronesian kingfisher) and Rota (for the Mariana crow and Rota bridled white-eye), training and RDT&E within the MIRC will not take place within these areas. Navy has determined that the activities proposed in the BA will not destroy nor adversely modify these critical habitat units.

3. The training and RDT&E within the MIRC "may affect, but is not likely to adversely affect" the following ESA-listed species: green sea turtle and hawksbill sea turtle within USFWS jurisdiction, Mariana swiftlet, Mariana crow, Mariana common moorhen, nightingale reed warbler, and Mariana fruit bat.

4. The training and RDT&E within the MIRC "may affect and is likely to adversely affect" the Micronesian megapode.

In conclusion, the Navy requests (1) initiation of formal consultation under Section 7 of the ESA for the Micronesian megapode, and (2) USFWS concurrence that the described actions are not likely to adversely affect the green sea turtle and hawksbill sea turtle when within USFWS jurisdiction (i.e., on land), Mariana swiftlet, Mariana crow, Mariana common moorhen, nightingale reed warbler, and Mariana fruit bat (conclusions supported by data and analyses provided in the BA)

Thank you for your assistance. We would appreciate being apprised of your estimated schedule for completion of these determinations and request a draft copy of your biological opinion regarding the Micronesian megapode for our review when it is completed. Please contact Vanessa Pepi, NAVFACPAC Supervisory Fish and Wildlife Biologist (Vanessa.Pepi@navy.mil / 808-472-1406), regarding this consultation request.

Sincerely,

L. M. FOSTER
By direction

SUBJECT: REQUEST FOR FORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE MARIANA ISLANDS RANGE COMPLEX [CONSULTATION #2007-1-0347]

Enclosure: Biological Assessment for the Mariana Islands Range Complex, Terrestrial Species Consultation (2 hard copies and 1 CD)

Copy to: (w/o encl)
National Marine Fisheries Service, Pacific Islands Regional Office (Mr. William L. Robinson)
Chief of Naval Operations, Washington, DC (N45)
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas (EV - Mr. Robert Wescom)

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0921
23 Jul 09

Mr. Alberto A. Lamorena V
Director
Guam Bureau of Statistics and Plans
[illegible]
[illegible]

Dear Mr. Lamorena:

SUBJECT: FEDERAL CONSISTENCY DETERMINATION FOR THE DEPARTMENT OF DEFENSE ACTIVITIES WITHIN THE MARIANA ISLANDS RANGE COMPLEX (MIRC)

We are in receipt of your letter of June 25, 2009 concerning the Federal Consistency Determination for the Department of Defense (DoD) activities in the Mariana Islands Range Complex (MIRC) and the associated Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). We have reviewed and considered the substance of your letter.

Contrary to your assertion, the Navy respectfully disagrees that it planned and prematurely submitted the Federal Consistency Determination for the DoD activities in the MIRC. The Navy's submission satisfied the procedural and substantive requirements for submission of a federal consistency determination.

The regulations implementing the Coastal Zone Management Act (CZMA) require that federal agencies provide consistency determinations to the state at the earliest practicable time in the planning of the activity but in no case later than 90 days before final approval of the federal activity (15 C.F.R. §930.36(b)). Further, pursuant to Guam's Coastal Management Plan (GCMP), as approved by the National Oceanic and Atmospheric Administration (NOAA), a letter describing the proposed activity and asserting that it "is consistent with and will be conducted (or supported) in a manner consistent" with the GCMP to the maximum extent practicable should be submitted to the Bureau of Planning (BOP) at least ninety (90) days before final approval of the federal activity. GCMP, Guam PL 26-169 and Guam Executive Order 12372. Both the federal and territorial procedures of the CZMA provide for a federal agency's determination to be made when sufficient information has been developed to reasonably determine the consistency of the activity with the GCMP, but before the federal agency reaches a significant point in the decision-making process. See, e.g., 15 C.F.R. §§ 930.36(b), 930.39. In fact, the Guam procedural guide recommends that the consistency determination be submitted early in the process to assure timely review before final federal action.

With respect to the DoD activities in the MIRC, submission of the consistency determination at the draft EIS stage was appropriate. The Navy did not submit the Federal Consistency Determination until it had obtained information necessary to determine whether the federal activities were consistent with the GCMP, which was reached this spring. Moreover, the Navy ensured that the Federal Consistency Determination was submitted more than 90-days before issuance of a Record of Decision.

Accordingly, the Navy submitted the consistency determination on March 18, 2009 and it was received by your office on or about April 2, 2009. The consistency determination addressed all actions within the coastal zone and those located outside the coastal zone that would have any impacts in the coastal zone. The CZMA regulations require that the state notify the federal agency within 14 days of receiving the consistency determination if all the necessary supporting information was not submitted, and the state believes required information is missing. 15 C.F.R. § 930.41. The Navy received no such notification. As a result, the requisite 60-day review period began on the date that the Federal Consistency Determination was submitted.

Based upon the Navy's firm commitment to working cooperatively with the GCMP, Mr. Ed Lynch and Mr. Robert Wescom on behalf of the DoD Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau (DoD Rep) met with you on April 14, 2009, and discussed the public's and the Bureau's interagency concerns and comments. At this time, despite its commitment to working with the GCMP, the Navy reiterated, per the above legal authority, that a formal objection to the consistency determination would have to be made within a timely manner but not later than 60 days after receipt of the consistency determination. Indeed, according to the express language of the regulations, if the state does not provide a response within 60-day review period, the federal agency may presume state concurrence. 15 C.F.R. § 930.41(a). This 60-day period passed without comment by the Bureau of Statistics and Plans, or any other office within the Government of Guam. Therefore, the Navy appropriately presumed that the Government of Guam concurred with the Navy's federal consistency determination for MIRC after the expiration of the 60 days.

Notwithstanding the previous meetings and discussions between the Navy and Guam, the letter does not identify a statutory or regulatory reference by which the Navy is required to take actions different than those outlined herein. Also missing from your letter is an indication of what effects our proposed activities may have on Guam's coastal zone. Your letter merely indicates that the action proponent of the EIS should consider all comments of the public and territorial agencies before a final decision is made. To this latter point, we are pleased to advise you that the comments attached to your June 25, 2009 letter were in fact received by the Navy prior to the Consistency Determination being finalized and were specifically considered in drafting the Consistency Determination.

The Navy received numerous comments on the Draft EIS/OEIS that will be addressed in the Final EIS/OEIS, as appropriate. Although the Navy would acknowledge that the consistency determination process informs the EIS/OEIS process, the federal Coastal Consistency Determination (CCD) is not designed to provide a platform for responding to comments that were submitted on the Draft EIS/OEIS. As such, the Navy disagrees that the "concerns and issues raised by the people of Guam should have been discussed" in the CCD. Rather the CCD should be seen as a separate evaluation to determine the Federal government's compliance with enforceable policies of the Government of Guam. We will provide you with a copy of the Final EIS upon its completion.

Thank you again for the letter and for the detailed comments you provided. The Navy looks forward to a continued partnership with the Government of Guam and hopes that the procedural issues raised in your letter can be expeditiously and amicably resolved through the continued cooperation of our respective offices. If you have any questions on this matter, please contact Mr. Edward J. Lynch, at (808) 471-1714 or by email at edward.j.lynch.ctr@navy.mil.

Sincerely,

D. A. McNAIR
Captain, U.S. Navy
By direction

Copy to:
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas
(EV - Mr. Robert Wescom)

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/1100
1 Oct 09

Mr. William Robinson
Regional Administrator
Pacific Islands Regional Office
National Marine Fisheries Service
[illegible]
[illegible]

Dear Mr. Robinson:

SUBJECT: ESSENTIAL FISH HABITAT ASSESSMENT FOR THE MARIANA ISLANDS RANGE COMPLEX

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and regulations governing conservation of Essential Fish Habitat (EFH), this responds to National Marine Fisheries Service's (NMFS) September 2, 2009 conservation recommendations for proposed military training activities in the Mariana Islands Range Complex (MIRC). Although the Navy's proposed action would not result in long-term-adverse impacts to EFH as described in the "Essential Fish Habitat and Coral Reef Assessment for the Mariana Islands Range Complex EIS/OEIS", the Navy herein responds to NMFS' conservation recommendations. As noted in NMFS's letter, the conservation recommendations are pursuant only to the MSA. The Fish and Wildlife Coordination Act and Coral Reef Executive Order 13089 referenced in NMFS's letter will be addressed in separate correspondence.

The following provides Navy's responses to the six (6) EFH recommendations offered in your letter pursuant to section 305(b)(4)(A) of the MSA:

NMFS EFH Conservation Recommendation 1:

We recommend that further analysis of the impacts of amphibious landings and over the beach insertion/extractions be undertaken. Due to the increased frequency of these events, the impacts are likely to be additive and cumulative in nature. Physical impacts to sufficient information has been developed to reasonably determine the consistency of the activity with the GCMP, but before the federal agency reaches a significant point in the decision-making process. See, e.g., 15 C.F.R. §§ 930.36(b), 930.39. In fact, the Guam procedural guide recommends that the consistency determination be submitted early in the process to assure timely review before final federal action.

With respect to the DoD activities in the MIRC, submission of the consistency determination at the draft EIS stage was appropriate. The Navy did not submit the Federal Consistency Determination until it had obtained information necessary to determine whether the federal activities were consistent with the GCMP, which was reached this spring. Moreover, the Navy ensured that the Federal Consistency Determination was submitted more than 90-days before issuance of a Record of Decision.

Accordingly, the Navy submitted the consistency determination on March 18, 2009 and it was received by your office on or about April 2, 2009. The consistency determination addressed all actions within the coastal zone and those located outside the coastal zone that would have any impacts in the coastal zone. The CZMA regulations require that the state notify the federal agency within 14 days of receiving the consistency determination if all the necessary supporting information was not submitted, and the state believes required information is missing. 15 C.F.R. § 930.41. The Navy received no such notification. As a result, the requisite 60-day review period began on the date that the Federal Consistency Determination was submitted.

Based upon the Navy's firm commitment to working cooperatively with the GCMP, Mr. Ed Lynch and Mr. Robert Wescom on behalf of the DoD Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau (DoD Rep) met with you on April 14, 2009, and discussed the public's and the Bureau's interagency concerns and comments. At this time, despite its commitment to working with the GCMP, the Navy reiterated, per the above legal authority, that a formal objection to the consistency determination would have to be made within a timely manner but not later than 60 days after receipt of the consistency determination. Indeed, according to the express language of the regulations, if the state does not provide a response within 60-day review period, the federal agency may presume state concurrence. 15 C.F.R. § 930.41(a). This 60-day period passed without comment by the Bureau of Statistics and Plans, or any other office within the Government of Guam. Therefore, the Navy appropriately presumed that the Government of Guam concurred with the Navy's federal consistency determination for MIRC after the expiration of the 60 days.

Notwithstanding the previous meetings and discussions between the Navy and Guam, the letter does not identify a statutory or regulatory reference by which the Navy is required to take actions different than those outlined herein. Also missing from your letter is an indication of what effects our proposed activities may have on Guam's coastal zone. Your letter merely indicates that the action proponent of the EIS should consider all comments of the public and territorial agencies before a final decision is made. To this latter point, we are pleased to advise you that the comments attached to your June 25, 2009 letter were in fact received by the Navy prior to the Consistency Determination being finalized and were specifically considered in drafting the Consistency Determination.

The Navy received numerous comments on the Draft EIS/OEIS that will be addressed in the Final EIS/OEIS, as appropriate. Although the Navy would acknowledge that the consistency determination process informs the EIS/OEIS process, the federal Coastal Consistency Determination (CCD) is not designed to provide a platform for responding to comments that were submitted on the Draft EIS/OEIS. As such, the Navy disagrees that the "concerns and issues raised by the people of Guam should have been discussed" in the CCD. Rather the CCD should be seen as a separate evaluation to determine the Federal government's compliance with enforceable policies of the Government of Guam. We will provide you with a copy of the Final EIS upon its completion.

Thank you again for the letter and for the detailed comments you provided. The Navy looks forward to a continued partnership with the Government of Guam and hopes that the procedural issues

Subj: FEDERAL CONSISTENCY DETERMINATION FOR THE DEPARTMENT OF DEFENSE ACTIVITIES WITHIN THE MARIANA ISLANDS RANGE COMPLEX (MIRC)

raised in your letter can be expeditiously and amicably resolved through the continued cooperation of our respective offices. If you have any questions on this matter, please contact Mr. Edward J. Lynch, at (808) 471-1714 or by email at edward.j.lynch.ctr@navy.mil.

Sincerely,

D. A. McNAIR
Captain, U.S. Navy
By direction

Copy to:
Naval Facilities Engineering Command, Pacific (EV)
Naval Facilities Engineering Command, Marianas
(EV - Mr. Robert Wescom)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2007-I-0347

MAY 0 2 2008

Ms. Karen Sumida
Department of the Navy
Naval Facilities Engineering Command, Pacific

Subject: Informal Consultation Request for the Proposed Establishment and Operation of the Mariana Islands Range Complex and for the Relocation of the U.S. Marine Corps Forces to Guam

Dear Ms. Sumida:

Thank you for your March 26, 2008, letter requesting agreement with the species list prepared for the proposed establishment and operation of the Mariana Islands Range Complex (MIRC) and for the relocation of the U.S. Marine Corps forces to Guam via the Joint Guam Program Office (JGPO). Your letter also requested to establish a date-of-record for the commencement of informal consultation under section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended (Act) for U.S. Navy actions associated with MIRC and JGPO. We received your letter on March 28, 2008. On April 21, 2008, you agreed to an extension of our deadline.

As you mention in your letter, we began informal discussions regarding MIRC and JPGO in 2007. We have compiled a list of meetings and conversations that have occurred over the past year where we received any information or any discussion of endangered or threatened species that may be affected by MIRC or JGPO. We request that you verify this list and add any conversations, electronic mailings, and/or meetings that we may have inadvertently left off the coordination history (see Table 1 and Table 2) for either MIRC or JGPO.

We reviewed the species list you provided and we concur that the species on the list are the federally listed, candidate, delisted, and migratory bird species known to use the terrestrial resources from Guam and the Commonwealth of the Northern Mariana Islands (CNMI). The population numbers provided within these tables should be viewed with caution as some of the data are older and some data are currently in revision. For example, a recent survey (2007) for the nightingale reed-warbler on Saipan estimated the population size at 2,596 pairs (Camp et al., *in prep.*) instead of 4,200 pairs as reported from 1997. Additionally, the tables enclosed within your letter only include species and do not include critical habitat. Therefore, we have enclosed a list of terrestrial critical habitat (see Table 3).

There are many sites within Guam and CNMI that have other protected habitats that are not designated as critical habitat. U.S. Navy lands at the Communications Annex and the ordnance Annex and Andersen Air Force Base on Guam were excluded from the critical habitat designation due to their respective Integrated Natural Resources Management Plans, which include projects that could maintain or benefit the Mariana fruit bat (*Pteropus mariannus mariannus*), Mariana crow (*Corvus kubaryi*), and Guam Micronesian kingfisher (*Halcyon cinnamomina cinnamomina*). Though the U.S. Navy and U.S. Air Force lands were not included in the final critical habitat designation, these areas are essential for the conservation of these species and to meet their respective recovery goals. In 1994, the U.S. Navy and U.S. Air Force entered into cooperative agreements with the Service to create the Guam National Wildlife Refuge Overlay on U.S Navy and U.S. Air Force lands on Guam. This agreement established that the U.S. Navy and the U.S. Air Force will coordinate with the Service regarding Federal activities which may affect these areas even if they are currently unoccupied by the species. In addition, there are areas that were not designated as critical habitat but are essential to the survival and recovery of listed species outside U.S. Navy and U.S. Air Force lands on Guam that may be affected by the proposed action. Approximately 936 acres (379 hectares) of land was preserved on Tinian, for the protection of the Tinian monarch, as a conservation measure within the Federal Aviation Administration's project description for improvements to the Tinian International Airport. Also, several wetlands have been restored, enhanced, or created as mitigation under the U.S. Army Corps of Engineers authority under the Clean Water Act. Many of these wetlands are important for listed species including the Mariana common moorhen and the nightingale reed-warbler. At this time we do not have a comprehensive list of all locations and habitats that have been set aside or receive protection from other local and Federal agencies.

We recommend that you coordinate directly with Guam Division of Aquatic and Wildlife Resources, CNMI Division of Fish and Wildlife, and National Marine Fisheries Service to ensure that the species lists adequately reflect trust resources protected under their respective jurisdictions. We also recommend that you contact these and other appropriate agencies regarding critical habitat, essential habitat, or habitats with local protections.

The purpose of informal consultation is to: clarify whether the action area has listed, proposed, and candidate species or designated critical habitat; determine the potential effects of the proposed action on these species or critical habitats; explore ways to modify the proposed action to reduce or remove adverse affects to the species or critical habitats; determine the need to enter into formal consultation or conference; and to explore the design or modification of an action to benefit the species or critical habitat. Although we have been coordinating for over a year, we are concerned that the Service and the Navy have not spent a sufficient amount of time discussing actions associated with the MIRC or JGPO and their potential affect to listed species and their habitats. We recommend that prior to completion of your biological assessment, a series of informal meetings be conducted to update species status and critical habitat information and to explore ways to avoid and minimize impacts to these species and their habitats.

We look forward to working with you regarding the two proposed projects. If you have questions regarding federally protected species, critical habitat, or this letter, please contact Holly Herod, Fish and Wildlife Biologist for Technical Assistance and Consultation at (808)792-9400.

Sincerely,

for Patrick Leonard
Field Supervisor

cc:
Tino Aguon, Guam Division of Aquatic and Wildlife Resources, Guam
Chris Bandy, U.S. Fish and Wildlife Service, Guam
Paul Bassler, Guam Department of Agriculture, Guam
Theresa Bernhard, Joint Guam Program Office, Washington DC
Lisa Fiedler, Joint Guam Program Office, Guam
Larry Foster, COMPACFLT (N01CE1), Hawaii
Sylvan Igisomar, CNMI Division of Fish and Wildlife Resources, Saipan
Ed Lynch, KAYA, Contractor to Navy Commander Pacific Fleet

Enclosures

Table 1. Coordination history regarding the proposed establishment and operation of the Mariana Islands Range Complex.

June 8, 2007. The Service received a letter dated June 1, 2007, from the Navy. The letter included a copy of a Federal Register document announcing the Notice of Intent for MIRC and public scoping meetings. The letter requested our input in identifying the scope of issues and significant issues related to MIRC.

July 11, 2007. Department of Defense (DOD) held a Quarterly meeting with participating agencies including the Service. DOD indicated that: scoping meetings are complete for MIRC; a timeline for NEPA was provided; MIRC covers existing training in existing training areas only; new training or new areas would be covered by JGPO.

July 23, 2007. The Service received a copy of a letter dated July 16, 2007, from the U.S. Environmental Protection Agency regarding their comments related to the MIRC scoping comments.

July 30, 2007. The Service sent a letter to the MIRC office providing comments on the NOI to develop and EIS/OEIS for MIRC.

September 21, 2007. The Service had a meeting with the Navy and its representatives regarding MIRC, JGPO, and the brown treesnake. We suggested one section 7 consultation to combine both MIRC and JGPO actions as the actions are all interrelated and interdependent. We further indicated that a thorough biological assessment would be needed for MIRC and JGPO.

September 24, 2007. The Service had a meeting with the Navy regarding JGPO and MIRC actions, improving cross agency communication, and surveys for species that may be impacted by the proposed actions. We indicated that migratory birds should be considered in the NEPA documents if large towers are going to be built.

October 4 – 5, 2007. The Service attended the JGPO partnering session on Guam and received JGPO related hard copy presentations. We received a hard copy of the presentation given by Ed Lynch, Navy contractor, regarding the MIRC EIS/OEIS.

November 7, 2007. DOD held a Quarterly meeting with the participating agencies including the Service. DOD indicated that the terrestrial biological assessment for MIRC was 50% complete; the JGPO DEIS was due out January 2009 and currently only Guam information was known.

November 14 – 16, 2007. The Service attended the Brown Treesnake (BTS) Working Group meeting held on Saipan. A review of JGPO and MIRC was provided by Captain Robert Lee (Navy) and Ed Lynch (Navy contractor), respectively. Earl Campbell (Service) provided an update and lead a discussion regarding the efforts that will be needed by the Navy to prevent the spread of BTS from the implementation of JGPO and MIRC.

February 14 – 15, 2008. The Service attended the JGPO partnering session on Guam. An update on MIRC was presented to participants.

March 7, 2008. Vanessa Pepi (Navy) and Patrice Ashfield (Service) met to discuss the MIRC DOPPA and Biological Assessment. Ms. Ashfield mentioned Service concerns regarding increased training at Farallon de Medinilla and the potential impacts to the Micronesian megapode, the listing of the Mariana fruit bat throughout its range, and potential impacts to sea turtles and their nesting beaches.

March 28, 2008. The Service received a letter dated March 26, 2008, from the Navy. The letter included an attached species list and requested: official commencement of informal consultation and concurrence with the attached species list for MIRC and JGPO.

April 16 – 18, 2008. Service attended the BTS Conference held in Honolulu, HI. The conference provided an update on JGPO and MIRC and focused on status of current research and invasive species issues associated with JGPO and MIRC.

Table 2. Coordination history regarding the proposed relocation of the U.S. Marine Corps forces to Guam (JGPO).

May 17, 2007. The Navy sent a letter to Mr. Dale Hall (Service) requesting that the Service be a cooperating agency in the JGPO NEPA process. This letter was provided by copy at the June 4 – 5, 2007 JGPO Partnering Session.

May 18, 2007. Dwayne Minton (Service – Ecological Services) and Chris Bandy (Service – Refuges) emailed Captain Robert Lee (Navy) the Service's comments regarding the March 7, 2007, Notice of Intent to develop an EIS/OEIS for the relocation of the U.S. Marine Corps Forces to Guam.

June 4 – 5, 2007. The Service attended the JGPO Partnering Session.

June 11, 2007. Vanessa Pepi (Navy) provided the Service with a copy of the Scope of Work and Survey Methods for the biological surveys that will occur on Guam.

July 3, 2007. The Service sent a letter to Commander Hinton (Navy) regarding cooperating agency status for the development of the JGPO EIS/OEIS.

July 7, 2007. Earl Campbell (Service) emailed a summary of a phone conversation with Vanessa Pepi (Navy) regarding: potential areas in the CNMI where JGPO activities may occur; need to discuss conservation areas and strategies early, internal meetings, and a letter for NEPA cooperating agency status.

July 11, 2007. Department of Defense (DOD) held a Quarterly meeting with participating agencies including the Service. DOD indicated that: scoping meetings are complete for MIRC; a timeline for NEPA was provided; MIRC covers existing training in existing training areas only; new training or new areas would be covered by JGPO.

July 18, 2007. Earl Campbell (Service) emailed Mr. Bice, Mr. Lee, and Mr. Schregardus (Navy) a request for staff and financial support needed for brown treesnake interdiction, control, and research efforts associated with JGPO activities. The email also included a report from OMB.

July 31, 2007. The Service sent a letter to the JGPO office requesting assistance related to the increase in Service expected workload related to JGPO.

August 15, 2007. The Service had a meeting with the Navy to discuss terrestrial biological information needs for JGPO. We indicated that consultation needs to remain informal until all the information necessary to complete a formal consultation is prepared and finalized. We further requested that surveys should be completed for any species that may be impacted and that the surveys should consider the full extent of the range or status for these species.

September 21, 2007. The Service had a meeting with the Navy and its representatives regarding MIRC, JGPO, and the brown treesnake. We suggested one section 7 consultation to combine both MIRC and JGPO actions as the actions are all interrelated and interdependent. We further indicated that a thorough biological assessment would be needed for MIRC and JGPO.

September 24, 2007. The Service had a meeting with the Navy regarding JGPO and MIRC actions, improving cross agency communication, and surveys for species that may be impacted by the proposed actions. We indicated that migratory birds should be considered in the NEPA documents if large towers are going to be built.

October 4 – 5, 2007. The Service attended the JGPO partnering session on Guam and received JGPO related hard copy presentations. We received a hard copy of the presentation given by Ed Lynch, Navy contractor, regarding the MIRC EIS/OEIS.

November 7, 2007. DOD held a Quarterly meeting with the participating agencies including the Service. DOD indicated that the terrestrial biological assessment for MIRC was 50% complete; the JGPO DEIS was due out January 2009 and currently only Guam information was known.

November 14 – 16, 2007. The Service attended the Brown Treesnake (BTS) Working Group meeting held on Saipan. A review of JGPO and MIRC was provided by Captain Robert Lee (Navy) and Ed Lynch (Navy contractor), respectively. Earl Campbell (Service) provided an update and lead a discussion regarding the efforts that will be needed by the Navy to prevent the spread of BTS from the implementation of JGPO and MIRC.

November 19, 2007. The Service emailed unofficial species lists for Guam and CNMI and resource lists for specific locations on Guam to Ed Lynch (Navy contractor), Teresa Bernhard (JGPO) and Lisa Fiedler (JGPO).

November 19, 2007. Earl Campbell (Service) participated in "The Department of Interior Interagency Group on Insular Affairs, Guam Interagency Task Force Meeting" and presented brown treesnake needs related to JGPO to the Natural Resources sub-Committee.

December 17, 2007. The Service met with the Navy regarding potential species surveys in the CNMI. We also provided information on the data needs for section 7 consultations as compared with the data needed for a programmatic NEPA document.

January 22, 2008. Earl Campbell (Service) provided a briefing to the Service, U.S. Marine Corps, and U.S. Army related to brown treesnake and JGPO activities.

January 23, 2008. Earl Campbell (Service) provided a briefing to Assistant Secretary of the Navy regarding brown treesnake and JGPO activities.

January 23, 2008. The Service attended a video teleconference regarding the upcoming JGPO Partnering Session meeting.

January 25, 2008. Earl Campbell (Service) provided an overview of the brown treesnake issues related to JGPO to the Service and Department of Defense.

January 29, 2008. Vanessa Pepi (Navy) emailed Dwayne Minton and Curt Kessler (Service) maps depicting the JGPO training concept plan for Tinian.

February 4, 2008. Stephen Smith (Navy) emailed Dwayne Minton, Curt Kessler, Kevin Foster, Michael Molina (Service) maps depicting the JGPO training concept study on Guam and CNMI.

February 14 – 15, 2008. The Service attended the JGPO partnering session on Guam.

February 19, 2008. Rick Spaulding (Navy contractor) emailed Nate Hawley, Earl Campbell, Holly Herod, and Dwayne Minton (Service) the Pre-Final Sampling Plan for the natural resource surveys to support JGPO on Guam.

March 27, 2008. The Navy emailed an initial monthly update related to the JGPO EIS.

March 28, 2008. The Service received a letter dated March 26, 2008, from the Navy. The letter included an attached species list and requested: official commencement of informal consultation and concurrence with the attached species list for MIRC and JGPO.

April 14, 2008. The Marines hosted a workshop to familiarize participants with the potential impacts from terrestrial training.

April 15, 2008. The Service hosted a workshop to familiarize participants with other DOD conservation strategies and to brainstorm conservation strategies that may be useful for implementation by JGPO.

April 16 – 18, 2008. Service attended the BTS Conference held in Honolulu, HI. The conference provided an update on JGPO and MIRC and focused on status of current research and invasive species issues associated with JGPO and MIRC.

Table 3. Designated critical habitat within Guam and the Commonwealth of the Northern Mariana Islands. DOD lands within the Guam National Wildlife Refuge (NWR) Overlay Refuge lands are not included in the totals below as they are not designated as critical habitat. However, the lands within the Guam NWR Overlay Refuge are essential to the recovery of several listed species and DOD is required to coordinate with us when projects may affect lands within Guam NWR Overlay Refuge, even when these lands are unoccupied.

Critical Habitat	Location	Area
Mariana fruit bat	Unit A: Guam NWR, fee simple area	376 acres (152 hectares)
Mariana crow	Unit A: Guam NWR, fee simple area	376 acres (152 hectares)
	Unit B: Rota – Subunit 1	5,668 acres (2,294 hectares)
	Unit B: Rota – Subunit 2	365 acres (148 hectares)
Guam Micronesian kingfisher	Unit A: Guam NWR, fee simple area	376 acres (152 hectares)
Rota bridled white-eye	Rota	3,958 acres (1,602 hectares)

BUREAU OF STATISTICS AND PLANS

(Bureau of Planning)

Government of Guam

Felix P. Camacho
Governor of Guam

Michael W. Cruz, M.D.
Lieutenant Governor

P.O. Box 2950 Hagåtña, Guam 96932
Tel: (671) 472-4201/3
Fax: (671) 477-1812

Alberto "Tony" Lamorena V
Director

JUN 25 2009

Commander
Department of the Navy
United States Pacific Fleet
[illegible]
[illegible]

Attn: Captain J.P. Rios, USN

Reference: 5090 Ser NO1CE1/0312

Dear Sir:

The Bureau of Statistics and Plans has completed the review of the Department of the Navy's Federal Consistency Determination for the Department of Defense activities within the Mariana Islands Range Complex (MIRC) dated, March 18, 2009 (received by the Bureau on April 2, 2009). It shows that the Navy's determination document was prepared prior to March 31, 2009 extended closing of the comment period for the Draft MIRC draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). With specific regard to the amount of time being given to us to review the document, it should be noted that as a general rule, it takes around ten (10) days or more for review documents from Hawaii to reach Guam and the Bureau, not considering the additional days that the document was posted, which gives us even less time to review.

We are concerned that most of the "Discussion" portion of the submitted Assessment of the Guam Coastal Management Program policies indicated that "***the proposed project, military training activities would continue to take place primarily either in international waters or within the boundaries of federally-owned lands, including submerged lands, on Guam.***" Please note that federal consistency requirement applies when any federal activity, regardless of location, affects any land or water use or natural resource of the coastal zone, Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) Public Law No. 101-508. The CZMA regulations 15 CFR Part 923.33(b), in part states, "The exclusion of Federal lands does not remove Federal agencies from the obligation of complying with the consistency provisions of section 307 of the Act when Federal actions on these excluded land have spillover impacts that affect any land or water use or natural resource of the coastal zone within the purview of a state's management program."

In our April 14, 2009 meeting on Guam with Mr. Edward J. Lynch, Commander Pacific Fleet NO1CE19, Mr. Robert Wescom, and Ms. Evangeline Lujan, GCMP Administrator, the issues regarding the numerous comments received from the community of Guam, the local government, public/private organizations and other individuals with regards to the proposed MIRC activities were discussed. The DOD/Navy is well aware that the people of Guam have legitimate questions regarding Guam's natural resources and its environment that need to be answered/clarified and issues that need to be addressed by the Navy and/or Department of Defense in the Final EIS/OEIS, including the Bureau's comments dated, March 16, 2009. It has been agreed that those legitimate concerns and issues raised by the people of Guam should have been discussed in the DOD Federal Consistency document and addressed in the Final EIS/OEIS, where the Navy's federal consistency determination must also be based.

It is apparent that the Federal Consistency Determination was pre-maturely prepared and submitted by the Navy and therefore, the Bureau is not in a position to concur with the submitted Federal Consistency Determination until the issues and concerns that were raised in the review of the draft EIS/OEIS are addressed/allayed or resolved.

In this respect, we suggest that the Navy/DOD further coordinate with the Bureau and submit an updated or a supplemental Federal Consistency Determination document incorporating and addressing issues and concerns iterated in the enclosed Bureau of Statistics and Plan's March 16, 2009 review of the MIRC Draft EIS/OEIS. Please provide us the revised/and or supplemental Navy/DOD's Federal Consistency determination in order that we can conduct a review and issue the Federal consistency statement at the earliest practicable time.

Should you need further questions, please do not hesitate to call Ms. Evangeline D. Lujan, GCMP Administrator at (671) 475-9672 or email: vangelujan@yahoo.com, cc: mely.deleon@bsp.guam.gov.

Sincerely,

ALBERTO A. LAMORENA V
Director

Enclosure: a/s

cc: GEPA
DoAg
DPR/GHPO
DLM
Ed Lynch
R. Wescom
B.Millhouser
K.Chaston
Paul Shintaku
AG's Office

BUREAU OF STATISTICS AND PLANS

Government of Guam

Felix P. Camacho
Governor of Guam

Michael W. Cruz, M.D.
Lieutenant Governor

P.O. Box 2950 Hagåtña, Guam 96932
Tel: (671) 472-4201/3
Fax: (671) 477-1812

Alberto "Tony" Lamorena V
Director

MAR 16 2009

Mariana Islands Range Complex EIS
Attn: EV2

Hafa Adai:

The following are the Bureau of Statistics and Plans (BSP) comments in the review of the Draft Environmental Impact Statement/Overseas Impact Statement (DEIS/OEIS) for the proposed Mariana Islands Range Complex (MIRC) dated January 2009:

I – CZMA Federal Consistency Requirement

1.5.3. Coastal Zone Management Act was listed as one of the other Environmental Requirements considered in the DEIS. However, no Federal consistency determination, analysis, or even the timeline to accomplish the requirement was addressed. A consistency determination must include a detailed description of the activity, its coastal zone effects, and comprehensive data and information sufficient to support such determination. Therefore, a Consistency determination must be submitted to the BSP's Guam Coastal Management Program for review as mandated by the Coastal Zone Management Act (CZMA) of 1972, 16 USC § 1456 (c) (1), the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) Public Law 101-508. Any action proposed by a Federal agency that will have a reasonably foreseeable effect on any land or water sue or natural resource of a State's coastal zone, which in CZMA context is the Island of Guam in its entirety, must be consistent to the maximum extent practicable with the enforceable policies of State's federally approved CZMA programs, Section 307(c)(1)(A), 15 CFR Part 930, unless compliance is prohibited by existing law applicable to the federal agency's operations. BSP has to either concur or object to the proposed activity. Changes must be made before the Federal activity is permitted. There is no categorical exemption for any federal activity. However, under certain circumstances the President may exempt a specific federal activity. (see 16 U.S.C. 1456(c)(1)(b). Federal consistency requirement for Federal activities are detailed at 16 U.S.C. 1456©(1) and (2) and at 15 CFR Part 930 subpart C.

II – Issues and Concerns:

- Flight exercises should not be allowed over populated areas of Guam at any time. Catastrophic effects of aircraft accident due to increase in volume of air traffic expose people and properties to potential accident. Although, the risk to people on the ground of being killed or injured by aircraft accidents is small, an aircraft accident is a high consequence event and the result is often catastrophic. The 1998 US Air force AICUZ Report (April 1998) states that the Air Force determined that 75% of the accidents had definable debris impact areas, although they varied in size by type of accident. Of the 369 major USAF accidents 1968-1972, 70 percent occurred in daylight and fighter and training aircraft accounted for 80 percent.

Cumulative Impacts:

- Our coastal marine and terrestrial habitat will be affected by training exercises within the ocean surface and undersea areas, i.e. training explosions in Apra Harbor. The cumulative wastes and discharges from continued training explosions will generate pollutants and threaten our estuarine and reefs.

What assurances are there that our designated Northern Aquifer will not be impacted?

- Any type of land disturbing activity increases the potential for erosion to occur resulting in loss of shorelines that will eventually lead to damages to our coral reefs and disturbance of marine habitat.

- The cumulative impacts from continued firing range exercises will affect our native forests and wetland areas. What measures are there to ensure that this type of activity does not pose unreasonable risks to the health, safety or welfare of the people of Guam?

- Impacts from air traffic will have an effect on our community most especially on the elderly who will live in fear with the sounds of ammunition going off. This will affect their health to cause memories of war time and all the hardships endured by it, and cause them to live in fear from the constant loud sound of airplanes etc

- What assurances are there to protect our native birds, marine animals and disturbance to our native forests? Our marine environment will be subjected to continuous trauma from the military exercise leaving our marine animals defenseless.

2.2.1. This DEIS lacks a range of reasonable alternatives and does not provide an adequate explanation as to why other alternatives were eliminated from full consideration. As such, we believe the DEIS does not fulfill the requirement to "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated (40 CFR §1502.14)." Our analysis of the alternatives in the DEIS leads us to believe that other alternatives may have been foreclosed prematurely, without adequate explanation regarding their elimination from the range of alternatives analyzed in the EIS. While some explanation is provided regarding the three alternatives that were eliminated from consideration, the categorical exclusion of these alternatives, without considering potential combinations of components of these broad alternatives (e.g., some training conducted elsewhere in the region, increased use of simulated training for certain activities, and possible combined use of certain sites in order to reduce the total number of training sites) resulted in essentially one alternative (see below for our opinion on why alternative 2 is not a reasonable alternative). It is difficult to accept that a proper analysis of all possible reasonable alternatives was conducted when we are left with essentially one alternative.

2.2.1. The authors of the MIRC DEIS indicate that the paucity of alternatives is the end result of a process that eliminated all other alternatives. While the criteria for determining the reasonableness of an alternative are provided, the decision making process that led to the elimination of a range of possible alternatives was not a process open to public input nor was it properly documented in the DEIS, and thus cannot be considered as fulfilling the requirements of the NEPA process. Alternatives analysis should clearly indicate why and how the particular range of project alternatives was developed, including what kind of public and agency input was used. In addition, alternatives analysis should explain why and how alternatives were eliminated from consideration. It must be made clear what criteria were used to eliminate alternatives, at what point in the process the alternatives were removed, who was involved in establishing the criteria for assessing alternatives, and the measures for assessing the alternatives' effectiveness. It is general practice by many federal agencies that in the preparation of NEPA documents, project sponsors should be candid about the rationale for generating, evaluating, and eliminating alternatives. If alternatives are eliminated from further consideration because they "do not meet the purpose and need," the action proponent must adequately explain how or why this alternative doesn't meet the purpose and need. We do not believe these criteria were met.

2.2.1. The Navy's Environmental and Natural Resources Program Manual provides examples of the types of alternatives that should be included in an EIS, including 1) taking no action, 2) postponing action, and 3) selecting actions of a significantly different nature that would meet mission and project objectives with different environmental impacts. We believe that Alternative 1 and Alternative 2 are not sufficiently different, leaving reviewers with essentially one action alternative (which, then, is not an "alternative" at all), and thus a range of reasonable alternatives is not offered for evaluation of environmental impacts. Alternatives should address alternate designs, site locations, etc. when establishing the selection criteria.

2.2.1. In general, it appears as though the information used to support conclusions about the impacts of various activities under the No Action Alternative were based on the information presented in the 1999 Military Training in the Marianas EIS. While the level of training would remain relatively consistent under the No Action Alternative, this approach does not take into account changes in the environment that may have occurred since the 1999 EIS. For example, a recent survey of immigrants to Guam conducted by the U.S. Census Bureau and the Government of Guam indicated that the population of immigrants from the Freely Associated States increased from about 10,000 in 2003 to over 18,000 in 2008. There have also been increases in other demographic groups over this period, pushing the total population significantly higher. There are various direct and indirect effects of population increases, such as changes in land use, recreational use, resource condition, etc., that may result in impacts different than those determined in the 1999 EIS. There may also have been changes to laws, rules, and regulations that may call for a different analysis of the current level of training. We have also learned a lot more about climate change and its expected impacts to coastal resources and coastal communities over the last 10 years. Our improved understanding of these impacts would likely result in a different analysis of impacts of the current level of training activity. It is not reasonable to apply the results of impact analysis conducted more than 10 years ago to the current EIS process, so a new analysis of impacts of activities under the No Action alternative should be carried out for inclusion in the FEIS. And because the No Action alternative serves as the baseline for Alternative 1 and Alternative 2, the impacts of these alternatives must also be re-evaluated.

3.3.4. The authors of the MIRC DEIS claim that unavoidable impacts to water quality are only temporary and would not result in adverse effects. However, Government of Guam biologists have witnessed highly turbid water apparently related to the nearby LCAC activity while snorkeling at Jade Shoals on February 2, 2009 that was severe enough to raise concern about the veracity of that statement. A sediment plume was visible in the immediate vicinity of the craft near relatively shallow areas, and the water quality appeared to diminish as one approached the landing beach, indicating that the shallow water near the landing beach was the main source of the suspended solids. While temporary, these impacts should not be considered insignificant, especially if the intensity of these activities will increase. While the poor water quality observed at Jade Shoals would not likely cause the mortality of corals and other reef organisms directly, it does place upon the reef community a level of stress that would not otherwise occur but for the activity of the LCACs. Corals, for example, would have to expend additional energy removing sediment that would not otherwise occur, potentially resulting in reduced fecundity, reduced growth rates, and increased susceptibility to pathogens. Many of the reefs of Guam are subject to intense anthropogenic impacts, and as such many are in poor to fair condition. Additional impacts to corals and other reef organisms should be considered within this context, especially within the larger context of climate change and the expected impacts to reefs; the cumulative impacts of the myriad of impacts caused by human activity should be considered in this analysis. This section does not provide sufficient support for the claim that there will be no significant impacts to water quality by training activities described in this DEIS.

3.5.4. We find it hard to believe that so few residences will be impacted by the increase in aircraft events. Part of the impact analysis should include interviews with current residents in order to calibrate the models results (what the community thinks is disruptive/annoying vs. some other standard). Even if additional analysis indicates the relatively few residents will indeed be affected by airborne noise, mitigation (e.g., soundproofing their windows, A/C units, etc.) should be offered to these residents similar to the mitigation offered to residents affected by airborne noise associated with the International Airport.

3.7.3.1.8. A recent publication (Parsons et al. 2008) that was not cited in the DEIS raises concern about sonar impacts to marine mammals, particularly as a result of injuries resulting from behavioral impacts of active sonar use. Secondary, or indirect effects, such as injury or mortality sustained from disrupted behavior or physiology are not considered because consideration of secondary effects "would result in much Level A harassment being considered Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary or physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A)" and thus "considerations of secondary effects would lead to circular definitions of harassment." While admitting that secondary effects are possible, the authors of the DEIS claim that these injuries "can only be reliably predicted in circumstances where the responses have been well documented." Such an approach seems to exclude the consideration of one the main suspected mechanisms by which marine mammals could be injured – namely, through a physiological injury resulting from behavioral changes spurred by the presence of anthropogenic acoustic sources. If the end result of a cascade resulting in the reduced fitness or death of a marine mammal (behavior change-physiological injury-reduced fitness or behavior change-physiological injury-mortality), than it seems as though it should be considered Level A harassment as it is not a temporary, recoverable physiological effect. Parsons et al. (2008) claim that there is sufficient circumstantial evidence to raise serious concern about the potential for active sonar to injure marine mammals, and they raise concern over the inappropriateness of the most commonly used impact analyses in estimating potential impacts. We request that the preparers respond to these and other points raised in Parsons et al. (2008).

Reference: Parsons, E.C.M., S.J. Dolman, A.J. Wright, N.A. rose, and W.C.G. Burns. 2008. Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Marine Pollution Bulletin 56: 1248-1257.

3.7.4. We are concerned about the impact of landing craft exercises on the dolphins that reside in Agat Bay. LCAC's, for example, are very loud and have a high potential to disturb the natural behavior of the dolphin pod that resides in Agat Bay. There is also the chance of injury resulting from vessel collisions. Repeated temporary disturbances may result in long term impacts, such as abandonment of that area. The apparently high potential for disturbance/injury to cetaceans as a result of increased intensity of exercises involving amphibious vehicle suggests that there will be unavoidable impacts, a conclusion not shared by the authors of the DEIS.

3.7.3.8.3. We are also concerned about the impacts of UNDET activities on dolphins and other cetaceans. What assurances can be provided that marine mammals will not be impacted during an UNDET exercise, particularly in Agat Bay?

3.7.3.1.16. The authors of the DEIS claim that there has been no stranding of beaked whales in Marianas associated with sonar use. However, the Guam Department of Agriculture's Division of Aquatic and Wildlife Resources responded to a stranding of a live Cuvier's beaked whale on August 30, 2007, two weeks after Operation Valiant Shield was conducted between August 7-14. The animal was disoriented and appeared to have injured itself by impact with the reef, but was deemed to be in sufficient condition to be escorted to deeper water and released. While the cause(s) of the stranding cannot be determined conclusively, especially without a detailed examination of a carcass, the circumstances of the stranding are highly suspicious. A handful of marine mammal strandings have occurred on Guam in the last decade, but only in the incident associated with the Valiant Shield exercise was it known to local resource agencies that mid-frequency sonar was being used. Another suspicious stranding incident occurred on April 11, 2007, and involved a dolphin and a false killer whale stranding at approximately the same time and at separate locations on the island. It would be interesting to examine the dates of the strandings with known Navy sonar activity, especially in instances involving beaked whales. We highly recommend contacting with the Department of Agriculture for information regarding strandings, as well as other marine and terrestrial resource-related data/information that are integral to ensuring that adequate impact assessments are carried out.

3.8.3.1.3. We disagree with the conclusion that sea turtles would not be affected by landing craft training activities conducted in the MIRC. We are concerned about the direct threat to turtles by vessel collision, disturbance of natural behavior, and impacts to the nesting habitat as a result of repeated landing events. Increased compaction, erosion, and other impacts will likely result from this activity, causing the beach to become less suitable or unsuitable for turtle nesting activity. We feel that these potential impacts are not adequately addressed in the DEIS, and request that more information be provided regarding these impacts.

3.9.3.2.2. We are very concerned about the impacts of LCAC and AAV activity on coral reef habitat at Tipalao, Dadi, and areas within Apra Harbor. While the shallow benthic habitat at Tipalao does not possess a large amount of living coral, this does not mean that EFH will not be impacted. Living coral is not the only type of EFH. Impacts that alter the structure of the reef, whether covered with living coral, crustose coralline algae, turf algae, macroalgae, etc. can also be considered impacts to EFH. For example, the repeated use of AAVs in the shallow waters at Tipalao would likely alter the reef structure, possibly reducing rugosity and thus affecting its suitability to certain fish species. We also have concern about the impact of LCAC use at Dadi Beach and in the area near Dry Dock Island. As mentioned above, the resuspended sediments resulting from LCAC operation in shallow water has the potential to stress corals and associated reef life. In addition, the improper use of these craft could directly impact shallow coral reef habitat. For example, anecdotal reports from a past LCAC demonstration at Dadi Beach indicate that large coral colonies were disturbed (e.g., detached from substrate) when an LCAC was brought down in the shallow water just beyond the beach, and then raised again to bring the craft upon the beach. What measures will be implemented so that this type of impact does not occur? And what type of mitigation will occur if this impact does occur?

3.11. A major concern voiced to us by residents of Yigo is the current impact of low-flying helicopters along the cliffline in Yigo to native wildlife, particularly the Marianas fruit bat. These activities are not described in the EIS, and it is assumed they are not considered allowable activities, but yet they still occur. Who is accountable for these deviations from protocol and who does the community contact in order to address these concerns?

3.11. There appears to be a lack of a biosecurity plan to prevent introduction of invasive species and to prevent spread of species (e.g., brown tree snake) to other islands as a result of vessel/aircraft movement during training activities.

3.12.2.4.2. Andersen Air Force Base: Practice takeoffs/landings and instrument approaches, and base maintenance runup activities conducted during normal working hours (scheduled between 0600 and 2200); GCMP suggest to conduct activities during the hours of 8:00a.m. to 5:00p.m. and that the community be notified.

3.16. The section describing the impacts to Guam's economy does not adequately address the potential impacts to commercial fishing and tourist operators or to Guam's tourism economy as a whole. Even short term impacts to commercial fishing and tourism operations result in lost income. This is especially true for areas that have been identified in a recent coral reef valuation study conducted by an international team of researchers as being exceptionally valuable (e.g. Western Shoals, Gab Gab II, Blue Hole, Hap's Reef, and Double Reef). Access to sites that are already restricted when training activities are conducted will be further restricted, while sites not currently restricted may experience restrictions as a result of landing craft training or some other type of training. It is also difficult to understand how the preparers reached the conclusion that there will be no impacts or that impact will be unlikely when access to important fishing grounds such as Galvez and Santa Rosa banks and Double Reef will be restricted more frequently. Repeated incidences, and cumulative impacts of other activities, could cause substantial impact on the viability of certain commercial operations. This is especially true if repeated training activity, such as UNDET exercises or exercises involving landing craft, disturb the resident dolphin pod(s) in Agat Bay to the point of abandoning the site. These potential impacts are not recognized within the DEIS, and thus mitigation for these impacts are not addressed in any way. The claims that there will be no impacts or that impacts will be unlikely to commercial fishing, recreational and subsistence fishing, and tourism are unsubstantiated. Some suggestions are to obtain creel data from DAWR to determine how much use these areas receive and interview fishermen and commercial operators to find out how often they are restricted from important areas and how that impacts their businesses. The potential cumulative impacts of increased intensity/frequency of training activities, in combination with an overall increase in U.S. military presence on Guam, on the tourism economy should also be carried out. It seems reasonable to be concerned about the potential impacts to a tourism economy largely dependent on Japanese tourists. Was there any survey of the Japanese tourists' perceptions of the U.S. military and how an increased presence may alter their perception of Guam and perhaps change their willingness to visit the island?

3.16.2.2. The supposedly greater "ripple effect" of defense spending versus recreational spending is not a justification for displacing current recreational spending, and is unsubstantiated and is actually quite offensive. Is this statement suggesting that the displacement of recreational spending is beneficial to the economy, thus justifying any impacts to Guam's tourism sector? Do you really think that the people of Guam would rather replace a self-sustaining, locally-managed tourism industry with increased federal defense spending over which they have no control?

3.17. The Recreation section is perhaps one of the weakest sections in the MIRC EIS, and includes what could be described as a cursory analysis of potential impacts. It appears as no interviews with local agencies (e.g., Department of Parks and Recreation or the Guam Coastal Management Program) or with individual recreational users were conducted. As a result, we strongly feel that this section does not adequately address the range of potential impacts to recreational use on Guam. A few of the many examples of potential impacts to recreational users include restricted fishing access to the offshore banks occurring within area W-517, restricted access to the Double Reef and Haputo Bay areas by fishermen, divers, boaters, and other recreators, and restricted access to/disturbance of fishermen, divers, boaters, and other recreators in Apra Harbor and Agat Bay. While temporary, these impacts can be significant when they occur regularly, which is already a concern under the current training regime. While access to these areas is already restricted while training activities are underway under the current level of training, access will be further restricted if either of the action alternatives is adopted. We would also like to reiterate our concern about the inappropriateness of using the 1999 EIS to evaluate the impacts of the current level of training intensity within the present day context. The claim that there will be no significant impact to recreational use is not substantiated, and in contrast we believe that there will indeed be significant impacts to recreational users, especially when considering the cumulative impacts of other military activities.

General Comments:

Based on input provided to us by mayors, vice mayors, and other community members in Agat and Yigo, where the bulk of the training activity impacts would occur, there is concern about the lack of proper notification for a range of exercises that occur in the vicinity of residents. The mayor's office in Agat, for example, was not provided advance notice of training activities occurring off shore of their community, including insertions and extractions involving helicopters. The vice mayor was not personally alarmed by this activity, but was concerned about the potential reaction of some of the residents and the lack of respect demonstrated by the lack of advanced notification. Similar concerns were raised by the Yigo Mayor's Office, which voiced concern over low-flying helicopter activity in residential areas. Concern was also voiced over the potential impact of helicopters flying very low, and along the cliffline, producing loud noise, disturbing wildlife, and potentially harming native vegetation. Helicopter activity was also reported at night from several locations around the island. It is our understanding that training activities typically occur in daylight hours. There were several other reports of activities occurring without proper notification.

The above concern brings up a larger issue that was commented upon by several community members: who is accountable for deviations from protocol established for various training activities? Where do community members turn when they observe activities that they believe deviate from protocol and cause disruption to their quality of life or cause harm to wildlife or habitat? We have heard numerous reports of activities that appear to be against protocol, but no one – including the mayors - knew what they should do about it. Also, who is accountable in the event of an accident (e.g., plane crash) – the risk of which will increase as the frequency of aircraft events increases? Concern was also raised about the potential for debris to fall from aircraft into residential areas.

The preparers appear to treat all of area W-517 as open ocean, but offshore banks (e.g. Galvez and Santa Rosa banks) occur in this area. These banks are important to fishing and may serve as an important source of larvae for Guam's near shore reefs. Impacts of concern include vessel collision, explosive use, anchoring, and the restriction of access for fishermen.

We wish to emphasize that the Bureau does not agree with DEIS/OEIS conclusion (last paragraph page ES-30) that, "The proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or the general welfare of the public. The comments and concerns that were received from the Natural Resources agencies and the public are too important to ignore in the development of the Final EIS/OEIS.

Sincerely,

ALBERTO A. LAMORENA V
Director

cc: Guam Environmental Protection Agency
Department of Agriculture/DAWR
Department of Parks & Recreation/Historic Preservation
Department of Land Management
UOG/Guam Soil & Water Conservation

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2009-F-0345

AUG 2 1 2009

Mr. Larry M. Foster
Department of the Navy
U.S. Pacific Fleet

Subject: Initiation of Formal Consultation for the Proposed Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands

Dear Mr. Foster:

This letter acknowledges the U.S. Fish and Wildlife Service's July 22, 2009, receipt of your July 14, 2008, letter requesting initiation of formal section 7 consultation pursuant to the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended. The Mariana Islands Range Complex (MIRC) project proposes to support and conduct current and emerging training; implement research, development, testing and evaluation activities; and upgrade or modernize capabilities to enhance and sustain military training and testing in Guam, the Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, and the Republic of Palau. You have determined that implementation of the proposed project will not affect six species; may affect, but is not likely to adversely affect seven species; may affect and is likely to adversely affect one species; and will not adversely modify or destroy critical habitat units for four species (Table 1).

The early coordination between our offices and exceptional effort on the part of U.S. Navy staff has resulted in the Biological Assessment containing all the required information to initiate consultation. However, additional information and some clarification of the Biological Assessment is necessary to complete the consultation. Therefore, we request a coordination meeting as soon as possible. To facilitate this meeting, we have provided our information request in Table 2. We have assigned log number 2009-F-0345 to this consultation. Please refer to that number in future correspondence on this consultation.

Section 7 allows the Service 135 calendar days to deliver the final biological opinion (unless we mutually agree to an extension). Therefore, we expect to provide you with our final biological opinion no later than December 20, 2009.

As a reminder, the Endangered Species Act requires that after initiation of formal consultation, the Federal action agency may not make any irreversible or irretrievable commitment of resources that limits future options. This practice insures agency actions do not preclude the formulation or implementation of reasonable and prudent alternatives that avoid jeopardizing the continued existence of endangered or threatened species or destroying or modifying their critical habitats.

We appreciate the opportunity to assist you with the proposed project. If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact Holly Herod, Fish and Wildlife Biologist, at (808) 792-9400.

Sincerely,

Patrice Ashfield

for Loyal Mehrhoff
Field Supervisor

Attachments

Table 1. Endangered and threatened species on Guam and the Commonwealth of the Northern Mariana Islands that may be affected by implementation of the Mariana Islands Range Complex (NE = No Effect; NLAA = May Affect, Not Likely to Adversely Affect; NJ = May Adversely Affect, Non-Jeopardy).

Common Name	Scientific Name	Status	Navy's Determination
Plants			
Hayun Lagu	*Serianthes nelsonii*	E	NE
No common name	*Osmoxylon mariannense*	E	NE
No common name	*Nesogenes rotensis*	E	NE
Reptiles			
Green Sea Turtle	*Chelonia mydas*	T	NLAA
Hawksbill Turtle	*Eretmochelys imbricata*	E	NLAA
Birds			
Nightingale reed-warbler	*Acrocephalus luscinia*	E	NLAA
Mariana Swiftlet	*Aerodramus bartschi*	E	NLAA
Mariana Crow	*Corvus kubaryi*	E	NLAA
Mariana Common Moorhen	*Gallinula chloropus guami*	E	NLAA
Guam Micronesian Kingfisher	*Halcyon c. cinnamomina*	E	NE
Guam Rail	*Gallirallus owstoni*	E	NE
Micronesian megapode	*Megapodius laperouse*	E	NJ
Rota bridled white-eye	*Zosterops rotensis*	E	NE
Mammals			
Mariana Fruit Bat	*Pteropus mariannus*	T	NLAA
Critical Habitat Units	**Common Name**	**Size**	**Adverse Modification**
Ritidian Point, Guam	Mariana fruit bat, Mariana crow, Guam Micronesian kingfisher	152 hectares (376 acres)	NE
Rota	Mariana crow	2,594 ha (6,409 ac)	NE
Rota	Rota bridled white-eye	1,602 ha (3,958)	NE

Table 2. Items within the MIRC Biological Assessment needing additional detail or clarification.

Comment Number	Page Number	Comment
1	3	The MIRC DEIS indicates that the endangered short-tailed albatross *(Phoebastria albatrus)*, endangered Hawaiian petrel *(Pterodroma sandwichensis)*, and threatened Newell's shearwater *(Puffinus auricularis newelli)* have been detected within the action area. However, these species were not considered in section 1.2.3 (species evaluated in the BA) or section 1.2.6 (species eliminated from analysis). Because these species are protected under the ESA and are discussed within the DEIS, we request that you make an affect determination for each of these three species and provide justification to support your determination.
2	8	The BA indicates that Unai Chulu beach on Tinian requires repairs prior to use; however, beach repairs are not included within your action. If the beach will be repaired within the next 5 years (duration of EIS and BO), please provide a description of the type of repairs and how these repairs will be implemented so that we may consider the potential impacts to sea turtles. Alternatiavely, please indicate that if repairs are planned, a separate consultation will be initiated to review potential impacts of this activity to sea turtles.
3	8	The BA indicates that sniper training may occur outside the Exclusive Military Use Area, Tinian on a case-by-case basis. Please confirm that the Navy will request consultation if sniper training is planned outside of areas evaluated within the BA and the subsequent BO, if these areas provide potential habitat for ESA listed species.
4	8	The U.S. Army Reserve was interested in building a training facility and ranges on Saipan. It is our understanding their training needs would be incorporated in the MIRC (reference email exchange April 30 – May 1, 2009). We want to confirm their training needs are covered by the MIRC and no construction is planned for Saipan.
5	9, 39	The training area description for the Marpi Maneuver area is inconsistent with the description on Figure 2.3, page 14. We will analyze the impacts to species within the Marpi Maneuver area based upon Figure 2.3 instead of restricting the analysis to "cow town" to allow for maximum flexibility for military training within this area.
6	9-10	The following locations were included within the action area of the MIRC DEIS but are not listed within the BA as training areas: Kilo Warf, Clipper Channel, Toyland Beach, and Polaris Point Site III. Please let us know if these sites will be used for MIRC training. We can extract the needed site descriptions from the MIRC DEIS.
7	27-35	Each conservation measure needs an implementation timeline or timeframe.

8	27	Interdiction of brown treesnakes on Guam is a multifaceted program. We appreciate that the Navy is committed to a 100 percent inspection rate for all cargo, vessels, and outgoing aircraft. The BA did not indicate all of the interdiction actions that the Navy has previously committed to and currently implements (i.e., control of brown treesnakes occurs in areas in and around shipping sites and includes trapping, toxicant application, hand capture, and public education. Therefore, we will include these actions as a component of our analysis.
9	27	After your statement, "In addition, the Navy will route inbound personnel and cargo for tactical approach exercises that require an uninterrupted flow of events direct to CNMI training locations to avoid Guam seaports and airfields to the extent possible" we recommend you incorporate the following additional conservation measure into section 2.6.1 A bullet one: "Additionally, tactical approach exercises will involve only cargo/equipment that has not originated from areas containing a brown treesnake population or will be 100 percent inspected by certified BTS Detector Canine Programs."
10	27	In the statement above the BA indicates the tactical approach exercises...will avoid Guam to the extent possible. Please provide an example of conditions that may preclude implementation of this measure. Please describe the measures that would be implemented to maintain biosecurity in the event Guam is not avoided during tactical approach exercises.
11	27	Under conservation measure A bullet one, we suggest the following revision "The Navy, in compliance with the DoD Defense Transportation Regulations, Chapter 505 protocols, is committed to implementing 100 percent inspection of all outgoing vessels and aircraft with dog detection teams by USDA-Wildlife Services. The Navy, USFWS, USDA-Wildlife Services and CNMI DFW will evaluate training activities on a case-by-case basis to determine how best to meet 100 percent inspection goals for training activities (DoD 2008, page 3). The Service will have approval and quality-assurance authority over proposed brown treesnake interdiction activities. The Navy in cooperation with USDA -Wildlife Services and the Service will develop Standard Operating Protocols for training activities. The protocols will describe brown treesnake interdiction procedures associated with a specific activity, who is responsible for implementing the activity and who is accountable if protocols are not implemented appropriately. The Navy understands that inspection capacity limitations exist within the present USDA-WS interdiction capabilities and 100 percent inspection might not occur. In the event of military units, vehicles, and equipment leaving Guam without inspection, the Navy will notify the point of destination port or airport authorities. In addition, the Navy will route inbound personnel and cargo for tactical approach exercises that require an uninterrupted flow of events direct to CNMI training locations to avoid Guam seaports and airfields to the extent possible. For example, a Hawaii-based unit destined to Tinian for MOUT training will travel

		direct to Tinian and only pass through Guam on the outbound journey. The Navy is committed to implementing redundant inspections, where and when appropriate after discussions with appropriate stakeholders. Redundant inspections include inspections at the receiving jurisdiction for administrative and logistical movements that do not require a tactical approach to complete the training requirements. It is anticipated that redundant inspections would utilize existing quarantine and inspection protocols at receiving ports."
12	27-28	The Navy has committed to notifying points of destination if units, vehicles, or equipment leave Guam without inspections and have committed to redundant inspections at the receiving jurisdiction for administrative and logistical movements that do not require a tactical approach for training. The Navy anticipates these inspections would use existing quarantine and inspection protocols at receiving ports. Please describe the Navy's anticipated response if the receiving jurisdictions notify the Navy they are unable to provide the inspections. For example: "The Navy will provide staff, tools, and detector dogs to the receiving ports to complete these inspections."
13	28	The Navy proposes to work with USGS-BRD to develop procedures and protocols to implement rapid action for a brown treesnake sighting. We request that the Navy complete this action prior to implementing any training within the MIRC.
14	28	The Navy proposes to fund additional research by USGS to improve snake sightings in low density areas using human and canine teams. Please identify the number of years and the funding contribution that the Navy proposes to provide to USGS.
15	28	The Navy proposes to supplement and update the existing environmental education program. The BA lists a number of actions that may be included in this update. To allow for flexibility in determining the best environmental education program components, we request that the Navy agree to a modification of the conservation measure so that it describes the overall objective of the program. For example, "In addition, the Navy will supplement and update the existing environmental education program for new arrivals such that each individual is aware of the threats facing biological resources, what the individual can do to lead by example and not contribute to the threats (reduce the spread of invasive species, etc.), and what the individual is required to do to ensure threat awareness and implementation of conservation measures extends from the chain of command to the individual marine, sailor, solider, and airman."
16	29	The Navy is preparing a Regional Biosecurity Plan; however, this plan will not be complete prior to the completion of the consultation or the onset of training. Therefore, we request the following: the general framework, how activities identified in the plan will be implemented, how the plan will be funded, roles and responsibilities of all participating agencies.

17	29	In the interim between MIRC planning and the completion of a Regional Biosecurity Plan, we request that the Navy modify conservation measure 2.6.1 C. The measure should reflect that each action to be implemented under MIRC *will be* subject to an invasive species pathway analysis. This analysis will evaluate risk and define procedures that will be implemented for each action to reduce the risk of introducing or spreading invasive species. These procedures can be new but should also include existing procedures like the brown treesnake interdiction described under measure A and the self inspections of personnel and equipment under measure B. As a point of clarification, HACCP is a pathway analysis tool that helps the user prescribe implementable actions to prevent the spread or introduction of species and can be used to meet the goal of this conservation measure.
18	29	Under conservation measure D, Standard Operating Procedures related to brown treesnake interdiction are needed for activities prior to implementation of training. Please provide a description of how the Standard Operating Procedures will be produced and who will be responsible for implementation. Please also provide a template for the Standard Operating Procedures so that we may consider the template within our effects analysis. The Standard Operating Procedures should be implemented immediately using best available information and is not dependant upon the Regional Biosecurity Plan.
19	29	Under conservation measure E, please describe the procedure that would be used if a brown treesnake was sighted or captured during a training event.
20	30, 89, 106	Conservation measure 2.6.2 A. You have made an NLAA determination for the Mariana fruit bat on FDM; however, you also state on page 89 that after a natural catastrophic event, training events scheduled at FDM may adversely affect the species. Therefore, we recommend an additional conservation measure be developed and implemented to support your NLAA determination for Mariana fruit bat on FDM. For example, if a catastrophic event such as a typhoon or volcanic eruption occurs in the vicinity of the northern islands, training will be postponed until the Navy can evaluate FDM for the presence of transient fruit bats and determine they are absent.
21	30	We recommend that you revise conservation measure 2.6.2 D. so that the Micronesian megapode life history study includes the following: identification and habitat evaluation of breeding sites; observations on breeding behaviors; number of eggs laid per female; duration of egg and juvenile phases, and survival ratios for egg and juvenile phases.
22	30, 90, 106	Conservation measure 2.6.3 A. To support your NLAA determination for nightingale reed-warbler, please confirm that the intent of this measure is that each Commanding Officer will plan to use the Marpi Maneuver area during the non-peak breeding season (October through December or April through June). If plans can not accommodate the timing restriction our office will be contacted for additional avoidance and minimization measures at least 135 days prior to the planned action

		so that if avoidance and minimization are not possible, formal consultation can be initiated.
23	31	Conservation measure 2.6.4 A bullet 2. Please confirm that the intent of the management plan for Lake Hagoi and other wetlands in the MLA will be designed and implemented to benefit Mariana common moorhen and other native species.
24	31	Conservation measure 2.6.4 A bullet 3. Please ensure that program staff that will monitor sea turtle nests for hatching success have training and necessary permits.
25	31	Conservation measure 2.6.4 A bullet 4. Please identify the avoidance radius established around potential sea turtle nests.
26	32	The BA indicates that if restoration of beach topography is required, it is conducted using non-mechanized methods. Please define non-mechanized methods.
27	32, 91-92, 105	The BA indicates that Figure 2.2 (page 13) depicts areas with restrictions on cross country off-road vehicle travel and other activities which may disturb listed species or degrade habitats. Lake Hagoi is the only area depicted in this figure with training restrictions. Please confirm that the native limestone habitat (megapode and bat), Mahalang wetlands (moorhen), Bateha wetlands (moorhen), and FAA mitigation parcels will be restricted as well. Timing restrictions (i.e., only train during the dry season) may be appropriate for areas surrounding the Mahalang and Bateha wetlands.
28	32	Conservation measure 2.6.4 B indicates the only area authorized for open fires and pyrotechnics is restricted to the north Field. Please confirm that open fires and pyrotechnics are only used on paved (or non-vegetated) surfaces. Please provide us with a copy of the Standard Operating Procedures that outlines the wildfire response measures.
29	34, 94	You have made a NLAA determination for Mariana common moorhen on Guam. Conservation measure 2.6.6 B indicates that training will occur near the spillway area supporting moorhens. During our meetings we discussed that the overflight restrictions and use of the deeper areas of the reservoir versus the shallow areas could disturb the moorhens, but it is highly unlikely this disturbance would result in take. You propose to monitor for significant behavioral changes to fully document that the actions do not result in take. However, if only significant behavioral changes are noted, you may not detect behavioral changes that constitute take. Therefore, to ensure compliance with the ESA and for clarification purposes, the conservation measure should be revised to read "The Navy will monitor behavior of any moorhens during the first three training exercises. If any behavioral changes are detected that could lead to take (i.e., changes that suggest a bird may interrupt foraging, breeding, or nesting behaviors) the Navy action will cease pending additional section 7 consultation."

30	35	Conservation measure 2.6.6 D. The overflight restrictions in the Naval Munitions site (see 2.6.6 A) should minimize impacts to the Mariana swiftlet and further support your NLAA determination for this species. Therefore, we will consider this measure in our analysis for swiftlets.
31	36, 105	Conservation measure 2.6.6 E. We recommend that this conservation measure be revised to state " Potential nesting habitats (palustrine emergent wetlands) are dispersed throughout the SLNA and NLNA. No maneuver and navigation training will occur in areas supporting these habitats to further avoid impacts to the Mariana common moorhen."
32	36	Conservation measure 2.6.6 F. We recommend that this conservation measure be revised to include that the Navy will implement the fire management plan for the Naval Munitions Site and other Navy lands on Guam. Please provide our office with a copy of the Fire Management Plan cited in this measure.
33	36	Sea turtles (both green and hawksbills) are known to nest on Guam. The Navy implements many conservation measures to avoid or minimize impacts to sea turtles on Guam; however, these measures are not included within section 2.6.6. (except under Amphibious landing restrictions focusing on Sumay Cove). Please provide a list of the all the conservation measures the Navy uses on Guam to support your determination of NLAA.
34	44, 106	Mariana fruit bat incidental take limits authorized by the ISR Strike are being approached. We have new information that suggests the colony may not have declined in number on Guam, but is possibly shifting its location. To ensure take is not exceeded we recommend that an additional conservation measure be added to provide for additional monitoring to determine if the colony is shifting.
35	79-80	The BA adequately depicts the Guam National Wildlife Refuge Overlay; however, an analysis of potential impacts and an effect determination was not provided in the BA. Under the Cooperative Agreement between the Navy and the Service, and the Air Force and the Service, any project that may impact endangered or threatened species habitat within the Guam National Wildlife Refuge Overlay (even if the species is not present) must be reviewed under section 7. We request that you make an affect determination regarding training impacts to habitat within the Guam National Wildlife Refuge Overlay.
36	90	Section 5.2.2 Saipan, the BA indicates that resident moorhens and fruit bats may be extirpated on Saipan and bases the impact determination for these two species upon this assumption. Saipan supports a number of resident moorhens and fruit bats; therefore, a determination based upon extirpation on the island is inaccurate. The determination should be based upon the likelihood of the species using the action area.
37	91	Please confirm that the information regarding decisions made in the Operation Tandem Thrust consultation is provided for informational purposes only and that Operation Tandem Thrust is not proposed for MIRC.

38	93	The clearing of strand vegetation in areas currently used by sea turtles would represent an impact to the species even if the areas were evaluated in the 1999 consultation. Please describe if nesting has occurred within the last ten years at beaches that were evaluated in 1999.
39	98	Cumulative Effects. On Saipan the Marpi Maneuver area has also been proposed for agricultural farm plots. These may or may not receive the benefit of section 7 consultation. Additional harvest of tangantangan for charcoal likely occurs within this area.
40	104-105	Chapter 6.3 lists the species for which you made a NLAA determination and provides supporting justification. For the green sea turtle, you indicate that no additional take is needed because take had been authorized at Sumay Cove in previous consultations. However, no take was previously authorized for green sea turtles at Sumay Cove. Instead this take was previously authorized for hawksbill sea turtles. In addition you mention that the previous take is sufficient to account for increased operations at Sumay. For this consultation you have made an NLAA determination for sea turtles; therefore, no take of adult sea turtles or their nests, eggs, or hatchlings will be authorized or allowed for actions implemented under MIRC. Any previous take authorizations from prior biological opinions will be superseded by this consultation.
41	105	As a point of clarification you indicated that the ISR Strike biological opinion determined that the action would not adversely affect the Mariana crow. Instead the biological opinion determined that the action would not jeopardize the survival and recovery of the Mariana crow.
42	105	To fully support your determination of NLAA for Mariana common moorhen, we recommend the inclusion of additional conservation measures as described above (comment 23 and 27).
43	106	To fully support your NLAA determination for Mariana fruit bat we recommend that you incorporate additional conservation measures as described above (comment 16). MIRC will not increase activities beyond those analyzed for the ISR Strike. If an increase is planned, the Navy should coordinate with our office to determine if the conservation measures and amount of take authorized by the ISR Strike is still appropriate.
44	107	The Navy does not expect take of megapodes on Tinian; however, the BA does not specifically mention that the limestone habitat will be avoided during training. We recommend adding limestone forest avoidance as a conservation measure as described above (comment 24).

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2009-F-0345

AUG 2 1 2009

Mr. Larry M. Foster
Department of the Navy
U.S. Pacific Fleet

Subject: Initiation of Formal Consultation for the Proposed Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands

Dear Mr. Foster:

This letter acknowledges the U.S. Fish and Wildlife Service's July 22, 2009, receipt of your July 14, 2008, letter requesting initiation of formal section 7 consultation pursuant to the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended. The Mariana Islands Range Complex (MIRC) project proposes to support and conduct current and emerging training; implement research, development, testing and evaluation activities; and upgrade or modernize capabilities to enhance and sustain military training and testing in Guam, the Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, and the Republic of Palau. You have determined that implementation of the proposed project will not affect six species; may affect, but is not likely to adversely affect seven species; may affect and is likely to adversely affect one species; and will not adversely modify or destroy critical habitat units for four species (Table 1).

The early coordination between our offices and exceptional effort on the part of U.S. Navy staff has resulted in the Biological Assessment containing all the required information to initiate consultation. However, additional information and some clarification of the Biological Assessment is necessary to complete the consultation. Therefore, we request a coordination meeting as soon as possible. To facilitate this meeting, we have provided our information request in Table 2. We have assigned log number 2009-F-0345 to this consultation. Please refer to that number in future correspondence on this consultation.

Section 7 allows the Service 135 calendar days to deliver the final biological opinion (unless we mutually agree to an extension). Therefore, we expect to provide you with our final biological opinion no later than December 20, 2009.

As a reminder, the Endangered Species Act requires that after initiation of formal consultation, the Federal action agency may not make any irreversible or irretrievable commitment of resources that limits future options. This practice insures agency actions do not preclude the formulation or implementation of reasonable and prudent alternatives that avoid jeopardizing the continued existence of endangered or threatened species or destroying or modifying their critical habitats.

We appreciate the opportunity to assist you with the proposed project. If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact Holly Herod, Fish and Wildlife Biologist, at (808) 792-9400.

Sincerely,

Patrice Ashfield

for Loyal Mehrhoff
Field Supervisor

Attachments

Table 1. Endangered and threatened species on Guam and the Commonwealth of the Northern Mariana Islands that may be affected by implementation of the Mariana Islands Range Complex (NE = No Effect; NLAA = May Affect, Not Likely to Adversely Affect; NJ = May Adversely Affect, Non-Jeopardy).

Common Name	Scientific Name	Status	Navy's Determination
Plants			
Hayun Lagu	*Serianthes nelsonii*	E	NE
No common name	*Osmoxylon mariannense*	E	NE
No common name	*Nesogenes rotensis*	E	NE
Reptiles			
Green Sea Turtle	*Chelonia mydas*	T	NLAA
Hawksbill Turtle	*Eretmochelys imbricata*	E	NLAA
Birds			
Nightingale reed-warbler	*Acrocephalus luscinia*	E	NLAA
Mariana Swiftlet	*Aerodramus bartschi*	E	NLAA
Mariana Crow	*Corvus kubaryi*	E	NLAA
Mariana Common Moorhen	*Gallinula chloropus guami*	E	NLAA
Guam Micronesian Kingfisher	*Halcyon c. cinnamomina*	E	NE
Guam Rail	*Gallirallus owstoni*	E	NE
Micronesian megapode	*Megapodius laperouse*	E	NJ
Rota bridled white-eye	*Zosterops rotensis*	E	NE
Mammals			
Mariana Fruit Bat	*Pteropus mariannus*	T	NLAA
Critical Habitat Units	**Common Name**	**Size**	**Adverse Modification**
Ritidian Point, Guam	Mariana fruit bat, Mariana crow, Guam Micronesian kingfisher	152 hectares (376 acres)	NE
Rota	Mariana crow	2,594 ha (6,409 ac)	NE
Rota	Rota bridled white-eye	1,602 ha (3,958)	NE

Table 2. Items within the MIRC Biological Assessment needing additional detail or clarification.

Comment Number	Page Number	Comment
1	3	The MIRC DEIS indicates that the endangered short-tailed albatross *(Phoebastria albatrus)*, endangered Hawaiian petrel *(Pterodroma sandwichensis)*, and threatened Newell's shearwater *(Puffinus auricularis newelli)* have been detected within the action area. However, these species were not considered in section 1.2.3 (species evaluated in the BA) or section 1.2.6 (species eliminated from analysis). Because these species are protected under the ESA and are discussed within the DEIS, we request that you make an affect determination for each of these three species and provide justification to support your determination.
2	8	The BA indicates that Unai Chulu beach on Tinian requires repairs prior to use; however, beach repairs are not included within your action. If the beach will be repaired within the next 5 years (duration of EIS and BO), please provide a description of the type of repairs and how these repairs will be implemented so that we may consider the potential impacts to sea turtles. Alternatiavely, please indicate that if repairs are planned, a separate consultation will be initiated to review potential impacts of this activity to sea turtles.
3	8	The BA indicates that sniper training may occur outside the Exclusive Military Use Area, Tinian on a case-by-case basis. Please confirm that the Navy will request consultation if sniper training is planned outside of areas evaluated within the BA and the subsequent BO, if these areas provide potential habitat for ESA listed species.
4	8	The U.S. Army Reserve was interested in building a training facility and ranges on Saipan. It is our understanding their training needs would be incorporated in the MIRC (reference email exchange April 30 – May 1, 2009). We want to confirm their training needs are covered by the MIRC and no construction is planned for Saipan.
5	9, 39	The training area description for the Marpi Maneuver area is inconsistent with the description on Figure 2.3, page 14. We will analyze the impacts to species within the Marpi Maneuver area based upon Figure 2.3 instead of restricting the analysis to "cow town" to allow for maximum flexibility for military training within this area.
6	9-10	The following locations were included within the action area of the MIRC DEIS but are not listed within the BA as training areas: Kilo Warf, Clipper Channel, Toyland Beach, and Polaris Point Site III. Please let us know if these sites will be used for MIRC training. We can extract the needed site descriptions from the MIRC DEIS.
7	27-35	Each conservation measure needs an implementation timeline or timeframe.

8	27	Interdiction of brown treesnakes on Guam is a multifaceted program. We appreciate that the Navy is committed to a 100 percent inspection rate for all cargo, vessels, and outgoing aircraft. The BA did not indicate all of the interdiction actions that the Navy has previously committed to and currently implements (i.e., control of brown treesnakes occurs in areas in and around shipping sites and includes trapping, toxicant application, hand capture, and public education. Therefore, we will include these actions as a component of our analysis.
9	27	After your statement, "In addition, the Navy will route inbound personnel and cargo for tactical approach exercises that require an uninterrupted flow of events direct to CNMI training locations to avoid Guam seaports and airfields to the extent possible" we recommend you incorporate the following additional conservation measure into section 2.6.1 A bullet one: "Additionally, tactical approach exercises will involve only cargo/equipment that has not originated from areas containing a brown treesnake population or will be 100 percent inspected by certified BTS Detector Canine Programs."
10	27	In the statement above the BA indicates the tactical approach exercises…will avoid Guam to the extent possible. Please provide an example of conditions that may preclude implementation of this measure. Please describe the measures that would be implemented to maintain biosecurity in the event Guam is not avoided during tactical approach exercises.
11	27	Under conservation measure A bullet one, we suggest the following revision "The Navy, in compliance with the DoD Defense Transportation Regulations, Chapter 505 protocols, is committed to implementing 100 percent inspection of all outgoing vessels and aircraft with dog detection teams by USDA-Wildlife Services. The Navy, USFWS, USDA-Wildlife Services and CNMI DFW will evaluate training activities on a case-by-case basis to determine how best to meet 100 percent inspection goals for training activities (DoD 2008, page 3). The Service will have approval and quality-assurance authority over proposed brown treesnake interdiction activities. The Navy in cooperation with USDA -Wildlife Services and the Service will develop Standard Operating Protocols for training activities. The protocols will describe brown treesnake interdiction procedures associated with a specific activity, who is responsible for implementing the activity and who is accountable if protocols are not implemented appropriately. The Navy understands that inspection capacity limitations exist within the present USDA-WS interdiction capabilities and 100 percent inspection might not occur. In the event of military units, vehicles, and equipment leaving Guam without inspection, the Navy will notify the point of destination port or airport authorities. In addition, the Navy will route inbound personnel and cargo for tactical approach exercises that require an uninterrupted flow of events direct to CNMI training locations to avoid Guam seaports and airfields to the extent possible. For example, a Hawaii-based unit destined to Tinian for MOUT training will travel

		direct to Tinian and only pass through Guam on the outbound journey. The Navy is committed to implementing redundant inspections, where and when appropriate after discussions with appropriate stakeholders. Redundant inspections include inspections at the receiving jurisdiction for administrative and logistical movements that do not require a tactical approach to complete the training requirements. It is anticipated that redundant inspections would utilize existing quarantine and inspection protocols at receiving ports."
12	27-28	The Navy has committed to notifying points of destination if units, vehicles, or equipment leave Guam without inspections and have committed to redundant inspections at the receiving jurisdiction for administrative and logistical movements that do not require a tactical approach for training. The Navy anticipates these inspections would use existing quarantine and inspection protocols at receiving ports. Please describe the Navy's anticipated response if the receiving jurisdictions notify the Navy they are unable to provide the inspections. For example: "The Navy will provide staff, tools, and detector dogs to the receiving ports to complete these inspections."
13	28	The Navy proposes to work with USGS-BRD to develop procedures and protocols to implement rapid action for a brown treesnake sighting. We request that the Navy complete this action prior to implementing any training within the MIRC.
14	28	The Navy proposes to fund additional research by USGS to improve snake sightings in low density areas using human and canine teams. Please identify the number of years and the funding contribution that the Navy proposes to provide to USGS.
15	28	The Navy proposes to supplement and update the existing environmental education program. The BA lists a number of actions that may be included in this update. To allow for flexibility in determining the best environmental education program components, we request that the Navy agree to a modification of the conservation measure so that it describes the overall objective of the program. For example, "In addition, the Navy will supplement and update the existing environmental education program for new arrivals such that each individual is aware of the threats facing biological resources, what the individual can do to lead by example and not contribute to the threats (reduce the spread of invasive species, etc.), and what the individual is required to do to ensure threat awareness and implementation of conservation measures extends from the chain of command to the individual marine, sailor, solider, and airman."
16	29	The Navy is preparing a Regional Biosecurity Plan; however, this plan will not be complete prior to the completion of the consultation or the onset of training. Therefore, we request the following: the general framework, how activities identified in the plan will be implemented, how the plan will be funded, roles and responsibilities of all participating agencies.

17	29	In the interim between MIRC planning and the completion of a Regional Biosecurity Plan, we request that the Navy modify conservation measure 2.6.1 C. The measure should reflect that each action to be implemented under MIRC *will be* subject to an invasive species pathway analysis. This analysis will evaluate risk and define procedures that will be implemented for each action to reduce the risk of introducing or spreading invasive species. These procedures can be new but should also include existing procedures like the brown treesnake interdiction described under measure A and the self inspections of personnel and equipment under measure B. As a point of clarification, HACCP is a pathway analysis tool that helps the user prescribe implementable actions to prevent the spread or introduction of species and can be used to meet the goal of this conservation measure.
18	29	Under conservation measure D, Standard Operating Procedures related to brown treesnake interdiction are needed for activities prior to implementation of training. Please provide a description of how the Standard Operating Procedures will be produced and who will be responsible for implementation. Please also provide a template for the Standard Operating Procedures so that we may consider the template within our effects analysis. The Standard Operating Procedures should be implemented immediately using best available information and is not dependant upon the Regional Biosecurity Plan.
19	29	Under conservation measure E, please describe the procedure that would be used if a brown treesnake was sighted or captured during a training event.
20	30, 89, 106	Conservation measure 2.6.2 A. You have made an NLAA determination for the Mariana fruit bat on FDM; however, you also state on page 89 that after a natural catastrophic event, training events scheduled at FDM may adversely affect the species. Therefore, we recommend an additional conservation measure be developed and implemented to support your NLAA determination for Mariana fruit bat on FDM. For example, if a catastrophic event such as a typhoon or volcanic eruption occurs in the vicinity of the northern islands, training will be postponed until the Navy can evaluate FDM for the presence of transient fruit bats and determine they are absent.
21	30	We recommend that you revise conservation measure 2.6.2 D. so that the Micronesian megapode life history study includes the following: identification and habitat evaluation of breeding sites; observations on breeding behaviors; number of eggs laid per female; duration of egg and juvenile phases, and survival ratios for egg and juvenile phases.
22	30, 90, 106	Conservation measure 2.6.3 A. To support your NLAA determination for nightingale reed-warbler, please confirm that the intent of this measure is that each Commanding Officer will plan to use the Marpi Maneuver area during the non-peak breeding season (October through December or April through June). If plans can not accommodate the timing restriction our office will be contacted for additional avoidance and minimization measures at least 135 days prior to the planned action

		so that if avoidance and minimization are not possible, formal consultation can be initiated.
23	31	Conservation measure 2.6.4 A bullet 2. Please confirm that the intent of the management plan for Lake Hagoi and other wetlands in the MLA will be designed and implemented to benefit Mariana common moorhen and other native species.
24	31	Conservation measure 2.6.4 A bullet 3. Please ensure that program staff that will monitor sea turtle nests for hatching success have training and necessary permits.
25	31	Conservation measure 2.6.4 A bullet 4. Please identify the avoidance radius established around potential sea turtle nests.
26	32	The BA indicates that if restoration of beach topography is required, it is conducted using non-mechanized methods. Please define non-mechanized methods.
27	32, 91-92, 105	The BA indicates that Figure 2.2 (page 13) depicts areas with restrictions on cross country off-road vehicle travel and other activities which may disturb listed species or degrade habitats. Lake Hagoi is the only area depicted in this figure with training restrictions. Please confirm that the native limestone habitat (megapode and bat), Mahalang wetlands (moorhen), Bateha wetlands (moorhen), and FAA mitigation parcels will be restricted as well. Timing restrictions (i.e., only train during the dry season) may be appropriate for areas surrounding the Mahalang and Bateha wetlands.
28	32	Conservation measure 2.6.4 B indicates the only area authorized for open fires and pyrotechnics is restricted to the north Field. Please confirm that open fires and pyrotechnics are only used on paved (or non-vegetated) surfaces. Please provide us with a copy of the Standard Operating Procedures that outlines the wildfire response measures.
29	34, 94	You have made a NLAA determination for Mariana common moorhen on Guam. Conservation measure 2.6.6 B indicates that training will occur near the spillway area supporting moorhens. During our meetings we discussed that the overflight restrictions and use of the deeper areas of the reservoir versus the shallow areas could disturb the moorhens, but it is highly unlikely this disturbance would result in take. You propose to monitor for significant behavioral changes to fully document that the actions do not result in take. However, if only significant behavioral changes are noted, you may not detect behavioral changes that constitute take. Therefore, to ensure compliance with the ESA and for clarification purposes, the conservation measure should be revised to read "The Navy will monitor behavior of any moorhens during the first three training exercises. If any behavioral changes are detected that could lead to take (i.e., changes that suggest a bird may interrupt foraging, breeding, or nesting behaviors) the Navy action will cease pending additional section 7 consultation."

30	35	Conservation measure 2.6.6 D. The overflight restrictions in the Naval Munitions site (see 2.6.6 A) should minimize impacts to the Mariana swiftlet and further support your NLAA determination for this species. Therefore, we will consider this measure in our analysis for swiftlets.
31	36, 105	Conservation measure 2.6.6 E. We recommend that this conservation measure be revised to state " Potential nesting habitats (palustrine emergent wetlands) are dispersed throughout the SLNA and NLNA. No maneuver and navigation training will occur in areas supporting these habitats to further avoid impacts to the Mariana common moorhen."
32	36	Conservation measure 2.6.6 F. We recommend that this conservation measure be revised to include that the Navy will implement the fire management plan for the Naval Munitions Site and other Navy lands on Guam. Please provide our office with a copy of the Fire Management Plan cited in this measure.
33	36	Sea turtles (both green and hawksbills) are known to nest on Guam. The Navy implements many conservation measures to avoid or minimize impacts to sea turtles on Guam; however, these measures are not included within section 2.6.6. (except under Amphibious landing restrictions focusing on Sumay Cove). Please provide a list of the all the conservation measures the Navy uses on Guam to support your determination of NLAA.
34	44, 106	Mariana fruit bat incidental take limits authorized by the ISR Strike are being approached. We have new information that suggests the colony may not have declined in number on Guam, but is possibly shifting its location. To ensure take is not exceeded we recommend that an additional conservation measure be added to provide for additional monitoring to determine if the colony is shifting.
35	79-80	The BA adequately depicts the Guam National Wildlife Refuge Overlay; however, an analysis of potential impacts and an effect determination was not provided in the BA. Under the Cooperative Agreement between the Navy and the Service, and the Air Force and the Service, any project that may impact endangered or threatened species habitat within the Guam National Wildlife Refuge Overlay (even if the species is not present) must be reviewed under section 7. We request that you make an affect determination regarding training impacts to habitat within the Guam National Wildlife Refuge Overlay.
36	90	Section 5.2.2 Saipan, the BA indicates that resident moorhens and fruit bats may be extirpated on Saipan and bases the impact determination for these two species upon this assumption. Saipan supports a number of resident moorhens and fruit bats; therefore, a determination based upon extirpation on the island is inaccurate. The determination should be based upon the likelihood of the species using the action area.
37	91	Please confirm that the information regarding decisions made in the Operation Tandem Thrust consultation is provided for informational purposes only and that Operation Tandem Thrust is not proposed for MIRC.

38	93	The clearing of strand vegetation in areas currently used by sea turtles would represent an impact to the species even if the areas were evaluated in the 1999 consultation. Please describe if nesting has occurred within the last ten years at beaches that were evaluated in 1999.
39	98	Cumulative Effects. On Saipan the Marpi Maneuver area has also been proposed for agricultural farm plots. These may or may not receive the benefit of section 7 consultation. Additional harvest of tangantangan for charcoal likely occurs within this area.
40	104-105	Chapter 6.3 lists the species for which you made a NLAA determination and provides supporting justification. For the green sea turtle, you indicate that no additional take is needed because take had been authorized at Sumay Cove in previous consultations. However, no take was previously authorized for green sea turtles at Sumay Cove. Instead this take was previously authorized for hawksbill sea turtles. In addition you mention that the previous take is sufficient to account for increased operations at Sumay. For this consultation you have made an NLAA determination for sea turtles; therefore, no take of adult sea turtles or their nests, eggs, or hatchlings will be authorized or allowed for actions implemented under MIRC. Any previous take authorizations from prior biological opinions will be superseded by this consultation.
41	105	As a point of clarification you indicated that the ISR Strike biological opinion determined that the action would not adversely affect the Mariana crow. Instead the biological opinion determined that the action would not jeopardize the survival and recovery of the Mariana crow.
42	105	To fully support your determination of NLAA for Mariana common moorhen, we recommend the inclusion of additional conservation measures as described above (comment 23 and 27).
43	106	To fully support your NLAA determination for Mariana fruit bat we recommend that you incorporate additional conservation measures as described above (comment 16). MIRC will not increase activities beyond those analyzed for the ISR Strike. If an increase is planned, the Navy should coordinate with our office to determine if the conservation measures and amount of take authorized by the ISR Strike is still appropriate.
44	107	The Navy does not expect take of megapodes on Tinian; however, the BA does not specifically mention that the limestone habitat will be avoided during training. We recommend adding limestone forest avoidance as a conservation measure as described above (comment 24).

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, Hawaii 96814-4700
(808) 944-2200 • Fax: (808) 973-2941

September 2, 2009

Ms. Nora Macariola-See
Project Manager, CodeEV21
Naval Facilities Engineering Command, Pacific
[illegible]
[illegible]

Dear Ms. Macariola-See:

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service Pacific Islands Regional Office (NMFS) Habitat Conservation Division has reviewed the "Essential Fish Habitat and Coral Reef Assessment for the Mariana Islands Range Complex (MIRC) EIS/OEIS" prepared in May 2009. The document and supporting EIS describe various activities and potential impacts associated with Navy's Marina Islands Offshore Areas. The preferred alternative includes provisions for current training, increased training supported by modernization and upgrades/modifications to existing capabilities, training associated with ISR/strike, and multi-national and/or joint exercises.

NMFS Habitat Conservation Division conducted this review in accordance with the Fish and Wildlife Coordination Act (16 U.S.C. § 662(a)), the Magnuson-Stevens Fishery Conservation and Management Act (MSA), (16 U.S.C. § 1855(b)(2)), Coral Reef Executive Order 13089 and the National Environmental Policy Act. Since this project involves essential fish habitat (EFH), the process is guided by the requirements of our EFH regulations (50 C.F.R. §§ 600.905 - 930), which mandate the preparation of EFH Assessments and generally outline each agency's obligations in this consultation procedure.

FISH AND WILDLIFE COORDINATION ACT /Executive Order 13089

Background. The purpose of the Fish and Wildlife Coordination Act (FWCA) is to ensure that wildlife conservation receives equal consideration and is coordinated with other aspects of water resources development. *See* 16 U.S.C. 661. The FWCA establishes a consultation requirement for federal departments and agencies that undertake any action that proposes to modify any stream or other body of water for any purpose, including navigation and drainage. *See* 16 U.S.C. 662(a). Consistent with this consultation requirement, NMFS provides recommendations and comments to federal action agencies for the purpose of conserving fish and wildlife resources.

Under Executive Order 13089 all federal agencies are obliged to the extent permitted by law to ensure that any actions they authorize, fund, or carry out will not degrade the conditions of U.S. coral reef ecosystems.

Coral reefs are considered special aquatic sites and are afforded protection under a variety of federal statutes. Any adverse impact to these sites must be avoided and minimized to the extent practicable. If impacts can not be avoided, we recommend that a mitigation plan be prepared that compensates for the loss of these resources.

Magnuson-Stevens Fishery Conservation and Management Act

Background. Pursuant to the MSA, the Secretary of Commerce, through NMFS, is responsible for the conservation and management of fishery resources found off the coasts of the United States. *See* 16 U.S.C. 1801 *et seq.* Section 1855(b)(2) of the MSA requires federal agencies to consult with NMFS, with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act." The statute defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity." 16 U.S.C. 1802(10). Adverse effects on EFH are defined further as "any impact that reduces the quality and/or quantity of EFH," and may include "site-specific or habitat-wide impacts, including individual, cumulative or synergistic consequences of actions." 50 C.F.R. § 600.810(a). The consultation process allows NMFS to make a determination of the project's effects on EFH and provide Conservation Recommendations to the lead agency on actions that would adversely affect such habitat. *See* 16 U.S.C. 1855(b)(4)(A).

Essential Fish Habitat

The proposed project site is located in an area that has been identified as essential fish habitat under the following Western Pacific Regional Fishery Management Council (WPRFMC) Fishery Management Plans (FMPs): Pelagics (eggs, larvae, juveniles, adults), Bottomfish (eggs, larvae, juveniles, adults), Crustaceans (eggs, larvae, juveniles, and adults), and Coral Reef Ecosystem (eggs, larvae, juveniles and adults). Potential impacts as a result of this project include direct physical impacts to corals from amphibious landing operations, impacts from turbidity generated by various ship maneuvers and weapons testing, impacts to biota from ingestion or exposure to hazardous materials, and direct physical impacts from "shock waves".

Proposed avoidance/mitigation measures to minimize impacts to EFH include conducting operations in open ocean away from sensitive EFH, avoiding areas of live coral during inshore operations, and restricting amphibious landing to specific areas of designated beaches.

EFH Conservations Recommendations

Pursuant to section 305(b)(4)(A) of the MSA, we recommend that the following measures be implemented to avoid, minimize and mitigate impacts to EFH:

1.) We recommend that further analysis of the impacts of amphibious landings and over the beach insertions/extractions be undertaken. Due to the increased frequency of these events, the impacts are likely to be additive and cumulative in nature. Physical impacts to coral reef habitat will likely be exacerbated by other local anthropogenic impacts. The cumulative impacts of sedimentation caused by landing activities in the harbor in addition to foreseeable development should also be addressed. The Dadi nearshore sandy area (60 to 300 ft depth) beyond the reef margin area is known for garden eels, stingrays and dolphins.
2.) Additional avoidance measures and possibly compensatory mitigation may be required based on this information. Base-line surveys for shallow water detonation site at Tipalao Beach and amphibious landing sites in Tipalao and Dadi Beaches described in the EFH Assessment should be conducted on a scale to accurately characterize the resources. Satellite derived benthic habitat maps are not suitable for the level of detail required. We recommend that charge sizes be limited and appropriately shielded when possible. Detonations should be coordinated with local resource agencies to conduct post detonation inspections.
3.) Recommended avoidance measures for amphibious landings and insertion/extractions (in addition to the sea turtle nesting beach avoidance measures recommended in USFWS B.O. 1-2-98-F-07:
    a. Amphibious landings will occur at high tide to minimize damage to shallow reef habitat.
    b. Amphibious landings will be constrained to specific approaches at each site to minimize impacts. This includes avoiding off-site patch reefs and shoals less than 10ft deep during ingress and regress.
    c. AAV landings will be restricted to an established approach lane and allowed to land only in single file.
    d. LCAC will remain on full cushion until they reach the beach.
    e. Surveys should be conducted before and after each landing and a suitable control site should also be monitored. Surveyors will record coral size frequency data, physical impact to corals, turbidity, fish assemblage and sedimentation rates and topography of each site.
4.) The placement of PUTR transponders in sensitive or coral reef habitat should be avoided This includes Galvez Bank and Santa Rosa Reef, as well as known seamounts and hydrothermal vents that may support deep sea communities.
5.) Due to the increase in hazardous materials being expended, particularly in the W-517 range area, we recommend a risk assessment be conducted to examine the potential for bioaccumulation of heavy metals and other hazardous materials, particularly in food webs supporting fishery management species.
6.) The information provided for the SINKEX is insufficient to evaluate impacts to EFH. This activity has the potential to result in a significant impact to benthic habitat and associated water column due to the size of the vessel, the large amount of weaponry expected to be used in the exercise and the frequency of the exercise. Further analysis will be required to ensure that impacts to EFH are minimized to the extent practicable.

Please be advised that regulations (Section 305(b)(4)(B) of the MSA) to implement the EFH provisions of the MSA require that Federal action agencies provide a written response to this letter within 30 days of its receipt and at least 10 days prior to final approval of the action. A preliminary response is acceptable if final action cannot be completed within 30 days. Their final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If their response is inconsistent with our EFH Conservation Recommendations, they must provide and explanation of the reason for not implementing those recommendations.

Individual actions covered under the EIS may require permitting from the U.S. Army Corps of Engineers. We reserve the right to provide additional comments or conservation recommendations during the Corps permit review process.

NMFS appreciates the opportunity to comment on this project. If you have any questions regarding this determination, contact Mr. Alan Everson at (808) 944-2212 (alan.everson@noaa.gov) in Honolulu or Ms. Val Brown at (671) 735-4032 valerie.brown@noaa.gov in Guam.

Sincerely,

William Robinson
Regional Administrator

Copies Furnished:

Western Pacific Fishery Management Council, 1164 Bishop Street, Suite 1400, Honolulu, HI 96813
U.S. Fish and Wildlife Service, Environmental Services, P.O. Box 50088, Honolulu, HI 96850
U.S. Army Corps of Engineers, Guam Regulatory Branch, PCS 455, Box 188, FPO AP 96540-1088
Guam Environmental Protection Agency, P.O. Box 22439 GMF, Barrigada, Guam 96921
Guam Division of Aquatic and Wildlife Resources, Department of Agriculture, 192 Dairy Road, Mangilao, Guam 96923
Guam Bureau of Planning, Coastal Management Program, P.O. Box 2950, Hagatna, Guam 96932

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2009-F-0345

FEB 2 2 2010

Mr. Larry M. Foster
Department of the Navy
U.S. Pacific Fleet

Subject: Biological Opinion for the Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands 2010-2015

Dear Mr. Foster:

This letter is in response to your July 17, 2009, request for formal consultation for the proposed Mariana Islands Range Complex (MIRC), Territory of Guam and Rota, Tinian, Saipan, and Farallon de Medinilla, Commonwealth of the Northern Mariana Islands (CNMI) (proposed project). The U.S. Navy (USN) is serving as the lead Federal agency for the implementation of the Department of Defense (DoD) military readiness training, increases in training, and infrastructure repairs and improvements to facilitate training associated with MIRC. We received your letter on July 22, 2009. At issue are the potential effects of the proposed project on multiple listed species, critical habitat units, and essential habitat occurring on Guam, Rota, Tinian, Saipan, and Farallon de Medinilla (Table 1; Figure 1). We have reviewed and provided a summary of our concurrence with the determinations made by the USN within this biological opinion. Essential habitat for several listed species is also present on Guam. Per the requirements identified in the Cooperative Agreement between the USAF, USN, and the U.S. Fish and Wildlife Service (USFWS) for the establishment and management of the Guam National Wildlife Refuge (USAF and USFWS 1994, p. 6; USN and USFWS 1994, p. 6), we have provided coordination regarding potential impacts to essential habitat from the proposed project. The findings and recommendations in this consultation are based on: (1) numerous email exchanges, phone calls and meetings with staff from your office; (2) the Draft Environmental Impact Statement for the MIRC dated January 2009 (USN 2009a, 1,444 pp.); (3) the biological assessment for the MIRC dated July 2009 (USN 2009b, 120 pp.); and (4) other information available to us. A complete administrative record is on file in our office. This response is in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*).

Table 1. Endangered and threatened species on Guam and the Commonwealth of the Northern Mariana Islands that may be affected by implementation of the Mariana Islands Range Complex (NE = No Effect; NLAA = May Affect, Not Likely to Adversely Affect; NJ = May Adversely Affect, Non-Jeopardy).

Common Name	Scientific Name	Status	USN ESA Determination
Plants			
Hayun Lagu	*Serianthes nelsonii*	E	NE
No common name	*Osmoxylon mariannense*	E	NE
No common name	*Nesogenes rotensis*	E	NE
Reptiles			
Green Sea Turtle	*Chelonia mydas*	T	NLAA
Hawksbill Turtle	*Eretmochelys imbricata*	E	NLAA
Birds			
Nightingale reed-warbler	*Acrocephalus luscinia*	E	NLAA
Mariana Swiftlet	*Aerodramus bartschi*	E	NLAA
Mariana Crow	*Corvus kubaryi*	E	NJ
Mariana Common Moorhen	*Gallinula chloropus guami*	E	NLAA
Guam Micronesian Kingfisher	*Todirhamphus c. cinnamominus*	E	NE
Guam Rail	*Gallirallus owstoni*	E	NE
Micronesian megapode	*Megapodius laperouse*	E	NJ
Short-tailed albatross	*Phoebastria albatrus*	E	NE
Hawaiian petrel	*Pterodroma sandwichensis*	E	NE
Newell's Shearwater	*Puffinus auricularis newelli*	T	NE
Rota bridled white-eye	*Zosterops rotensis*	E	NE
Mammals			
Mariana Fruit Bat	*Pteropus mariannus*	T	NJ
Critical Habitat Units	**Common Name**	**Size**	**USN ESA Determination**
Guam National Wildlife Refuge Ritidian Point Unit, Guam	Mariana fruit bat, Mariana crow, Guam Micronesian kingfisher	152 hectares (376 acres)	NE
Rota	Mariana crow	2,594 hectares (6,409 acres)	NE
Rota	Rota bridled white-eye	1,602 hectares (3,958 acres)	NE
Essential Terrestrial Habitat	**Common Name**	**Size**	
Guam National Wildlife Refuge Overlay, USAF and USN	Mariana Fruit Bat, Mariana Crow, Guam Micronesian Kingfisher, Guam Rail, Mariana Common moorhen, Mariana swiftlet	22,536 hectares (9,118 acres)	---

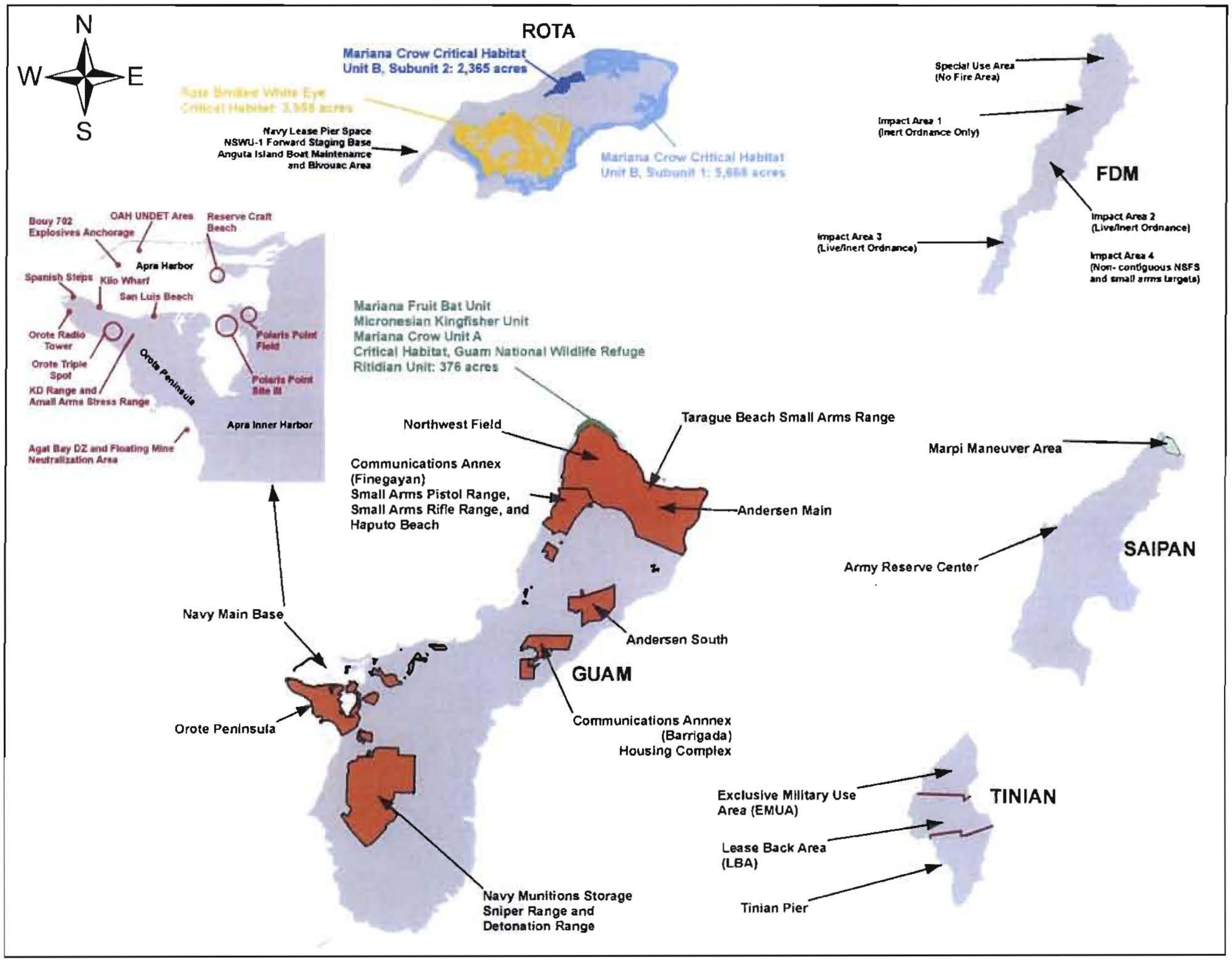


Figure 1. Mariana Islands Range Complex action areas (USN, unpublished).

CONSULTATION HISTORY

January 4, 1999. The USFWS completed the formal consultation for "Military Training in the Marianas" (USFWS 1999, 43 pp).

June 8, 2007. The USFWS received a letter from the USN dated June 1, 2007, that included a copy of the Federal Register document announcing the Notice of Intent for the MIRC and public scoping meetings.

July 30, 2007. The USFWS sent a letter to the USN providing comments on the Notice of Intent to develop an Environmental Impact Statement-Overseas Environmental Impact Statement (Draft EIS-OEIS) for MIRC (USFWS 2007a, 2 pp.).

March 7, 2008. Vanessa Pepi (USN) met with Patrice Ashfield (USFWS) to discuss informal consultation information needs.

March 28, 2008. The USFWS received a letter from the USN dated March 26, 2008, requesting concurrence on a species list for the biological assessment and to establish a date-of-record for requesting informal consultation.

May 2, 2008. The USFWS sent a letter to the USN dated May 2, 2008, concurring with the species list, accepting informal consultation, and providing additional technical assistance (USFWS 2007b, 9 pp.).

June 20, 2008. Vanessa Pepi (USN) met with the USFWS (Patrice Ashfield and Holly Herod) to develop a tentative timeline for the Section 7 consultation.

August 14, 2008. Vanessa Pepi (USN) met with Holly Herod (USFWS) to discuss a preliminary draft version of the biological assessment and information needs.

September 25, 2008. Vanessa Pepi (USN) met with Holly Herod (USFWS) to discuss conservation measures for the proposed action.

October 10, 2008. Vanessa Pepi (USN) and Ed Lynch (USN contractor) attended meetings with USFWS representatives (Patrice Ashfield, Holly Herod, Earl Campbell, and Karl Buermeyer) to discuss conservation measures for the proposed action.

November 10, 2008. Vanessa Pepi (USN) met with Holly Herod (USFWS) to discuss a preliminary draft version of the biological assessment and the need for additional conservation measures.

December 31, 2008. Vanessa Pepi (USN) and Holly Herod (USFWS) met to discuss the preliminary draft version of the biological assessment and additional conservation measures.

March 2, 2009. Vanessa Pepi (USN) provided an update via email to Holly Herod (USFWS) regarding the Draft EIS-OEIS public hearings and site visits to the Songsong area of Rota.

March 16, 2009. The USFWS provided comments to the USN regarding the Draft EIS-OEIS for the MIRC (USFWS 2009a, 19 pp.).

April 2, 2009. Vanessa Pepi (USN) and Earl Campbell (USFWS) held a conference call to discuss the conservation measures specific to brown treesnake interdiction and control.

April 23-24, 2009. Vanessa Pepi (USN) and Holly Herod (USFWS) exchanged emails regarding preliminary determination of effects for Mariana common moorhens at Fena Reservoir and nightingale reed warbler on Saipan.

May 1, 2009. Vanessa Pepi (USN) and Holly Herod (USFWS) exchanged emails to answer questions regarding moorhen utilization of storm water settling ponds at Andersen Air Force Base and beach-specific turtle nesting data for Tinian. Emails were also exchanged to answer questions related to Army Reserve training on Saipan.

June 4, 2009. Representatives of the USFWS (Earl Campbell, Holly Herod, and Karl Buermeyer) met with Vanessa Pepi (USN) and Ed Lynch (USN contractor) to discuss conservation measures related to invasive species control and interdiction.

June 8-19, 2009. Holly Herod (USFWS) attended site visits to MIRC training areas on Guam, Rota, Tinian, and Saipan with USN representatives (Vanessa Pepi, Anne Brooke, and Gretchen Grimm).

June 9, 2009. Ed Lynch (USN contractor) provided to USFWS an organizational chart for the Joint Region. The information provided to USFWS also included USN point of contact information for scheduling brown treesnake coordination meetings.

July 22, 2009. The USFWS received a request from the USN to initiate formal consultation for the MIRC.

August 21, 2009. The USFWS provided the USN with a letter accepting initiation of formal consultation and a table of items needing minor clarification (USFWS 2009b, 10 pp.).

September 3, 2009. Holly Herod (USFWS) and Vanessa Pepi (USN) met to resolve the items for clarification outlined in the initiation letter.

December 18, 2009. The USFWS provided a draft biological opinion to the USN.

February 1, 2010. The USFWS received comments from the USN regarding the draft biological opinion.

February 4, 2010. Holly Herod (USFWS) and Vanessa Pepi (USN) met to resolve outstanding comments related to the draft biological opinion.

February 5 – 18, 2010. Holly Herod (USFWS) and Vanessa Pepi (USN) exchanged multiple emails to resolve all outstanding comments related to the draft biological opinion.

SUMMARY OF THE PROPOSED ACTION

The purpose of the proposed action is to achieve and maintain Department of Defense (DoD) readiness using the MIRC to support and conduct current, emerging, and future training and research, development, testing, and evaluation activities, while enhancing training resources throughout the Pacific. The proposed action does not involve extensive changes to the existing MIRC facilities, activities, or training capabilities, nor does it involve an expansion of the existing MIRC property (USN 2009a, p. 1-2). The proposed action does not involve the redeployment of U.S. Marine Corps, USAF personnel or assets, carrier berthing capability, or deployment of strategic missile defense assets to the MIRC. Instead, the proposed action focuses on the development and improvement of existing training capabilities in the MIRC and will not include any military construction projects, other than repairs and improvements to existing training areas.

Training actions that may affect terrestrial resources can be grouped into the following activities: 1) Strike Warfare; 2) Amphibious Warfare; 3) Expeditionary Warfare; 4) Special Warfare; 5) Special Expeditionary Warfare; and 6) Anti-Terrorism and Force Protection (USN 2009b, p. 8). Appendix A lists each training category, specific actions within the training category, the equipment (platform) and ordnance used, the existing and proposed level of training, and the action areas where the training may occur. See below for a brief list of actions at each training area. One annual Joint Multi-Strike Group Exercise is also proposed. All activities associated with the Joint Multi-Strike Group Exercise are located in open ocean; therefore, this activity will not be considered within this consultation.

ACTION AREA

This consultation reviews anticipated impacts to the listed species using terrestrial areas of the MIRC and will encompass all of Farallon de Medinilla and portions of Saipan, Tinian, Rota, and Guam. Near-shore marine and open ocean activities and the potential impacts to listed species there are not evaluated within this consultation as these species and their habitats are under the jurisdiction of the National Marine Fisheries Service.

Farallon de Medinilla (USN 2009b, pp. 8, 30). The action area on Farallon de Medinilla (FDM) includes the entire island and is approximately 74 hectares (182 acres) in size (Figure 2). Farallon de Medinilla is leased by DoD from the CNMI and is used for live and inert bombing via surface-to-ground and air-to-ground training via strike, amphibious, and special warfare. Three impact areas are targeted: inert ordnance is used in Area 1 and inert and live ordnance is used in Areas 2 and 3. These impact areas total approximately 13.8 hectares (34 acres), which accounts for approximately 20 percent of the island's area. The northern portion of the island is protected from bombardment and training and is referred to by the USN as the "No Drop Zone." The "No Drop Zone" is depicted on Figure 2 as the area above the "No Fire Line."

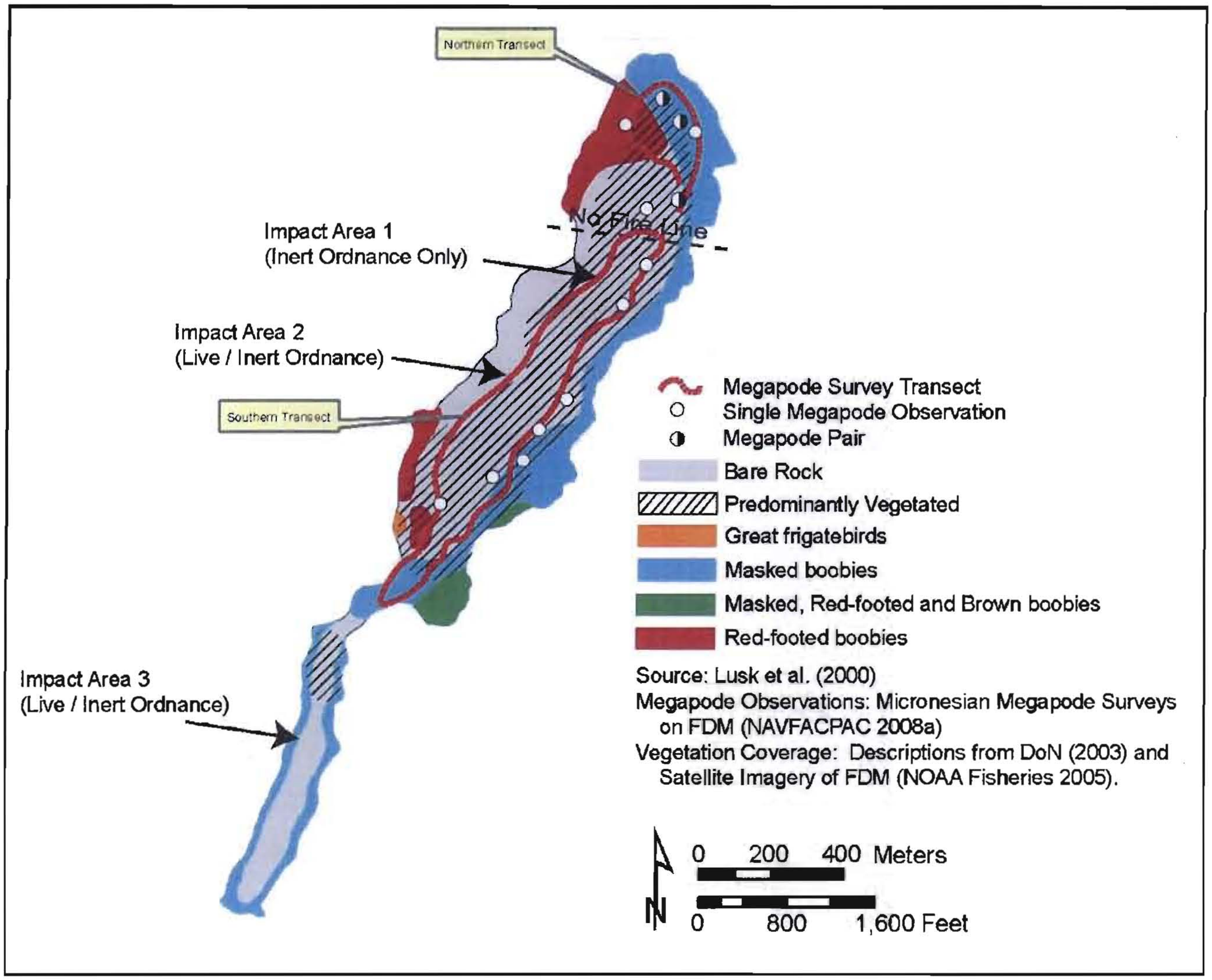


Figure 2. Farallon de Medinilla (USN 2009b, p. 12). The "No Drop Zone" is the region above the "No Fire Line."

Range maintenance will also occur to facilitate target installation and maintenance and reduce potential migration of munitions constituents off-range (USN 2009c, p. 2). To complete range maintenance, vegetation within a section of Impact Area 1 will be cleared (approximately 3.3 hectares; 8.3 acres) to allow adequate safety measures for personnel to conduct clearance operations of range residue (ordnance scrap and target debris which includes unexploded ordnance). Vegetation will be cleared either by the use of herbicides and prescribed burns. Range maintenance will occur as needed and is anticipated to occur once every two to five years.

Saipan (USN 2009b pp. 8-9, 14). Training on Saipan occurs at the Army Reserve Center in Garapan, the Commercial Port (40.5 hectares; 100 acres), and Marpi Maneuver Area (151.5 hectares; 374.5 acres) (Figure 3). The Saipan Army Reserve Center contains an armory, classrooms, administrative areas, maintenance facilities, laydown areas (areas of pavement, dirt, or short grasses) and supports command and control, logistics, anti-terrorism and force

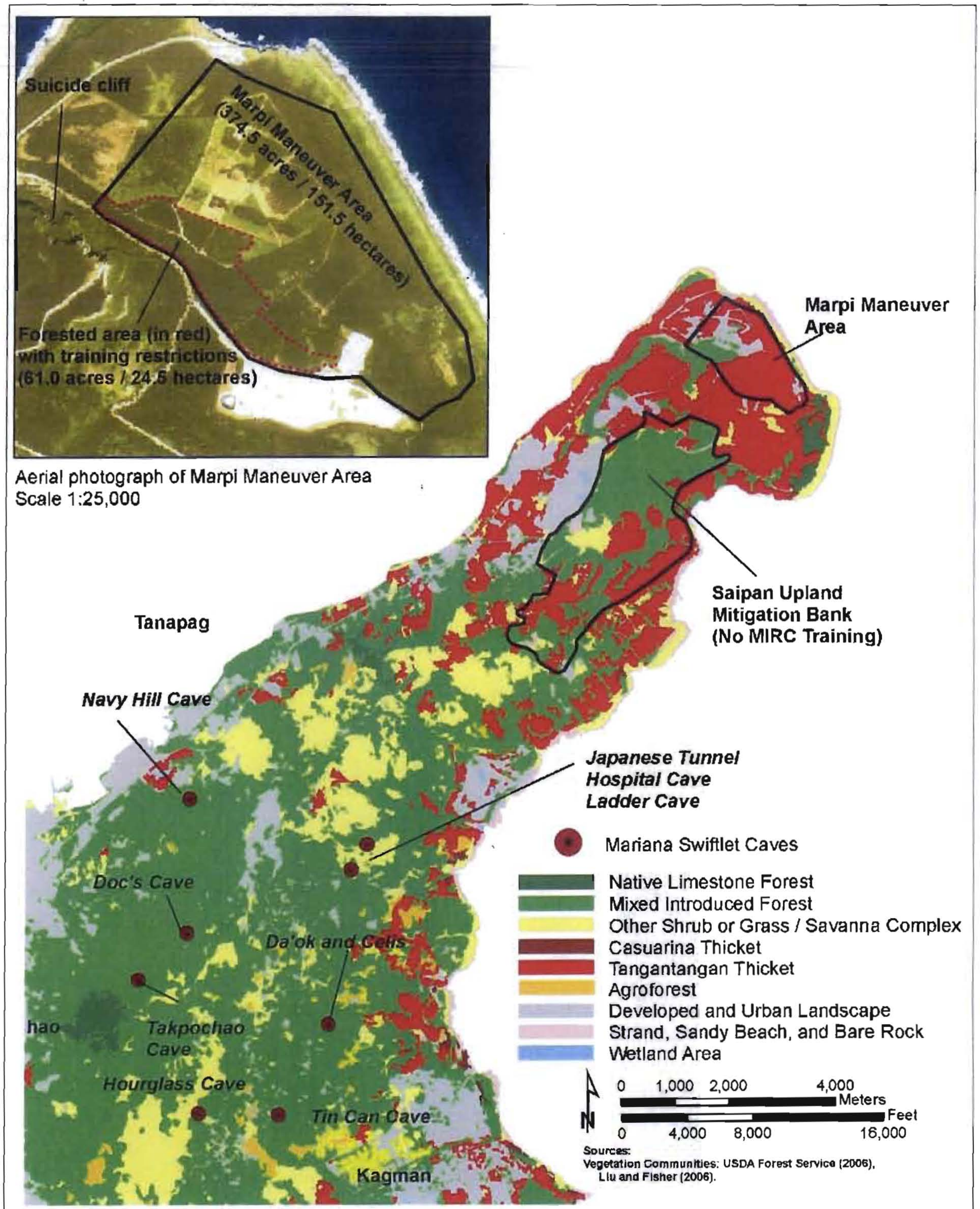


Figure 3. Saipan and the Marpi Maneuver Area (USN 2009b, p. 14).

protection, bivouac, vehicle land navigation, convoy training, and other headquarter activities. The Commercial Port is used for visit-board-search-seizure, anti-terrorism and force protection, and naval special warfare training activities. The Marpi Maneuver Area is used for pedestrian land navigation training.

Tinian (USN 2009b, p. 8). The Tinian Military Lease Area encompasses 6,230 hectares (15,400 acres) on the island of Tinian, leased by DoD from CNMI (Figure 4). Training on Tinian is conducted on two parcels within the Tinian Military Lease area: the Exclusive Military Use Area encompassing 3,080 hectares (7,600 acres) on the northern third of Tinian and the Leaseback Area encompassing 3,150 hectares (7,800 acres) on the middle third of Tinian.

The Exclusive Military Use Area is comprised of North Field and three beaches (Unai Chulu, Unai Dankulo (Long Beach), and Unai Babui). North Field is used for vertical and short field landings, command and control, air traffic control, logistics, armament, fuels, rapid runway repair, other airfield-related requirements, bivouac, and force on force airfield defensive and offensive training. Active live-fire is completed only by snipers using small arms and bullet traps and is associated with North Field World War II structures. Unai Chulu and Unai Dankulo may be used for landing craft air cushion training. Historically, only Unai Chulu has been used for landing craft air cushion training; however, additional use of this beach will require beach repairs. Unai Babui is a rocky beach and may be used for amphibious assault vehicle training.

The Leaseback Area is used for military operations in urban terrain, command and control, logistics, bivouac, vehicle land navigation, convoy training, and other field activities. Active live-fire occurs only within the old Japanese Communications Building using small arms and bullet traps.

One annual Joint Expeditionary Exercise is proposed for Tinian Exclusive Military Use Area. Pyrotechnics are restricted to paved runway areas and vehicles are limited to pavement or existing trails. The purpose of the action is to train a joint task force in crisis action planning for execution and contingency operations. Five annual Marine Air Ground Task Force (MAGTF) Exercises are proposed. An exercise may last up to ten days and is designed to maneuver and seize objectives and conduct self-sustaining operations with logistic support. These actions occur on Tinian and Guam in the action areas described above.

Tinian Harbor is outside of the Military Lease Areas and may be used for amphibious assault, amphibious raid, and humanitarian assistance and disaster relief operation training (USN 2009b, pp. 21-24, 41).

Rota (USN 2009b, p. 9). Training on Rota occurs at Angyuta Island, Songsong Harbor, and on non-DoD lands (Rota International Airport, Songsong Village, other areas in conjunction with local law enforcement) (Figure 5). Angyuta Island is used as a forward staging base and overnight bivouac site. Songsong Harbor is a commercial port facility used for boat refueling and maintenance. Visit-board-search-seizure and insertion-extraction training may occur at the harbor as well. The Rota International Airport is used for high altitude low opening parachute training and may be used for airfield seizure, anti-terrorism and force protection, surveillance

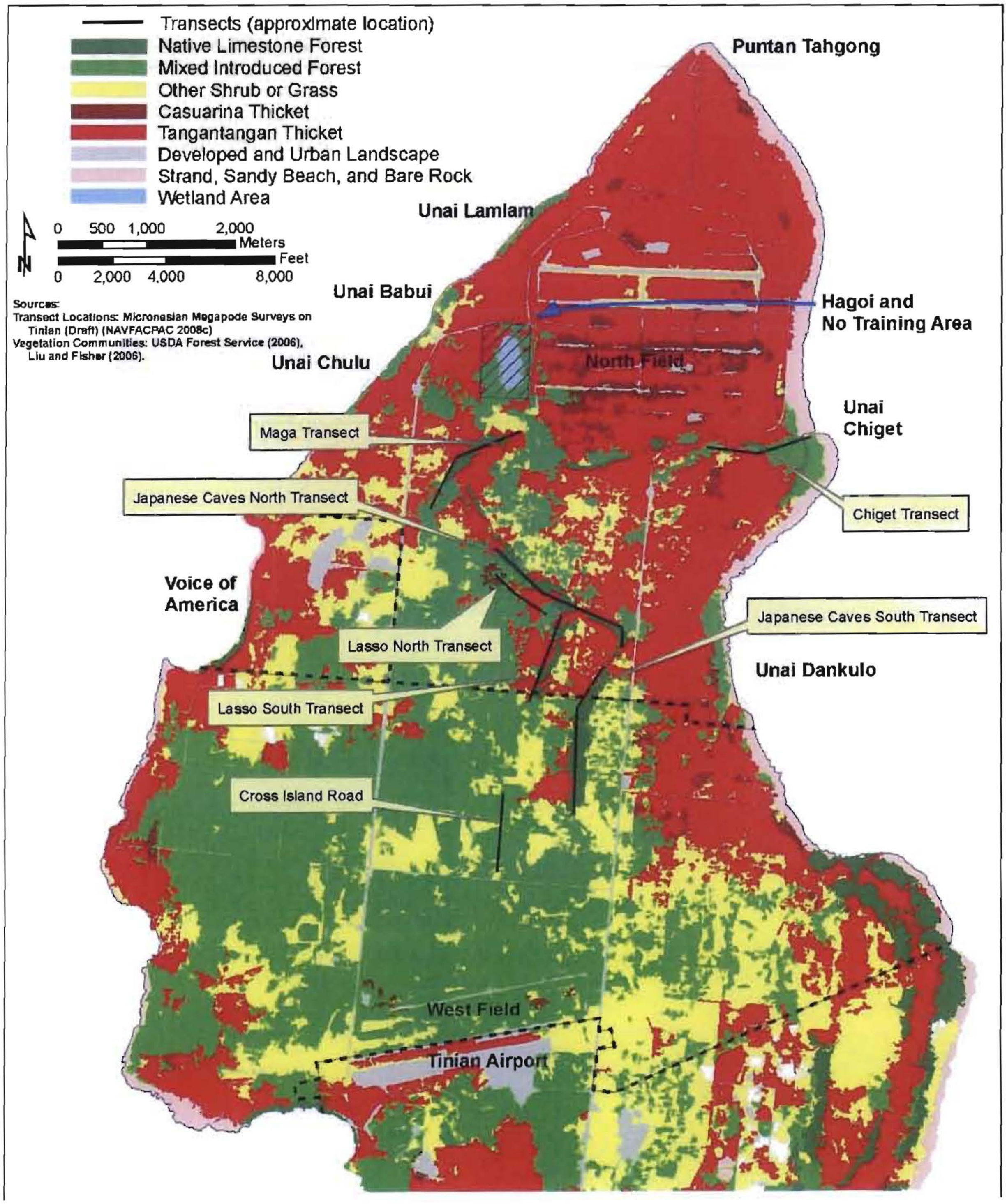


Figure 4. Military Lease Area, Tinian (USN 2009b, p. 13). No training occurs in the "No Training Area" or the native limestone forest.

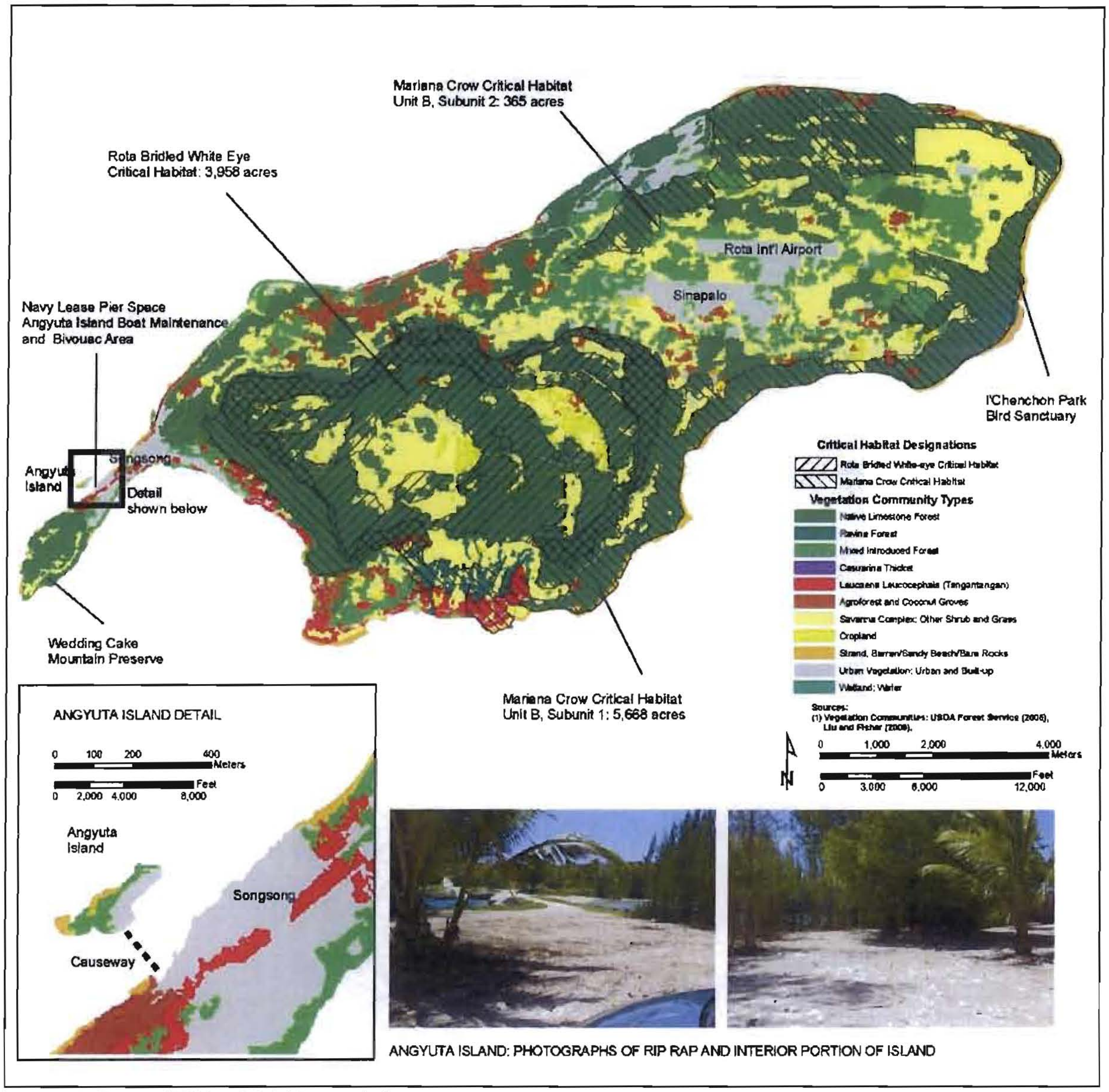


Figure 5. Rota (USN 2009b, p. 15).

and reconnaissance training. Military operations in urban terrain occur in Songsong Village. Other non-DoD lands in the municipality of Rota are used for special warfare training including hostage rescue, anti-terrorism and force protection, surveillance and reconnaissance, noncombatant evacuation operations, and military operations in urban terrain.

Guam (USN 2009b, pp. 9-11). Training on Guam includes multiple locations on DoD lands (Figures 5-9). In addition to routine training at the action areas below, five annual TRUEX (training in urban environment exercise) are proposed which consist of up to three Marine Corps companies training simultaneously with small arms and blanks. TRUEX typically takes place at Andersen South, but may also occur at Finegayan Housing Area, Barrigada Housing, and Northwest Field and is conducted over a period of weeks. Two annual Special Purpose Marine

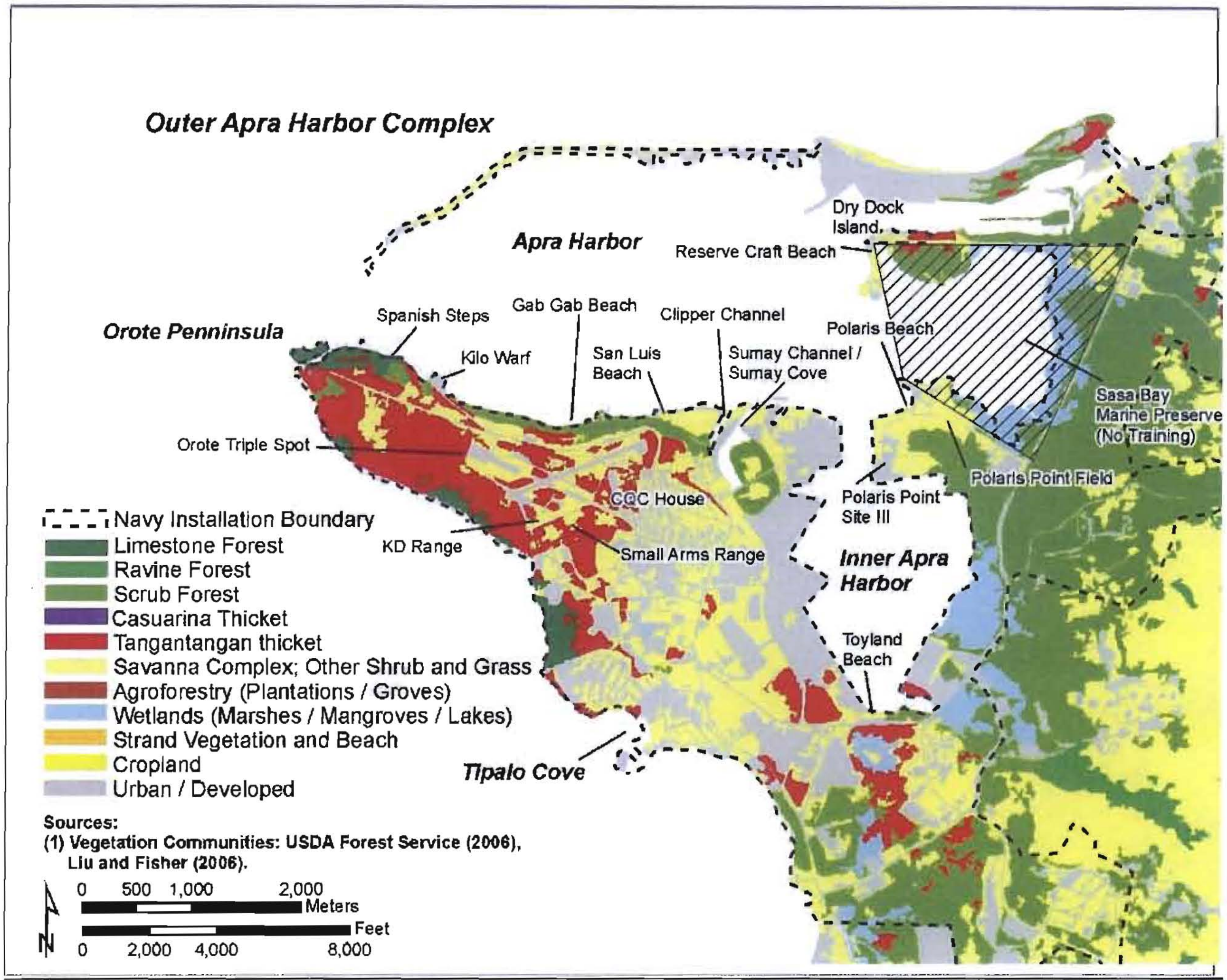


Figure 6. Naval Main Base, Guam (USN 2009b, p. 16).

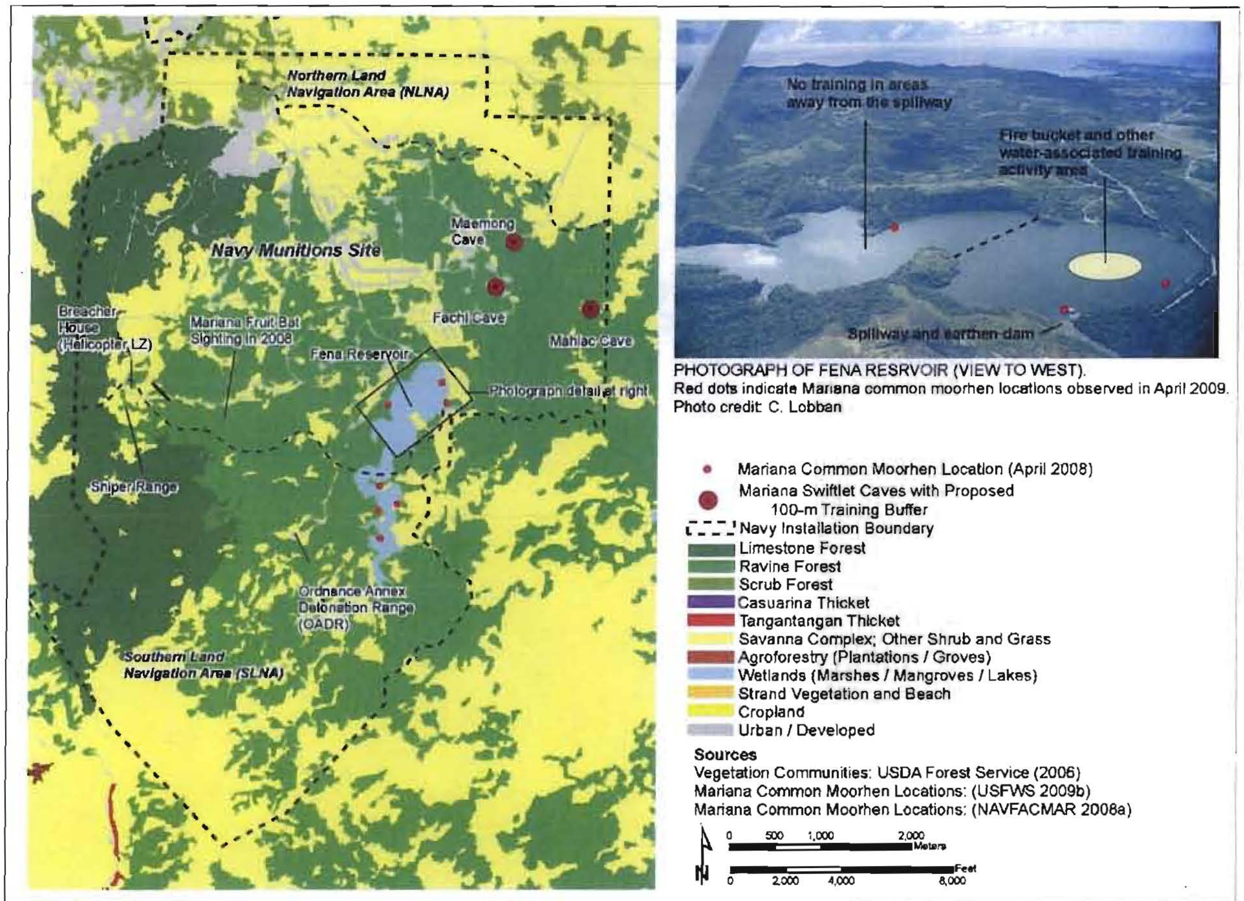


Figure 7. Naval Ordnance Annex, Guam (USN 2009b, p. 17).

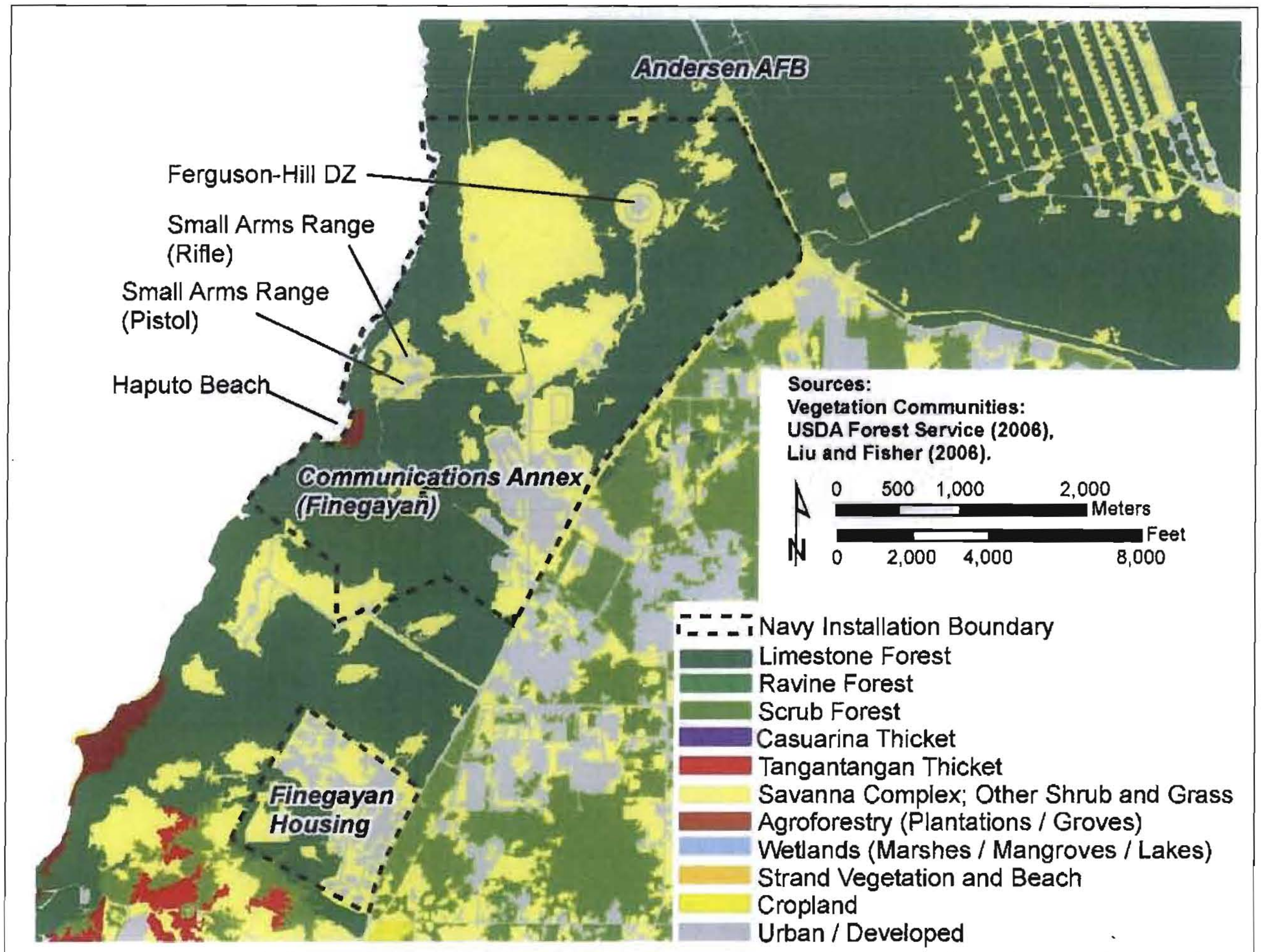


Figure 8. Communications Annex-Finegayan, Guam (USN 2009b, p. 18).

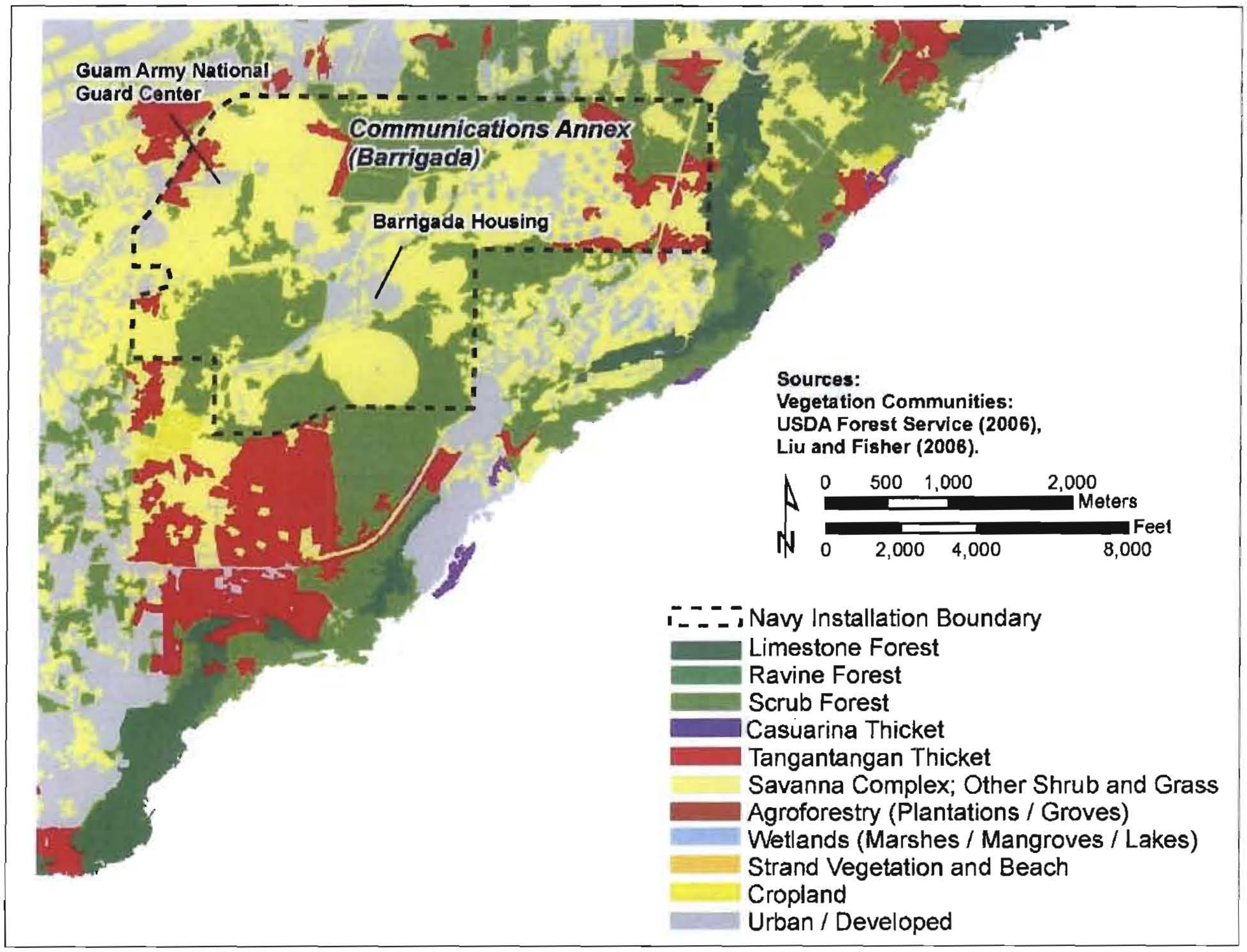


Figure 9. Communications Annex-Barrigada, Guam (USN 2009b, p. 19).

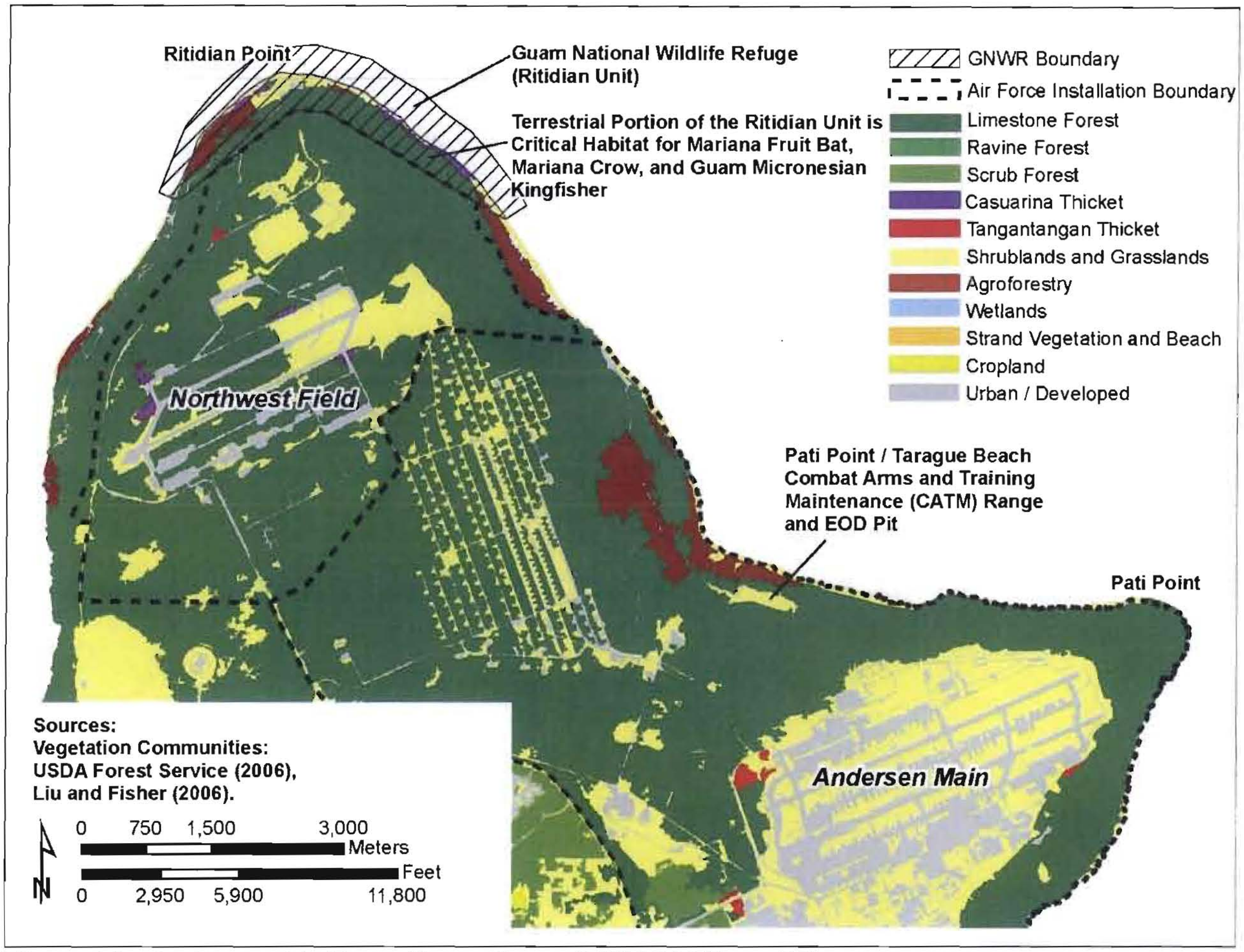


Figure 10. Andersen Air Force Base, Guam (USN 2009b, p. 20).

Air Ground Task Force Exercises are proposed and involve the introduction of forces, evacuation of non-combatants, and a planned withdrawal of all personal and non-combatants. Movement of people includes the use of helicopters, landing craft air cushion or other landing craft and may occur during the day or night at the action areas above.

Apra Harbor Naval Complex and Naval Main Base (2,511 hectares; 6,205 acres)

Tipalao Cove – Has the capability to support landing craft air cushion and amphibious assault vehicles training.

Dadi Beach (USN 2009a, p. 3.8-24) – Has the capability to support landing craft air cushion, landing craft utility, amphibious assault vehicles, combat rubber raiding craft, rigid-hulled inflatable boats, over the beach swimmer insertions, and combat swimmer special training against ships.

Gab Gab Beach – Used primarily for support of explosive ordnance disposal and naval special warfare activities including: military diving, logistics training, small boat activities, security activities, drop zones, and anti-terrorism and force protection. The beach is also used for recreational activities.

Reserve Craft Beach – Used as an offload area for amphibious landing craft including landing craft air cushion, inert explosive ordnance disposal training, military diving, logistics training, small boat activity, security activities and anti-terrorism and force protection.

Sumay Channel and Cove – Provides moorage for recreational and other small boats, and used for insertion-extraction training for naval special warfare, amphibious vehicle ramp activity, military diving, logistics training, small boat activities, security activities, and anti-terrorism and force protection training.

San Luis Beach – Used for explosive ordnance disposal and naval special warfare including: military diving, logistics training, small boat activities, security activities, drop zones, visit-board-search-seizure, and anti-terrorism and force protection. The beach is also used for recreational activities.

Toyland Beach – Is suitable for landing craft air cushion, landing craft utility, amphibious assault vehicles, combat rubber raiding craft, rigid-hulled inflatable boats, over the beach swimmer insertions, and combat swimmer special training against ships.

Polaris Point Field – Used for small field training exercises, temporary bivouac, craft laydown, parachute insertions, assault training activities, anti-terrorism and force protection, explosive ordnance disposal, and special forces training. The beach is also used for recreational activities and provides access to small landing craft.

Polaris Point Beach – Used for military diving, logistics, training, small boat activities, amphibious landings including landing craft air cushion, security activities, drop zones, and anti-terrorism and force protection. The beach is also used for recreational activities.

Orote Point Airfield and Runway – Used for vertical and short field military aircraft, field training exercise, parachute insertions, emergency vehicle driver training, explosive ordnance disposal, and special warfare training.

Orote Point Close Quarter Combat Facility – This is a small, one-story building where small arms, live-fire training occurs in support of military operations in urban terrain activities.

Orote Point Small Arms Range and Known Distance Range – Used for small arms, machine gun training (up to 7.62 millimeter), and sniper training to a distance of 457 meters. This range is a long, flat, cleared area with an earthen berm used as a backstop. The range will be upgraded to an automated scored range system.

Orote Point Triple Spot – This area supports a helicopter landing zone and is used for personnel transfer, logistics, parachute training, and other training activities using helicopter transport.

Ordnance Annex (3,561 hectares; 8,800 acres)

Breacher House – This area supports a concrete structure used for tactical entry (small explosive charge) and a helicopter landing zone used for raid assault activities.

Emergency Detonation Site – This area has a helicopter landing site and is certified to detonate explosives up to 3,000 pounds.

Sniper Range – Open terrain with a natural earthen backstop used to support marksmanship training with sniper rifles (ammunition up to .50 caliber).

Northern Land Navigation Area – This location supports small field exercises and foot and vehicle land navigation training.

Southern Land Navigation Area – This location supports pedestrian land navigation.

Fena Reservoir – This location supports close air support, combat search and rescue, insertion-extraction, and fire bucket training.

Communications Annex-Finegayan (1,214 hectares; 3,000 acres) – This area supports field exercises and military training in urban terrain.

Haputo Beach – is used for small craft landings (combat rubber raiding craft) and over the beach insertions. The training area is part of the Haputo Ecological Reserve Area.

Finegayan Small Arms Ranges – This area is a long, flat, cleared location with an earthen berm that supports qualification and small arms training up to 7.62 millimeters.

Finegayan Housing Area – This area is a group of unoccupied buildings that support company size (200-300 troops) military operations in urban terrain including the use of landing and drop zones.

Ferguson Hill – Is currently used as a landing zone. The use and logistics of a new drop zone is being considered by the Federal Aviation Administration and may be permitted in the future.

Open Fields – These areas are used for command and control, logistics, bivouac, vehicle land navigation, convoy training, and other field activities.

Communications Annex-Barrigada (728 hectares; 1,800 acres) – This location supports field exercise and military operations in urban terrain and consists of unoccupied housing units and open areas (former transmitter sites). Command and control, logistics, bivouac, vehicle land navigation, convoy training, and other field activities occur in this location. The Army Reserve Center and Guam Army National Guard Center are also located in Barrigada. The Army Reserve Center provides an indoor small arms range (9 millimeter) and the Guam Army National Guard Center contains an armory, classrooms, administrative areas, maintenance facilities, and laydown areas (USN 2009a, p. 2-22).

Northwest Field (1,821 hectares; 4,500 acres) – Northwest Field is an unimproved expeditionary World War II era airfield used for vertical and short field landings. Approximately 280 acres of land are cleared near the eastern end of both runways for parachute drop training (see also USFWS 2008a, 30 pp.). The south runway is used for short field and vertical lift aircraft training and often supports various types of ground maneuver training. Helicopter units use other paved surfaces for confined area landing, simulated amphibious ship helicopter deck landings, and insertions and extractions of small maneuver teams. About 3,562 acres in Northwest Field are used as maneuver training areas for field exercises and bivouacs. Routine training exercises include camp and tent setup, survival skills, land navigation, day and night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense and security, field equipment training and chemical attack and response. This area also supports Northwest Field Beddown and Training and Support Initiative, which co-located the rapid engineer deployable heavy operations repair squadron engineers, that includes its silver flag training unit, the commando warrior training program, and the combat communications squadron (see also USFWS 2006a, 7 pp.; USFWS 2009c, 5 pp.).

Andersen Air Force Base (AFB) Main Base (4,654 hectares; 11,500 acres) – The base is used for aviation, small arms at bermed, outdoor ranges, and explosive ordnance training. As a working airfield, the base has a full array of operations, maintenance, and community support facilities and supports all U.S. Military aircraft and personnel transiting the Mariana Islands. Facilities are available for cargo staging and inspection.

Andersen South (778 hectares; 1,922 acres) – Andersen South consists of abandoned military housing and open area. Andersen South open fields and wooded areas are used for basic ground maneuver training including routine training exercises, camp and tent setup, survival skills, land navigation, day and night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense and security, and field equipment training. Vacant single family housing and vacant dormitories are used for military operations in urban terrain and small unit tactics. The current state of the buildings may need some repairs to interior and exterior surfaces (e.g., hanging doors) to be suitable for training (USN 2009a, p. 2-18).

Pati Point Combat Arms Training and Maintenance Rifle Range (8.5 hectares; 21 acres) – This location is used for small arms training with pistols, rifles, machine guns, and inert mortars up to 60 millimeters. Training is also conducted with a 40 millimeter grenade launcher (M203) using inert training projectiles without percussive force.

CONSERVATION MEASURES

The following conservation measures are designed to avoid or minimize effects to listed species and their habitats or further the recovery of the species under review. All conservation measures are proposed in the biological assessment (USN 2009b, pp. 27-35; or as revised during a meeting held September 3, 2009) unless otherwise noted. Conservation measures are considered part of the proposed action and their implementation is required. Any changes to, modifications of, or failure to implement these conservation measures may result in a need to reinitiate this consultation. Implementation of many of the measures included below are already underway. For the actions that are not currently in place, we anticipate that these will be implemented immediately upon finalization of this biological opinion unless otherwise stated.

General Measures These actions will be implemented throughout all MIRC action areas and are intended to avoid and minimize effects and risks to endangered and threatened species and their habitats.

1.0 Invasive Species Interdiction and Control

1.1 Brown Treesnake Interdiction and Control

1.1.1 Per Public Law 110-417, [Division A], title III, Section 316, October 14, 2208, 122 Statute 4410 and per DoD Defense Transportation Regulations, Chapter 505 protocols, the USN commits to implementing 100 percent inspection of all outgoing vessels and aircraft with trained quarantine officers and dog detection teams, which could be supplemented by other pest control expertise (with appropriate U.S. Department of Agriculture Wildlife Services brown treesnake detection training and oversight) to meet 100 percent inspection goals for large scale training activities. As a stakeholder, the USFWS would have input on the USN protocols for implementing brown treesnake interdiction and control strategies. The USN will work cooperatively with USFWS and U.S. Department of Agriculture to seek information in development of protocols for implementation of interdiction and control methods aimed at controlling brown treesnake as related to training activities within the MIRC action area. On an as needed basis, the USFWS, U.S. Department of Agriculture, and USN may request meetings to discuss interdiction and control method protocols as related to military training in the MIRC.

a. In the event military units, vehicles, and equipment accidentally leave Guam without inspection, as soon as possible, the DoD will notify: (1) their inspection contractor and (2) the point of destination port or airport authorities and work with the destination port to resolve the issue. Urgency of notification is a priority so that rapid response or other actions can be implemented to reduce risk.

b. In addition, the USN will route inbound personnel and cargo for tactical approach exercises (that require an uninterrupted flow of events) directly to CNMI training locations to avoid Guam seaports and airfields. If Guam cannot be avoided, USN in cooperation with U.S. Department of Agriculture and USFWS shall identify and USN will implement appropriate interdiction methods that may include redundant inspections (see 1.1.1.c) or other interdiction methods as agreed to by the USFWS, U.S. Department of Agriculture, and USN. Additionally, tactical approach exercises will involve only cargo equipment that has not originated from areas containing a brown treesnake population or will be 100 percent inspected by certified brown treesnake canine programs. If the U.S. Department of Agriculture develops performance standards for this activity, the USN will adopt those standards, provided they are compatible with military mission.

c. The USN is committed to implementing redundant inspections after discussions with appropriate stakeholders. Redundant inspections include inspections on Guam and at the receiving jurisdiction for administrative and logistical movements that do not require a tactical approach to complete the training requirements. It is anticipated that redundant inspections would utilize existing quarantine and inspection protocols at receiving ports. Appropriate stakeholders include, but are not limited to: the USFWS to ensure the inspections are adequate to reduce risks to trust resources, U.S. Department of Agriculture Wildlife Services, receiving jurisdictions and their supporting agencies with expertise in invasive species control, and other inspection authorities as needed to ensure inspection methods are current and revised as new techniques, technology, or data become available.

1.1.2 The USN will also establish snake-free quarantine areas for cargo traveling from Guam to CNMI and locations outside of the MIRC. These brown treesnake sterile areas will be subject to: (1) multiple day and night searches with appropriately trained interdiction canine teams that meet performance standards under 1.1.b; (2) snake trapping, and (3) visual inspection for snakes. Temporary barriers may be preferable to permanent exclosures because of the variable sizes needed for various training activities. The USN will produce standard operating procedures for temporary barrier construction and use. Standard operating procedures will ensure that temporary barriers will be constructed and maintained in a manner that assures the efficacy of the barrier tool and that staff maintaining and constructing the temporary barriers will receive training related to this activity prior to construction. Standard operating procedures will be developed in cooperation with the USFWS, U.S. Geological Survey Biological Resources Discipline, and the U.S. Department of Agriculture Wildlife Services to ensure risk to trust resources is adequately minimized. If risks are not adequately minimized, recommendations will be provided for incorporation into the protocols until the USN and USFWS mutually agree the risk has been minimized. The USFWS, USN, and other appropriate parties will meet, if necessary, to resolve concerns such that the protocols ensure risk is adequately minimized.

1.1.3 The USN will support rapid response actions to brown treesnake sightings within the CNMI and locations outside of the MIRC (specifically Hawaii) by working with U.S. Geological Survey Biological Resources Discipline to develop procedures and protocols that will support rapid action for a brown treesnake sighting. For example, USN personnel (civilian and uniform) could be trained to augment response teams on Guam and Hawaii or the USN may retain an agreement with trained, local pest control contractors that meet performance. USN will contact the Brown Treesnake Rapid Response Team Coordinator (Coordinator) on Guam (coordinates and runs the Rapid Response Training course) within 90 days of receiving the BO to request the course. The Coordinator arranges the training based on trainers and attendees.

1.2 DoD participation in the Brown Treesnake Control Plan
1.2.1 The USN, working in collaboration with the USFWS, and U.S. Department of Agriculture Wildlife Services and Animal and Plant Health Inspection Service will decide how best to implement the Brown Treesnake Control Plan (BTS TWG 2009, 37 pp.) relevant to MIRC activities.

1.2.2 The USN provides an environmental education program for new arrivals (see a through d, below). Additionally, the current environmental education program may be updated to provide more recent information to ensure each individual has the most up-to-date training.

a. All new service personnel will receive the "Area Training Welcome Aboard Brief."

b. Mandatory viewing of a brown treesnake educational video.

c. Pocket guides with brown treesnake information and personal inspection guidelines will be carried at all times.

d. Assurance that brown treesnake awareness extends from the chain of command to the individual military service member.

1.3 Prevention of Invasive Species Introductions and Spread
1.3.1 All personnel involved in MIRC training will adhere to DoD Instruction 5090.7, which calls for individual troops to be responsible for conducting self inspections to avoid potential introductions of invasive species to Guam and the CNMI. Troops will inspect all gear and clothing (e.g., boots, bags, weapons, pants) for soil accumulations, seeds, invertebrates, and vertebrates). The intent of this measure is to minimize the potential risks and subsequent effects associated with transport of troops and personnel to Guam and to CNMI from areas that contain species that are not native to terrestrial habitats within the MIRC (extra-MIRC travel). In addition, compliance with Instruction 5090.7 will be required for travel to and from training sites within the MIRC (inter-MIRC travel).

1.3.2 In addition to self inspections, each action will undergo a pathway risk analysis as a tool to improve programmatic efficiency while preventing the spread or introduction of invasive species. Actions at risk of transporting invasive species will have prevention tasks identified and implemented to reduce risk. Methods such as Hazard Analysis and Critical Control Point (HACCP) planning (see http://www.haccp-nrm.org) may be utilized to conduct pathway analysis.

1.3.3 The USN is a participating agency in the development of the Regional Biosecurity Plan. Once completed, the Regional Biosecurity Plan will be applicable to MIRC training activities when such procedures do not unduly interfere with military training. The USN will continue to work cooperatively with USFWS and U.S. Department of Agriculture in development of protocols for implementation of interdiction and control methods in accordance with recommendations contained in the Regional Biosecurity Plan aimed at controlling brown treesnake and other invasive species as related to training activities within the MIRC action area. The Regional Biosecurity Plan will coordinate and integrate inter-agency invasive species management efforts such as control, interdiction, eradication, and research. This plan is currently in development and draft components of the plan will be completed in March 2010. The final plan is anticipated to be completed in January 2011.

1.4 Cooperative Development of Regional Training Standard Operating Procedures and Exercise Planning

The USN will invite the USFWS to participate in the development of regional standard operating procedures and exercise planning to better meet invasive species management needs associated with MIRC training. Current procedures can be found in 5090.10A "Brown Tree Snake Control and Interdiction Plan" (USN 2005, 28 pp.).

1.5 Coordination of Training Events

The DoD Representative will assure that "Area Training" coordinates meetings for brown treesnake interdiction on all training activities for the training execution phase and an after action review phase. If a snake is found during training, the USN policy is to kill the snake and is reported to USN Environmental Staff.

2.0 Erosion Control

2.1 The USN will locate ground-disturbing training activities on previously disturbed sites whenever possible.

2.2 The USN will ensure that all training areas, including transit routes necessary to reach training areas, are clearly identified or marked. Vehicular activities will be restricted to designated and previously identified areas.

2.3 The USN will continue to control erosion through the "Site Approval Process," whereby the USN environmental program reviews each proposed project for its erosion potential and involves the designated installation Natural Resource Specialist in the process.

2.4 The USN will continue to manage erosion in accordance with the applicable storm water pollution prevention plan at each training location.

2.5 The USN will prohibit off-road vehicle use except in designated off-road areas or on established trails.

2.6 The USN will comply with existing policies and management activities to conserve soils, including requirements and restrictions outlined in the Marianas Training Handbook.

3.0 Hazardous Waste

3.1 No aircraft washing activity will occur on Tinian.

3.2 The USN will reduce hazardous materials usage where possible. The USN will establish hazardous materials storage facilities away from catch basins, storm drains, waterways, and forested habitats used by listed species. Liquid hazardous materials will be stored in containers or facilities with an impervious lining.

3.3 The USN will use hazardous chemical warning labels on all hazardous materials. Material Safety Data Sheets for each hazardous material will be carried by all deploying units. The USN will establish and use designated collection points for segregation, packaging, and labeling of hazardous wastes for disposal. This will include the segregation of hazardous waste from general refuse. No hazardous materials or substances will be allowed in trash containers or dumpsters on shore. The USN will dispose of oily waste and bilge water at disposal facilities on Guam or Saipan.

3.4 The USN will report spills in water and in terrestrial habitats immediately. The USN will have available spill containment and cleanup equipment, trained spill response teams, packaging materials for hazardous materials and hazardous waste, wherever hazardous wastes may be spilled or exposed to habitats.

3.5 Emergency fuel release may only be conducted in designated aircraft emergency fuel release areas. If designated emergency fuel release areas are unavailable, fuel may be released as directed at locations at least 12 nautical miles from any land, sea mound or island, in depths greater than or equal to 1,000 fathoms (6,000 feet) of water and at an altitude safe for flight or as directed to ensure complete evaporation of the fuel.

3.6 Ordnance may be jettisoned in designated emergency jettison areas only. If designated emergency jettison areas are unavailable, ordnance may be jettisoned at locations at least 12 nautical miles from any land, sea mound or island, in depths greater than or equal to 1,000 fathoms (6,000 feet) of water and at an altitude safe for flight or as directed.

3.7 The USN will collect and haul away all expended brass, clips, and lead rounds from military operations in urban terrain.

Island Specific Measures

4.1 Farallon de Medinilla

On Farallon de Medinilla, restrictions are in place to minimize adverse effects such as decreasing wildfire potential, decrease direct strike potential of Micronesian megapodes and to limit degradation of habitat.

4.1.1 Vessels and aircraft will observe the following restrictions:

a. Targeting of ship and aircraft live-fire and aerial bombardment will be limited to only the interior portions of Farallon de Medinilla and no targeting of cliffs on the eastern coast of the island will occur (see Figure 1). Firing direction is from the west only towards the island.

b. No firing will occur north of a designated "No Fire Line." Three impact areas are used for training and have targets for training. Impact Areas 1 and 2 occur on the interior plateau of the island and Impact Area 3 occurs on the southern peninsula. Inert ordnance is used in Impact Area 1. Live and inert ordnance is used in Impact Areas 2 and 3.

c. Targets will be placed within the impact areas to avoid habitat and reduce fire risk.

d. Cluster bombs, live cluster weapons, and live scatterable munitions are prohibited.

e. Bombs greater than 2,000 pounds, all fuel-air explosives, and all incendiary devices are prohibited.

4.1.2 Range maintenance will use both herbicide and prescribed burn treatments on Farallon de Medinilla (USN 2009c, 12 pp.).

a. A visual survey for megapodes will be conducted in the area by a qualified biologist, prior to each vegetation removal event, that may include: herbicide application, fire retardant application, or prescribed burning.

b. Precautions (see conservation measures 1.3.1 and 1.3.2) will be taken to help prevent the accidental introduction of invasive species including plant seeds during range maintenance (i.e., during vegetation removal, conex box removal and replacement). All equipment will be washed prior to shipment and personnel will clean all personal gear (boots, clothing, equipment, etc.) of soils and seeds prior to embarking from Saipan.

c. Personnel will not stay overnight on Farallon de Medinilla but will fly back to Saipan each evening by helicopter. If food is brought to Farallon de Medinilla, then all trash and any uneaten food will be removed from the island daily or stored in rodent-proof containers.

d. Edges of the prescribed treatment area will be marked using GPS or flagging tape.

e. Aerial or manual (backpack) application of a registered herbicide will begin on the windward side of treatment area and all label restrictions will be followed. A dye marker solution will be used to ensure only the targeted area is covered and excess herbicide is not applied.

f. Prior to implementing the prescribed burn, personnel will ensure ground conditions conducive to conducting the prescribed burn so that a burn would most likely result in a low intensity ground fire. Methods will follow all precautions outlined in the range maintenance plan (USN 2009c, 12 pp.).

g. Fire retardant powder, foam or gel will be applied aerially, south of the "No Drop Zone" before the prescribed burn to prevent escape.

h. Seawater will be used to assist with extinguishing and controlling the fire. Devices (e.g., helicopter bucket, disposable bladders) will be available in the event fire control is required.

i. After the completion of the controlled burn, erosion control may be necessary until ground conditions stabilize. If erosion control is necessary (i.e., remaining vegetation is inadequate to prevent erosion), a straw wattle sediment control system will be installed. The straw wattle will be free of invasive pests.

j. Personnel will be advised of the presence of the Micronesian megapode and be cautioned to not interact with (e.g., harass, attempt to feed) any individual birds. However, because the personnel applying the herbicide may not be wildlife experts; personnel will be instructed to avoid any birds, nests, or eggs.

4.1.3 Nesting sea turtles are not expected; however, it is possible that a sea turtle may be basking on beaches or resting in holes or caves (USN 2009b, p. 52 and references within). Therefore, if a sea turtle is seen on a beach by participating aircraft, training will be altered until the sea turtle leaves the beach and nearby waters (USFWS 1997, 17 pp.).

4.1.4 The USN will conduct an island-wide rat eradication on Farallon de Medinilla. Diphacinone has recently been approved for conservation purposes by U.S. Environmental Protection Agency for rat eradications (USEPA 2007, 4 pp). If use of other toxicants is desired, then the USN will reinitiate this consultation as only the use of Diphacinone has been evaluated within the effects analysis. This action will provide direct benefits to nesting seabirds (eggs and nesting substrate) and indirect benefits to Micronesian megapodes by increasing vegetation on certain portions of the island, limiting competition, and by reducing predation risk. Line item funding (project specific funding) for this action has been requested for FY12. The USN policy is to contract actions to appropriate qualified contractors as quickly as possible once funding has been received.

4.1.5 The USN proposes to conduct research on the life history of the Micronesian megapode on Saipan and Sarigan. The data collected will include: identification and habitat evaluation of breeding sites; observations on breeding behaviors; number of eggs laid per female; duration of egg and juvenile phases, survival ratios for egg and juvenile phases; genetic data and other information necessary to evaluate population viability (restricted to Saipan and Sarigan). These data will be used to better recover the species by: estimating a minimum viable population, understanding behaviors in a "large" and a "small" population, and describing potential interactions between island populations. Line item funding (project specific funding) for this action has been requested for FY12. The USN policy is to contract actions to appropriate qualified contractors as quickly as possible once funding has been received.

4.1.6 The USN will conduct megapode surveys on Farallon de Medinilla to estimate density and abundance for this population every five years. These surveys will follow existing transects and methods established during prior surveys (Vogt 2009a, 12 pp.). Surveys will be conducted in coordination with other range management activities. These surveys will evaluate population trends, affects from military training, and the success of the avoidance, minimization, and conservation measures implemented on Farallon de Medinilla. Line item funding (project specific funding) for this action has been requested for FY12. The USN policy is to contract actions to appropriate qualified contractors as quickly as possible once funding has been received.

4.1.7 Seabird population monitoring will occur quarterly at Farallon de Medinilla. Surveys will be conducted using aerial observation (Vogt 2009b, 13 pp.).

4.2 Saipan

4.2.1 Training events as described under the MIRC will be conducted within areas of Saipan that are not near known occupied Mariana swiftlet caves, the two major wetland areas that support Mariana common moorhen, or beaches that could be used by sea turtles.

4.2.2 Training in the Marpi Maneuver Area is expected to be infrequent and limited to pedestrian land navigation training.

a. Training will be limited to open areas (i.e., grasslands; no forest or mixed shrub and scrub habitats) to minimize impacts to nightingale reed-warblers, Mariana fruit bat, and Micronesian megapodes.

b. The individual Commanding Officer conducting the training under guidance of the DoD representative will restrict training in the Marpi Maneuver Area to the nightingale reed-warbler non-peak breeding seasons (April through June; and October through December). If these training restrictions cannot be accommodated, the USN will contact the CNMI government, including Division of Fish and Wildlife regarding avoidance measures.

c. There will be no digging in the soil or cutting of vegetation along the southern border of the Marpi Maneuver Area in the mixed limestone forest (see Figure 2). No ground disturbance or vegetation removal of any kind is permitted in this area to avoid impacts to the Micronesian megapode and Mariana fruit bat. No habitat will be removed for any training activity on Saipan.

d. Smoking is not permitted during training activities and fire-safe portable receptacles for cigarette butts are used during periods of rest between training activities. No fires are permitted during bivouac activities.

e. If other areas are needed for training, the USN will contact the USFWS regarding the need for reinitiation of this biological opinion.

4.3 Tinian

Existing conservation measures for MIRC training are associated with limiting potential effects to sea turtles, Mariana common moorhen, Micronesian megapode, and Mariana fruit bat from aircraft training, amphibious landings, bivouac training, and vehicle and pedestrian land navigation within the Military Lease Area.

4.3.1 The USN will implement training restrictions at Unai Chulu, Unai Babui, and Unai Dankulo to avoid and minimize effects to sea turtles.

a. Biologists, trained in identifying sea turtle nests, will survey landing beaches no more than six hours prior to the first craft landing or use of other beach landing equipment. Any potential sea turtle nests will be flagged and avoided by landing craft and personnel.

The buffer zone will have a radius of 6 meters from the edge of the nesting activity (area disturbed by the turtle) to ensure complete avoidance.

b. Beach training activities will be coordinated with the monthly monitoring (see 4.5.4, below). If an active nest has been discovered, night-training will not occur once a pre-hatch hole is detected. (A pre-hatch hole indicates that the nest will hatch that evening.) Evening training may resume five days after the pre-hatch hole is discovered.
c. Further, each landing activity has a "beach master" that would stop vehicle approaches if sea turtles or sea turtle nests were observed on the land.

d. At Unai Chulu, the USN recognizes that surge waves generated by slow moving landing craft could break off coral heads and cause beach scour, degrading foraging habitat and resulting in erosion of nesting habitat for sea turtles. To minimize the surge effect, air cushioned landing craft use on Tinian is scheduled for high-tide and craft stay on-cushion until clear of the water. Landings occur only within a designated craft landing zone.

e. Within the craft landing zone, air cushioned landing craft come off-cushion onto an offload and vehicle traffic area. The USN recognizes ruts resulting from vehicle traffic on beaches may prevent sea turtle hatchlings from reaching the water and expose them to predation or desiccation. Although vessels and expeditionary vehicle traffic typically do not leave ruts, some compaction of sand in vehicle tracks is possible. If compaction occurs, beach topography will be restored within three days using non-mechanized methods (e.g., rakes, hand tools).

f. Amphibious assault vehicle landings at Unai Babui are restricted to an established approach lane and land at high tide one vehicle at a time.

g. The USN will ensure that protective measures are developed for amphibious landings and other training activities at implemented at Tinian beaches. Protective measures incorporate the restrictions within this biological opinion (and referenced documents) and are applied to a detailed training constraints map to be used by military service personnel.

h. Improvements to any beaches to facilitate training, will be coordinated with the USFWS if the action may affect listed species.

4.3.2 The USN currently implements and will continue to implement training restrictions near wetlands to avoid and minimize impacts to the Mariana common moorhen.

a. Lake Hagoi and adjacent areas are designated by the USN as a "No Training Area" (see Figure 3). Within a "No Training Area" ground disturbance or vegetation removal of any kind is prohibited. Training only occurs on existing roads and trails; therefore, the Mahalang and Bateha wetlands are avoided as well as there are no roads or paths that access these features.

b. The USN restricts helicopter training over Tinian wetland areas. Helicopters must maintain a minimum altitude of 305 meters (1,000 feet) above ground level during training exercises that require flights over Hagoi. The USN avoids flights over Mahalang wetland and Bateha wetlands.

4.3.3 The USN implements training restrictions within some forested areas to avoid and minimize impacts to the Micronesian megapode and Mariana fruit bat.

a. Limestone forest habitat on Tinian is a "No Wildlife Disturbance Area." Therefore the following actions are prohibited: cross-country, off-road vehicle travel, vehicle parking unless it is on cleared shoulders of existing roads or trails; pyrotechnics, demolitions, or breaching charges; digging or excavation without prior approval; open fires; mechanical vegetation clearing; live ammunition; firing of blanks; flights below 305 meters (1,000 feet) above ground level; and helicopter landings except in designated landing zones..

b. Maneuver units are tactical and will not have support camps.

c. Within the Federal Aviation Administration mitigation area, low-impact training may occur so long as it is compatible with the habitat and living conditions of the Tinian monarch (USN and CNMI 1999, p. 2).

d. If additional training areas outside the USN leased lands on Tinian are needed, the USN will coordinate with the USFWS.

4.3.4 The USN implements fire prevention and management within the Military Lease Area to benefit all listed species and their habitats.

a. No live-fire or tracer rounds will be used on Tinian. Use of pyrotechnics, flares, blank fire, and other potential fire-starting activities must be conducted on existing cleared runways and in accordance with the Fire Prevention Plan. The area authorized for open fires and pyrotechnics is restricted to the North Field and West Field on hardtop surfaces only (except for actual emergency signaling).

b. Cooking by individuals is not authorized in outdoor training areas (except for heating tabs and mechanisms in "meals ready to eat"). Large scale training exercises may include field kitchens in North Field in areas authorized for open fire.

c. North Field's existing runways and taxiways act as fire breaks and fire access roads, and the vegetation is primarily characterized by tangantangan (*Leucanena leucocephala*) thickets. Standard Operating Procedures for all exercises include fire response measures that must be implemented.

d. To date, no wildland fire has been ignited from MIRC training activities on Tinian (or on other DoD lands in the Mariana Islands). However, to further minimize risk and augment military fire response efforts, the Tinian Fire Department maintains a 300-gallon pump truck and fire crew to respond to wildland fires. The Tinian Fire Department also maintains a 750-gallon pumper truck and crew in San Jose to respond to and provide fire service for the southern Tinian and backup Crash-Fire-Rescue support to West Field. The USN will request the use of Tinian Fire Department assets for major exercises. The request will be made through the West Field command post. The USN will maintain airfield crash-fire-rescue equipment and crews at North Field for the duration of the exercise. Any military related fires will be controlled prior to the loss of any wetland or native limestone forest habitat is burned. Any military related fires in tangantangan will be controlled prior to the loss of five acres tangantangan habitat.

4.3.5 The next iteration of the Integrated Natural Resources Management Plan (INRMP) for DoD lands on Tinian and Farallon de Medinilla will include a management plan specific to Lake Hagoi and other wetlands within the Military Lease Area. The management plan will benefit the Mariana common moorhen and provide additional protection for these unique wetland areas.

4.3.6 The USN will continue monitoring Mariana common moorhen at Lake Hagoi to evaluate population trends and to determine success of avoidance and minimization measures described above (Vogt 2008, 10 pp.).

4.3.7 The USN will continue to monitor limestone forest habitats for the Micronesian megapode, Mariana fruit bat, and other native species to evaluate population trends and to determine success of avoidance and minimization measures described above (Vogt 2008, 10 pp.).

4.3.8 The USN will continue monitoring all sandy areas within Military Leased Lands on Tinian on a monthly basis (approximate) (Vogt 2008, 10 pp.). During the monthly sea turtle surveys, crawls, nests, potential nests, body pits, and hatchling tracks are noted. In addition, any beach erosion and compaction will be recorded during these surveys. Monitoring occurs at Unai Dankulo (Long Beach), Unai Chulu, Unai Masalok, and Unai Lamlam. These data are used to assess species trends, evaluate affects from military training, and the success of the avoidance, minimization, and conservation measures implemented on Tinian.

4.4 Rota

4.4.1 No maneuver training will occur on Rota.

4.4.2 The USN will not initiate any action requiring the removal, trimming, or pruning of any tree (or other vegetation) known to support nesting, roosting, or foraging habitat for the Mariana crow, Mariana fruit bat or Rota bridled white-eye.

4.4.3 No training activities will occur near or within critical habitat, habitat occupied by listed species, or other habitats designed for conservation use. If such activities are planned in the future, the USN will consult with the USFWS pursuant to section 7 of the ESA.

4.5 Guam

4.5.1 To avoid and minimize impacts to Mariana crow and Mariana fruit bat, DoD will continue to implement all the conservation measures and terms and conditions from the Northwest Field Beddown (USFWS 2006a, 7pp.; USFWS 2009c, 5 pp.; USFWS 2009d, 6 pp.) and the ISR Strike Establishment projects (USFWS 2006b, 73 pp.) consultations.

4.5.2 Areas identified within the Northwest Field Beddown and ISR Strike Establishment projects as mitigation areas will be designated as "No Training and Wildlife Disturbance Areas" to avoid effects to essential habitat and mitigation areas.

4.5.3 DoD will implement the following restrictions at all action areas on Andersen Air Force Base:

a. No vegetation clearing except: maintenance required to keep paved surfaces, landing zones, and the drop zones in a safe and useable condition and for bivouac purposes in the bivouac area. Tree species greater than 4-inches in diameter used for foraging, roosting, or nesting of bats and crows will not be removed.

b. Motorized vehicles shall be driven only on prepared surfaces, in the drop zone and landing zones as required and only rubber-tired vehicles will be allowed; no digging is allowed except in the Northwest Field bivouac area; and no harassment or killing of native wildlife is allowed.

c. Use of pyrotechnics and other incendiary devices is limited to paved surfaces, ground pits, or ceramic-lined rooms (USFWS 2006a, p. 2).

4.5.4 DoD will maintain helicopter and fixed-wing flight restrictions associated with training over portions of Northwest Field and Pati Point (USN 2009b, p. 33)

a. At Northwest Field, helicopter overflights north of the South Runway are prohibited below 305 meters (1,000 feet) above ground level.

b. Overflights of the Munitions Storage Area are prohibited below 305 meters (1,000 feet) above ground level.

c. Overflights within 915 meters (3,000 feet) of Pati Point are prohibited below 488 meters (1,600 feet) mean sea level, except for flights from the end of the Andersen Main runways.

4.5.5 DoD will implement Training Schedule Modifications (see also USFWS 2006b, 73 pp.) on Andersen AFB for post-typhoon actions and during Mariana crow nesting periods. After a typhoon event, food resources for the Mariana crow and Mariana fruit bat may be severely reduced, and therefore these species are under greater physiological stress. After a typhoon, the USAF implements the following modifications to training schedules:

a. If crows are nesting within an (approximate) 1,800-meter (5,906-feet) radius of cratering exercises and within 500 meters (1,640 feet) of small arms firing, no crater charges will be detonated within two to three months of a typhoon event.

b. If Mariana crows are nesting within these buffer areas within one to two months of a typhoon event, no cratering charges will be detonated, and no M2, M115A, and M116A munitions will be used.

c. If crows are nesting within these buffer areas within one month of a typhoon event, no training events will occur in the Northwest Field training areas.

d. The DoD will coordinate with Guam Division of Aquatic and Wildlife Resources on training schedules to avoid and minimize effects to solitary roosting bats or foraging bats after typhoon events.

4.5.6 The USN implements helicopter and fixed-wing flight restrictions associated with training over portions of the Naval Munitions Site to avoid and minimize effects to Mariana swiftlets, Mariana common moorhen, and Mariana fruit bat.

a. Helicopter bucket training at Fena Reservoir occurs in deeper waters towards the center of the reservoir, and avoids emergent vegetation areas in the shallower portions of the reservoir used by Mariana common moorhen.

b. The USN prohibits flights over the Naval Munitions Site below 305 meters (1,000 feet) above ground level for fixed-wing aircraft and 153 meters (500 feet) above ground level for helicopters (except at designated landing and drop zones) to minimize disturbance to Mariana fruit bat, Mariana common moorhen, and Mariana swiftlet.

c. The USN is coordinating with the Federal Aviation Administration regarding the development of a new drop and landing zone in the Communications Annex-Finegayan area named Ferguson Hill. If FAA determines that Ferguson Hill is an acceptable location for a new drop and landing zone, the USN will coordinate with the USFWS to determine if overflight restrictions or other avoidance and minimization measures are needed to reduce effects to listed species and their habitats. Overfight restrictions will not be included at the landing zone approaches which must be approached at heights above ground level consistent with training and safety.

4.5.7 Riparian wetlands are dispersed throughout the Northern and Southern Land Navigation Area. Currently these areas do not serve as habitat for Mariana common moorhen. However, if these wetlands become suitable (i.e., the area begins to supports palustrine, open water), no maneuver and navigation training will occur in these areas unless the action is reviewed pursuant to section 7 of the ESA.

4.5.8 The USN will establish a 100-meter (328-feet) "No Training Buffer Zone" around the three known Mariana swiftlet caves within the Naval Munitions Site.

a. Within the "No Training Buffer Zones" the following actions are prohibited: use of live ammunition, the firing of blanks, open fires, pyrotechnics, demolitions, training demolition or breaching charges, digging or excavation without prior approval, mechanical vegetation clearing, flights below 305 meters (1,000 feet) above ground level, helicopter landings except in designated landing zones, and cross-country and off-road vehicle travel except specifically authorized administrative troop and vehicle movement on designated trails or existing paved roads.

4.5.9 The USN implements restrictions at beach and boat ramp locations to minimize impacts to sea turtles and their habitats.

a. The USN maintains restrictions on landings and launches, such as the use of the concrete boat ramp at Sumay Cove which is across from potential sea turtle nesting habitat.

b. The USN implements speed restrictions to avoid creating wakes, the use of the Sumay Cove ramp avoids and minimizes effects to sea turtle nesting sites.

c. Currently, training does not occur on other Guam beaches that support sea turtles. Should the USN decide to use other Guam beaches for amphibious landings, the USN will implement the measures described above for sea turtles (see 4.3.1 and 4.3.8).

4.5.10 The USAF implements training and operation restrictions at the Combat Arms Training and Marksmanship (CATM) range at Tarague Beach, Guam to minimize effects to sea turtles, Mariana crow, and Mariana fruit bat.

a. Night-training occurs at the CATM range; therefore night-lighting is installed. The lighting configuration at this location is maintained with four flood lights, located below the tree canopy level that are directed inland and parallel to the coast. Lighting in this configuration will avoid impacts to nesting and hatching sea turtles and Mariana fruit bats.

b. The CATM range allows for training with small arms, inert mortars to 60 millimeter, and 40 millimeter grenade launchers. These weapons do not produce percussive force and no weapons that produce percussive force can be used at this facility.

4.5.11 The U.S. Forest Service has developed a fire management plan that the USN will use to develop a Naval Base Guam Wildland Fire Management Instruction to implement at the Naval Munitions Site and other USN lands on Guam (U. S. Forest Service 2008). The plan includes fire danger modeling of different fuel loadings within the Naval Munitions Site and determines if new fuel breaks are needed to protect personnel and infrastructure. These protections should benefit endangered and threatened species and their habitats. Any military related fires will be controlled prior to the loss of any wetland, native forest, or mixed limestone forest habitat.

4.5.12 To address the loss of potential breeding and foraging habitat from the Northwest Field Beddown (USFWS 2006a, 7pp.; USFWS 2009c, 5 pp.; USFWS 2009d, 6 pp.) and the ISR Strike Establishment projects (USFWS 2006b, 73 pp.) the USAF will continue to implement all conservation measures and terms and conditions from these previous consultations.

4.5.13 An ungulate management plan and an Environmental Assessment for USN and USAF are currently in development and upon implementation will provide a long-term program and methods for a sustained reduction of ungulates on DoD lands. Implementation is anticipated beginning FY12.

4.5.14 The USN will monitor behavior of moorhens at Fena Reservoir during the first three training exercises. If any behavioral changes are detected that could lead to take (i.e., changes that suggest a bird may alter foraging, breeding, or nesting behaviors), the USN action will cease all activities until additional section 7 consultation is completed.

4.5.15 The USN will continue (per their INRMP) to trap brown treesnakes in areas surrounding the Mariana swiftlet caves to reduce or prevent brown treesnake predation on the swiftlets and will continue to monitor swiftlet population trends on Guam to evaluate success of avoidance, minimization, and conservation measures described above.

4.5.16 The USN will monitor the Mariana fruit bat at the Pati Point colony and at other locations above and below the cliff line to determine if the Pati Point colony is shifting from its historical location. These data will be used to assess the current population size at the colony and determine if additional adaptive management actions are needed to minimize impacts associated with ISR Strike and MIRC.

SPECIES STATUS AND ENVIRONMENTAL BASELINE

Below is a summary of the biology and ecology of each species, critical habitat, and essential habitat considered within this consultation (refer to Table 1). Species and habitat for which a "no effect" or "may affect, not likely to adversely affect" are discussed as our concurrence relies upon proper implementation of the conservation measures proposed within the project description above. Failure to implement the conservation measures would result in a non-concurrence determination and consultation would need to be reinitiated. The environmental baseline describes the status of the species and factors affecting the environment of the species or critical habitat in the proposed action area during the consultation process. The baseline includes state, local, and private actions that affect a species at the time the consultation begins. Unrelated Federal actions that have already undergone formal or informal consultation are also a part of the environmental baseline. Federal actions within the action area that may benefit listed species or critical habitat are also included in the environmental baseline. The environmental baseline describes the species' health at a specified point in time, and it does not include the effects of the action under review in this consultation.

No Effect Determination

Plants

Osmoxylon mariannense and *Nesogenes rotensis* are two endangered plant species restricted to the island of Rota. *Serianthes nelsonii* (Hayun lagu) is an endangered tree that occurs on both Rota and Guam. The USN made a no effect determination for these three species because the training associated with MIRC will not overlap spatially with any of the known locations of these plants or in habitats where unknown specimens could occur on Rota (USN 2009b, p. 3). Training will overlap with suitable habitat for *Serianthes nelsonii* on Guam; however, the USN made a no effect determination because training actions are at least 300 meters from known locations of this species (USN 2009b, p. 3; see conservation measures 4.5.2 and 4.5.3). Additionally, the USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions as additional introduction or spread of invasive species could adversely affect these very rare plants (see conservation measure 1.0). We believe that avoidance of the plants and their suitable habitats along with the implementation of the invasive species interdiction and control conservation measures are key in supporting a no effect determination. Failure to implement these conservation measures would result in a non-concurrence determination from our office.

Terrestrial birds

The USN made a no effect determination for the Guam Micronesian kingfisher (*Todirhamphus cinnamominus cinnamominus*), Guam rail (*Gallirallus owstoni*), and Rota bridled white-eye (*Zosterops rotensis*). Guam Micronesian kingfisher is endemic to Guam and is no longer extant in the wild. The Guam rail is no longer extant in the wild on Guam; however, the species is currently extant on Rota. The Rota bridled white-eye is endemic to Rota. The training associated with MIRC will not overlap spatially with known locations or habitats on Rota that support the Guam rail or the Rota bridled white-eye (USN 2009b, 101; see conservation measures 4.4). Additionally, the USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions as additional introduction or spread of invasive species could adversely affect these birds on Rota (see conservation measure 1.0). We believe that implementation of the avoidance measures and invasive species interdiction and control measures are key in supporting a no effect determination. Failure to implement these conservation measures would result in a non-concurrence determination from our office.

Although the rail and kingfisher are extirpated from the wild on Guam, essential habitat for the recovery of these species is located on Guam. Per the requirements identified in the Cooperative Agreement between the USAF, USN, and the U.S. Fish and Wildlife Service (USFWS) for the establishment and management of the Guam National Wildlife Refuge (USAF and USFWS 1994, p. 6; USN and USFWS 1994, p. 6), we have provided coordination regarding potential impacts to essential habitat from the proposed project. See Essential Habitat for a summary of effects to essential habitat.

Seabirds

The ocean surface and undersea areas of the MIRC extend from waters south of Guam to north of Pagan (CNMI) and from the Pacific Ocean east of the Mariana Islands to the middle of the Philippine Sea, encompassing 501,873 square nautical miles (1,299,851 square kilometers) of open ocean and coastal areas (USN 2009a, p. 1-7). However, the USN has made a no effect determination for endangered and threatened species using the open ocean that are under the jurisdiction of the USFWS (short-tailed albatross, *Phoebastria albatrus*; Hawaiian petrel, *Pterodroma sandwichensis*; and Newell's shearwater, *Puffinus auricularis newelli*) because these species are only occasionally sighted flying through the action area. To reduce impacts to these and other seabirds protected under the Migratory Bird Treaty Act (16 U.S.C. 703 *et seq.*), as amended, the USN will implement multiple conservation measures (see 4.1.1; 4.1.4; and 4.1.7 within this biological opinion and USN 2009a, pp. 3.10-32, 3.11-66, 3.11-67). Therefore, actions occurring on the ocean surface, undersea, and the airspace above the open ocean will not be discussed further within this biological opinion.

Critical Habitat
There are three critical habitat units within the action area of the MIRC. Ritidian Point on Guam provides critical habitat for the Mariana fruit bat, Mariana crow, and Guam Micronesian kingfisher. Critical habitat on Rota is comprised of two units: one for the Mariana crow and one for the Rota bridled white-eye. The training associated with MIRC is spatially separated from the locations of each of these critical habitat units; therefore, the USN has made a no effect determination (USN 2009b, p.98). Additionally, the USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of indirect effects resulting in erosion, hazardous waste contamination, and the introduction, spread, and establishment of non-native invasive species due to MIRC actions (see conservation measures 1.0; 2.0; and 3.0). We believe that the implementation of these conservation measures are key in supporting a no effect determination, as additional erosion, contamination, or introduction or spread of invasive species could adversely affect these habitats such that the primary constituent elements could become non-functional (i.e., loss or destruction of foraging or roosting trees; loss of diverse structure; increased exposure to human activity or increased edge) (USFWS 2004, pp. 62,947 – 62,949). Failure to implement these conservation measures would result in a non-concurrence determination from our office.

Listed Species and Critical Habitats that Occur Outside Guam and the Commonwealth of the Northern Mariana Islands
We did not evaluate listed species or designated critical habitat in areas outside the MIRC action area that may support the movement of troops, materials, or equipment to and from action areas within MIRC (e.g., transporting troops from Guam to California or from California to Guam). We made this decision based upon conservation measures proposed by the USN as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions (see conservation measure 1.0). We believe that the implementation of invasive species interdiction and control is essential to prevent invasive species risks, as additional introduction or spread of invasive species could adversely affect listed species and their habitats. Failure to implement these conservation measures may result in the need to consult on additional species or action areas.

Not Likely to Adversely Affect Determination
Sea turtles – General
The USFWS and the National Marine Fisheries Service (NMFS) share ESA responsibilities for sea turtles. The USFWS addresses all issues involving sea turtles using terrestrial habitats; whereas, NMFS addresses sea turtles and their habitats in the marine environment. Therefore, we reviewed the proposed action for its potential impacts on eggs, hatchlings, nesting, and basking sea turtles, using terrestrial sea turtle habitat only. The following sea turtle biology section is summarized from recovery plans and five-year status reviews developed by the NMFS and USFWS and the references within (NMFS and USFWS 1998a, 95 pp.; 1998b, 95 pp.; 2007a, 105 pp.; 2007b, 93 pp.). Sea turtles are highly migratory, globally distributed, and generally found in tropical and subtropical waters along continental coasts and islands between 30° North and 30° South. The geographic range of sea turtles includes the Caribbean Sea, Atlantic, Pacific, and Indian Oceans and associated bodies of water.

Sea turtles use oceanic beaches for nesting. Upon hatching, sea turtles dig upward out of the sand, follow the light reflection from the moon and stars to reach the water, and then migrate to the open ocean. Emergence generally occurs at night and new hatchlings are strongly photopositive. Thus, they can be disoriented from the water if artificial lighting is present. Post-hatchling sea turtles then enter a primarily pelagic life stage of which little is understood. They are thought to drift along major current systems for several years, where they are assumed to forage at or near the surface along converge zones. Juvenile green and hawksbill sea turtles recruit to near-shore foraging habitats upon reaching a carapace length of about 35 centimeters. When sexually mature, sea turtles begin making breeding migrations that may span thousands of kilometers between their resident foraging grounds and their nesting areas.

Time from the hatchling stage to reproductive maturity may be as long as 20 to 50 years. Female sea turtles have high site fidelity to their hatching (natal) beaches, returning close to their own hatching site to lay their nests. Females crawl up the beach until a suitable area for nesting is found and dig a hole in the sand to lay their eggs. Nests are buried in the sand along the upper edge of the beach, often in the vegetation. Newly laid nests can be detected prior to beach disturbance by the presence of turtle "crawl" tracks in the sand or a characteristic depression in the sand where the nest is buried. Nest digging, egg laying, and nest burial can take several hours. Females may nest multiple times over a given nesting season. Nesting seasons typically occur at semiregular intervals, with inter-nesting intervals ranging between two to more than five years depending on the species. In addition to nesting, green sea turtles may also use beaches to haul out and bask, although this behavior has never been documented in Guam or the CNMI (CNMI) (Kelly 2009, pers. comm.; Wusstig 2009, pers. comm.).

Green sea turtle

Green sea turtles (*Chelonia mydas*) are regularly recorded in the waters surrounding Guam, Tinian, Rota, and Saipan (Kolinski *et al.* 2004, p. 110; Kolinski *et al.* 2001, p. 55; Kolinski *et al.* 2006, p. 509). Turtles have been detected around most of the northern islands within the CNMI (Ilo and Manglona 2002, p. 4), although in lesser abundance than in the southern islands (Kolinski *et al.* 2005, p. 290). Approximately 1,000 to 2,000 green sea turtles inhabit island reef areas in Guam and the southern CNMI (Rota, Tinian, Aguiguan, Saipan, and Farallon de Medinilla) (Kolinski *et al.* 2004, pp. 98, 111). In 1995 and 2001 (Tinian), 1999 (Saipan) and 2003 (Rota), the majority of individuals observed in the surrounding waters were juveniles or subadults (Kolinski *et al.* 2001, pp. 59, 66; Kolinski *et al.* 2004, p. 107; Kolinski *et al.* 2006, pp. 514, 517; Pultz *et al.* 1999, p. 92). The relationship or mixed stock analysis between the foraging population surrounding Guam and CNMI and source rookeries is not yet defined (Kolinski *et al.* 2004, p. 118; Kolinski *et al.* 2006, pp. 517 -518). The resident foraging population of green sea turtles at Tinian and Saipan is much greater than the number of turtles that may nest at these islands (Kolinski *et al.* 2004, p. 113). As is typical of other sea turtle populations, the nesting population on Tinian is likely a separate population from the turtles that forage there and are present all year (Pultz *et al.* 1999, p. 92). The foraging of genetically distinct populations (i.e., recruits from different nesting beaches) in the same waters has been documented for green sea turtles (and other species) suggesting that green sea turtles may randomly recruit to regional feeding populations (Bowen 1995, pp. 530, 532 and references within). Pultz *et al.* (1999, p. 92) also indicated that green sea turtles are known to have distinct foraging and nesting grounds, which are often thousands of kilometers apart. One foraging turtle tagged at Tinian was found nesting in the Philippines. Post-nesting green sea turtles have been documented to migrate between Guam and Kume Shima Island, Japan; the Philippines; and Indonesia (Wusstig 2009, pers. comm.). Therefore, it is unlikely that the population of juveniles and subadults found in the waters surrounding Guam and the CNMI contribute to the nesting population of the archipelago. NMFS is continuing to build rookery data to complete a stock assessment of foraging and nesting turtles within Guam and the CNMI (Kelly 2009, pers. comm.).

The status of some breeding green sea turtle populations in the Pacific (Hawaii, Australia and Japan) are increasing (Chaloupka *et al.* 2008, p. 299; NMFS and USFWS 2007a, p. 13); however, population trend data that may be available for other breeding concentrations do not span a full generation for the species (NMFS and USFWS 2007a, pp. 12-14). The nesting population on Guam is currently considered stable (NMFS and USFWS 2007a, p. 13). Nesting beaches on Guam include: Adotgan Dangkolo, Adotgan Dikiki, Waterfront Annex of Naval Base Guam, Kilo Wharf area, Spanish Steps, Cocos Island, Asiga Bay, Nomnia area, Deley Beach, Turtle Cove to Togcha Beach, Tagachan Beach, Andersen Air Force Base (Tarague Beach, Sirena Beach, Pati Point), Jinapsan Beach, Cetti Bay, Sella Bay, Inarajan Beach, Acho Bay, Guam National Wildlife Refuge, Haputo area, Urano area, Tumon Bay, and Cabras area (Sea Plane Beach) (Wusstig 2009, pers. comm.; Grimm and Farley 2008, p. 1).

Population trends for nesting green sea turtles within the CNMI are unavailable and surveys for nesting sea turtles have not been conducted in the northern islands within the CNMI with the exception of Anatahan (Ilo and Manglona 2002, p. 5). At the time of their survey, Anatahan did not support nesting habitat due to the rocky shoreline (Ilo and Manglona 2002, p. 5); however, since the volcanic eruption in early 2003, ash has been deposited forming potentially suitable nesting habitat (Kessler 2009a, pers. comm.). Pagan and Agrihan also have black sand beaches that may support sea turtle nesting (Kessler 2009a, pers. comm.). The suitability of nesting habitats within the northern islands has not been quantified. However, the other northern islands have steep volcanic slopes and rock beaches that would likely not support nesting (Kelly 2009, pers. comm.; Kessler 2009a, pers. comm.). Nesting of green sea turtles likely occurs on all beaches on Tinian (Pultz *et al.* 1999, p. 85); five beaches on Saipan (Unai Fanonchuluyan (Bird Island Beach), Unai Halaihai (Tang Beach), Unai Obyan, Unai Makpe (Wing Beach) and Laulau Beach (Ilo *et al.* 2005, p. 6; Kolinski *et al.* 2001, p. 59); and may occur on 11 beaches on Rota (Songton beach, Teteto beaches, Mochong beaches, Sagua (Kokomo Beach), Gagani (Coral Garden Beach), Okgok, Apanon, and Gaonan (the Cave Beach), Uyulan Beach, Tatgua Beach, and Latte Stone (Lalayak or I Batko) (Ilo and Manglona 2001, p. 9).

Nesting activity on Guam occurs throughout the entire year and peaks between April and July (Grimm and Farley 2008, p. 1); occurs from April through August on Saipan (Kolinski *et al.* 2001, p. 57); and occurs from January through mid-July on Tinian (Pultz *et al.* 1999, p. 86). Though nesting is known to occur, only low-level nesting has been reported for Saipan, Tinian, Rota, and Guam (Kolinski *et al.* 2001, p. 59; Pultz *et al.* 1999, pp. 84, 87; Kolinski *et al.* 2004, p. 113; Grimm and Farley 2008, p. 3). For example, green sea turtle nesting activity has been documented on Saipan with 4 to 18 nests laid per year, by an estimated 1 to 4 nesting females, respectively (Kelly 2009, pers. comm.). Female green sea turtles may nest four to five times over a given nesting season, with approximately 12 to 14 days between each nesting event (Kelly

2009, pers. comm.; Wusstig 2009, pers. comm.). Though, one large female on Guam was observed to deposit six clutches during one nesting season (Wusstig 2009, pers. comm.). Clutch data (n = 7 nests) from Guam during 2005, indicated that the total number of eggs within a nest ranged from 19 to 124 (Mean = 83 eggs) (Wusstig 2008a, pers. comm.). Hatching success of these nests was 84 percent and approximately 93 percent of the hatchlings emerged successfully (Wusstig 2008a, pers. comm.). Incubation periods on Guam may range between 50 and 90 days (Grimm and Farley 2008, p. 1). On Tinian, mean clutch size was 91 eggs, incubation period was 62 days, and hatching success was 89 percent for successful nests (Pultz *et al.* 1999, p. 85). One nest on Saipan was observed to hatch after 63 days and hatchlings were first detected on the island in late June (Kolinski *et al.* 2001, p. 59).

Hawksbill sea turtle

Hawksbill sea turtles (*Eretmochelys imbricata*) are frequently sighted in the near shore waters surrounding Guam (Grimm and Farley 2008, p. 1) and have been detected near Anatahan (Ilo and Manglona 2002, p. 5). This species was not observed during marine and terrestrial surveys between 1999-2003 at Tinian, Aguiguan, and Saipan (Kolinski *et al.* 2004, p. 110; Kolinski *et al.* 2001, p. 55; Kolinski *et al.* 2006, p. 509). However, two hawksbill turtles were captured by the in-water monitoring program around Saipan in 2009 (Kelly 2009, pers. comm.). Foraging hawksbills may occur in relatively high numbers around the Northern Mariana Islands and have been sporadically detected in the waters surrounding Farallon de Medinilla and possibly Rota (Kolinski *et al.* 2004, p. 110 and references within). During 2001, a single hawksbill sea turtle was observed in the waters surrounding Rota; however, the observation was not confirmed (Ilo and Manglona 2001, p. 4).

The status of breeding hawksbill sea turtles is generally decreasing globally; however, there has been a recent increase in reproductive effort within the Atlantic Ocean basin and at one location (Hawaii) in the Pacific Ocean basin (NMFS and USFWS 2007b, pp. 19-20 and references within). These data should be viewed with caution as they are a rough estimate of total reproductive output, not all sites have been surveyed, and some data represent single years only (NMFS and USFWS 2007b, p. 20). On Guam, the population is thought to be declining, with less than ten females expected to nest per season (NMFS and USFWS 2007b, p. 19). No trend data are available for the CNMI. Although anecdotal information suggests that hawksbill nesting occurred historically within the CNMI, no nesting activity has been documented in recent years (Kelly 2009, pers. comm.). As described for the green sea turtle above, hawksbill sea turtles also recruit to foraging grounds that may be hundreds or thousands of kilometers from their natal beaches (Bowen 1995, p. 532) and as such the CNMI may support only a foraging population of hawksbill sea turtles.

Hawksbill sea turtles were reported nesting in June and July at Tarague Beach, Guam; however, this is based on only one year of data (Wusstig 2008a, pers. comm.). Between 1991 and 1994, hawksbill sea turtles nested in Sumay Marina, Guam, during varying months – October, December, February, and March (Wusstig 2008b, pers. comm.). An average of 55 days (51 to 58 days; 4 nests) was documented from the time of nest discovery to nest hatch. Clutch sizes ranged from 81 to 121 eggs. Hatchling data is incomplete; however one clutch of 121 eggs produced 70 hatchlings. In 2008, four nesting attempts at Adotgan Dikiki, Guam were attributed to the hawksbill sea turtle (Grimm and Farley 2008, p. 3).

The MIRC activities on Saipan and Rota do not overlap with known sea turtle nesting areas (see conservation measures (4.2.1 and 4.4). Sea turtles have been detected in the marine environment surrounding Farallon de Medinilla (Vogt 2009b, pp. 2, 9-10) while basking turtles have not been documented on Farallon de Medinilla, basking could occur. Nesting does not occur on Farallon de Medinilla as the beach is submerged by high tide (Lusk *et al.* 2000, p. 24). Conservation measures (see 4.1.3) will be implemented to avoid a direct strike or excess noise generation while sea turtles may be basking on Farallon de Medinilla. Sea turtles do not feed while on shore and will therefore, not be exposed to toxicity from rodenticide for conservation use (see conservation measure 4.1.4).

Tinian training areas that are known to support sea turtle nesting are: Unai Chulu, Unai Dankulo (Long Beach), Unai Babui, Barcinas Beach, and Unai Lam Lam (Vogt 2008, p. 7; Ilo *et al.* 2005, p. 7). Guam training areas that may or are known to support sea turtle nesting are: Haputo Beach, Kilo Wharf area (Spanish Steps), Gab Gab Beach and San Luis Beach, (both near Sumay Cove), Sumay Cove, and Sirena Beach. The MIRC activities that may impact sea turtles in terrestrial habitats include noise from explosions at the EOD pit near Tarague Beach; nest disturbance or destruction and beach erosion from the use of landing craft air cushion, landing craft utility, amphibious assault vehicles, combat rubber raiding craft, rigid-hulled inflatable boats on nesting beaches; and nest disturbance or destruction and beach erosion from over the beach swimmer insertions, combat swimmer special training, diving and anti-terrorism and force protection activities (USN 2009a, pp. 2-4 through 2-7, 2-18 through 2-19). Conservation measures (see 2.0; 4.3.1; 4.3.8; 4.5.9; and 4.5.10) will be implemented to avoid affects (direct strike, nest trampling, excess noise, lighting, etc.) to basking adults, nesting adults, nests, hatching events and hatchlings on Tinian and Guam. Furthermore, these conservation measures will be implemented to prevent erosion of beach habitats such that training does not impact the suitability of beaches to support future nesting. Based upon the conservation measures that will be implemented to avoid adults, nests, and hatchlings and to prevent impacts to their nesting habitats, we concur with your determination that the proposed project may affect, but is not likely to adversely affect, the green sea turtle or the hawksbill sea turtle.

Nightingale reed-warbler

The nightingale reed-warbler (*Acrocephalus luscinia*) is endemic to the Mariana Islands and is known historically from five islands in the Mariana archipelago: Guam, Aguiguan, Saipan, Alamagan, and Pagan. The nightingale reed-warbler is also known prehistorically from Tinian (Steadman 1999, pp. 337-340). The nightingale reed-warbler has been extirpated from Guam since the 1970s (Reichel *et al.* 1992, p. 47, and references within). Surveys conducted on Aguiguan in 2008, did not detect nightingale reed-warblers (Camp *et al.* 2009, p. 12). The last documented sighting of the nightingale reed-warbler on Aguiguan occurred in 1995 (USFWS 1998a, p. 5). The Pagan subspecies was extirpated from Pagan prior to 1981 (Reichel *et al.* 1992, pp. 50-51). Therefore, the current distribution and estimated population of the nightingale reed-warbler includes Saipan (1,686 to 3,956 individuals) and Alamagan (240 to 454 individuals) (CNMI DFW 2000a, p. 10; Camp *et al.* in press, p. 30). The species is now extirpated from over half of its native range and population estimates indicate that the nightingale reed-warbler has declined on Saipan and may be declining on Alamagan (Camp *et al.* in press, p. 30; CNMI DFW 2000a, p. 11).

On Saipan, the nightingale reed-warbler is found in areas of dense understory, including reed marshes, wetland-edge vegetation, forest edge and openings, mixed tangantangan-grassland habitat, mixed tangantangan-secondary forest, and tangantangan forest. While this species is largely absent from mature native forest, beach strand, and swordgrass savannah, it has been detected in limestone forests, near golf courses, and in residential areas (Craig 1992, p. 440; USFWS 1998a, p. 12; Camp *et al.* in press, pp. 12-13). However, these habitats are considered less suitable and statistically significant declines in nightingale reed-warbler densities have been documented in residential areas and at golf courses (Camp *et al.* in press, pp. 12-13).

Training on Saipan is limited to developed areas or relatively open savanna areas, including the Marpi Maneuver Area (USN 2009b, p. 90). The Marpi Maneuver Area is approximately 176 hectares (436 acres) and contains mostly tangantangan thickets, grasslands, mixed secondary forest (151.5 hectares; 374.5 acres); and mixed limestone forest (24.5 hectares; 61 acres). Nightingale reed-warblers are known to use the Marpi Maneuver Area for breeding, feeding, and sheltering; however, densities of the species on the site are unknown. Average home range in upland tangantangan thickets is 4.19 ± 2.1 hectares (10.4 ± 5.2 acres, n = 13) (calculated from Mosher 2006, p. 100). Therefore, we estimate the Marpi Maneuver Area could support approximately 36 pairs of nightingale reed-warblers (151.5 hectares of tangantangan thickets, grasslands, mixed secondary forest divided by 4.19 hectares per pair of birds).
Training within the Marpi Maneuver Area is expected to be infrequent and limited to pedestrian land navigation training in open areas (USN 2009b, p. 90). Pedestrian land navigation training in the Marpi Maneuver Area may cause temporary behavioral disturbances in the nightingale reed-warbler using these habitats for shelter or forage. However, the nightingale reed-warbler is not known to breed in open grassland areas. The USN proposes to implement conservation measures to minimize potential effects by scheduling training to avoid the peak breeding seasons (January through March and July through September) on Saipan (see conservation measure 4.2.2). To reduce the likelihood of wildland fire hazard, smoking by soldiers during training activities will not be allowed (see conservation measures 4.2.2). Additionally, the USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions (see conservation measure 1.0). We believe that the implementation of invasive species interdiction and control measures reduces the risk of additional habitat degradation from invasive plants and predation from new invasive species within the Marpi Maneuver Area. Training operators within the MIRC may enter into new agreements with private landowners or CNMI land authorities to use additional lands for training purposes (USN 2009b, p. 39). Future agreements to train on private or CNMI lands will be reviewed for potential effects to listed species and their habitats (see conservation measure 4.2.2). Based on these conservation measures, we concur with your determination that the MIRC may affect, but is not likely to adversely affect, the nightingale reed-warbler.

Mariana common moorhen
The Mariana common moorhen is endemic to the Mariana archipelago and was known to occur on the islands of Guam, Saipan, Tinian, Pagan and Rota (prehistoric evidence) (USFWS 1991a, p. 3; Stinson *et al.* 1991, p. 38 and references within). The Mariana common moorhen is believed to be extirpated from Pagan due to the volcanic eruption in May 1981 and destruction of vegetation by feral ungulates (Stinson *et al.* 1991, pp. 41-42). Artificial wetlands (ponds for a

waste water treatment plant and a golf course) were constructed on Rota in 1994, and were subsequently colonized by a small number of adults, chicks, and juveniles (Worthington 1998, p. 414). Therefore, the current distribution (and approximate population size) includes Guam (n = 90), Saipan (n = 154), Tinian (n = 41), and Rota (n = 2) (Takano and Haig 2004a, p. 247).

The Mariana common moorhen prefers wetlands with diverse, non-persistent, emergent vegetation, containing deep and shallow water areas with equal areas of cover and open water (Stinson *et al.* 1991, p. 39; Ritter and Savidge 1999, p. 286) and avoids wetlands with dense monocultures (e.g., *Phragmites karka*) (Ritter and Savidge 1999, pp. 285-286). Edge and emergent vegetation is used for breeding, nest building, and escape cover (USFWS 1991a, p. 17 and references within; Ritter 1994, p. 129). Primary habitats (as defined in the Recovery plan) include: Agana marsh, Fena Valley reservoir, and the Naval Station Marsh, Guam; Lake Hagoi on Tinian; and Lake Susupe, Puntan Muchot, and Garapan wetlands on Saipan (USFWS 1991a, pp. 4-16). Several secondary wetland habitats were identified on Guam and Saipan; while only one secondary wetland on Tinian was considered important for the recovery of the species (USFWS 1991a, pp. 4-16).

MIRC activities will not spatially overlap with the Mariana common moorhen distribution on Rota or Saipan (see conservation measures 4.2.1 and 4.4). On Tinian, an index survey of Mariana common moorhen at Lake Hagoi indicates a slight increasing trend in the number of moorhens detected between 1999 and 2007 with a maximum of 18 individuals counted (Vogt 2008, pp. 2-5). Nest and egg production have been and continue to remain low which may be the result of predation by monitor lizards (Vogt 2008, pp. 2-5). The secondary wetlands on Tinian are not routinely monitored for the presence or abundance of moorhen. To avoid and minimize effects to the Mariana common moorhen on Tinian, the USN has established an 87-hectare (215-acre) "No Training Area" around Lake Hagoi and no MIRC activities will occur near the secondary wetlands on Tinian (see conservation measure 4.3.2; 4.3.5; and 4.3.6). The "No Training Area" is bounded by existing roads, with the closest road within 75 meters of the wetland. The only military training activities in a "No Training Area" are troop and vehicle movements along these established boundary roads.

On Guam, moorhens use Fena Reservoir, an approximately 82-hectare (203-acre) wetland located within the USN Munitions Site. Fena reservoir is used more in the dry season than the wet season (October through December) when moorhens typically disperse to other wetlands or rivers (Ritter and Savidge 1999, p. 286; Takano and Haig 2004b, p. 656). Recent survey data indicate the number of Mariana common moorhen routinely detected at Fena Reservoir during the dry season (when maximum abundance is anticipated) has declined since surveys were initiated in 1987 (Brooke and Grimm 2008, p. 3 pp.). Though surveys have been sporadic since 2004, breeding and recruitment appear to be low to none at Fena Reservoir, as the last nest was detected during January 2004, and the last juveniles were detected in July 2005 (Brooke and Grimm 2008, p. 3). Recently (April 2009), only six moorhen were observed at Fena Reservoir (Eggleston 2009, p. 1). The reduced numbers of moorhens and the lack of breeding and recruitment at Fena Reservoir has been hypothesized to correlate with the loss of *Hydrilla verticillata*, a non-native invasive aquatic plant that forms extensive mats, which was used as foraging and nesting habitat by the moorhen (Brooke and Grimm 2008, pp. 1-2). Moorhen also use Apra Harbor Naval Complex and USN Main Base, Guam. Mariana common moorhen have not been documented using the riparian wetlands within the northern and southern land navigation training areas (see conservation measure 4.5.7).

Training will not occur near wetlands on Apra Harbor Naval Complex or USN Main Base, Guam (USN 2009b, pp. 9-10). At Fena Reservoir, helicopter-based fire bucket training occurs on a regular basis in the center of the northern portion of the reservoir approximately 300 meters from the Fena Spillway (estimated from USN 2009b, p. 17). Frequent helicopter overflights occur over the entire reservoir. Noise from helicopter overflights may mask predator approaches and mating calls or cause flushing. Mariana common moorhens have been documented to halt vocalizations during routine overflights (estimated height of 244 to 305 meters; 800 to 1000 feet above ground level) of small airplanes above Lake Hagoi (USFWS 1996, p. 9). Conversely, the moorhens have increased vocalizations, including loud shrieks and honks in response to gun shots (USFWS 1996, p. 9). However, neither of these responses appears to have resulted in changes to breeding or foraging behaviors nor do these actions appear to alter predation rates (Vogt 2008, pp. 2-5). To minimize impacts from MIRC training at Fena Reservoir, the USN will implement overflight restrictions and restrict fire bucket training to deeper areas of Fena Reservoir away from areas typically used by moorhen (see conservation measures 4.5.4; 4.5.6 and 4.5.14).

Training (foot and vehicle land navigation, sniper training, small field exercises) in other areas of the USN Munitions site could start a wildfire; however, the use of incendiary training materials is limited such that fires in forested habitats are unlikely and a fire management plan has been developed by the U.S. Forest Service to minimize impacts associated with wildland fires (see conservation measures 4.5.11). To date, no wildland fires have been ignited within the Ordnance Annex due to military activity. Fires that have burned areas within the Ordnance Annex have originated off USN properties and are generally associated with trash burning (USN 2009b, p. 95). The wildland fire management plan will minimize impacts from any wildland fires. In addition, the existing configuration of firebreaks and road networks generally confines fires to upland savanna portions of the USN Munitions site so that they do not reach the wetland habitats (USN 2009b, p. 92). Additionally, the USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions (see conservation measure 1.0). We believe that the implementation of invasive species interdiction and control measures reduces the risk of additional habitat degradation from invasive plants and predation from new invasive species within the USN Munitions site. Based upon the avoidance of wetlands on Tinian, Saipan, and Rota, and the conservation measures described above for Guam, we concur with your determination that the MIRC may affect, but is unlikely to adversely affect, the Mariana common moorhen.

Mariana swiftlet

The Mariana swiftlet (*Aerodramus bartschi*) is endemic to Guam and the CNMI (Cruz *et al.* 2008, p. 233). A population was also established on Oahu, Hawaii between 1962 and 1965 (Wiles and Woodside 1999, p. 57). The Mariana swiftlet currently occurs on Guam (in three known caves within the USN Munitions site), Aguiguan (in nine known caves), and Saipan (ten known caves), and is considered extirpated from Tinian and Rota (Cruz *et al.* 2008, pp. 235-236; Grimm 2008, p. 1; USFWS 1991b, pp. 8, 13-14; Engbring *et al.* 1986, pp. 58-59). The current

Mariana swiftlet range (and population estimates) includes: Guam (n = 1,150); Aguiguan (n = 267); Saipan (n = 5,382); and Oahu (n = 66) (Cruz *et al.* 2008, pp. 237, 240; Grimm 2008, p. 1; Wiles and Woodside 1999, p. 59).

The species nests and roosts in limestone caves with the following characteristics: entrances typically a minimum of 2 meters (6.2 feet) high; chambers with dark zones; and fresh air (USFWS 1991b, p. 2). Mariana swiftlets are insectivorous and capture prey while flying. Foraging has been observed to occur over a wide variety of habitat types but they appear to favor ridge crests and open grassy savanna areas (USFWS, 1991b, p. 6). No information is available on preferred prey species. Mariana swiftlets have been documented to flush or fail to enter their caves when humans are near or within their caves (Wiles and Woodside 1999, pp. 57, 61). Their sensitivity to human presence has resulted in injuries to chicks and adults and could result in damage to eggs (Wiles and Woodside 1999, p. 61).

DoD will be training (foot and vehicle land navigation, sniper training, small field exercises) in areas known to support foraging swiftlets and their roosting and nesting caves. However, no training will occur within 100 meters of a cave entrance on Guam, no training will occur within or near caves on Saipan (see conservation measures 4.2.1 and 4.5.8). No foraging habitat (forests or grasslands in which they fly over to capture insects) will be removed due to training and overflight restrictions are in place over primary foraging areas (see conservation measure 4.5.3 and 4.5.6). The use of incendiary training materials is limited such that fires in forested habitats are unlikely (see conservation measures 4.2.2 and 4.5.11). The USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions (see conservation measure 1.0). We believe that the implementation of invasive species interdiction and control measures reduce the risk of additional habitat degradation from invasive plants and predation from new invasive species within the Ordnance Annex. Additionally, the USN implements recovery actions to increase the population numbers of Mariana swiftlets on Guam (see conservation measure 4.5.15). Therefore, we concur that the proposed action may affect, but is not likely to adversely affect, the Mariana swiftlet.

Essential Habitat

Essential habitat for sea turtles, Mariana common moorhen, Mariana crow, Guam rail, Guam Micronesian kingfisher, Mariana fruit bat, and the Mariana swiftlet is also present on Guam and Per the requirements identified in the Cooperative Agreement between the USAF, USN, and the U.S. Fish and Wildlife Service (USFWS) for the establishment and management of the Guam National Wildlife Refuge (USAF and USFWS 1994, p. 6; USN and USFWS 1994, p. 6), we have provided coordination regarding potential impacts to essential habitat from the proposed project. Training will continue to occur throughout the Guam National Wildlife Refuge Overlay and includes all activities listed in the action areas for the USN Ordnance Annex; Communications Annex-Finegayan, Andersen Air Force Base Northwest Field. Training in these areas is ongoing and will increase with implementation of MIRC. The proposed project will not remove any habitat (other than that authorized through previous consultations); however, the increased frequency in use could result in the inadvertent introduction or spread of non-native invasive species, vegetation trampling, soil compaction or erosion, and increased fire risk. The USN has proposed to implement multiple conservation measures to reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions; limit or prohibit activities that may ignite fire, implement a wildland fire management plan and will work to prevent erosion and impacts from hazardous waste (see conservation measures 1.0; 2.0; 3.0; 4.5.2; 4.5.3; 4.5.11; 4.5.12; and 4.5.13). However, based upon the implementation of these conservation measures, we believe that the proposed action will not result in negative impacts to essential habitat within the Guam National Wildlife Refuge Overlay.

May Affect, Likely to Adversely Affect

Mariana Crow

The Mariana crow is endemic to Rota and Guam and was listed as endangered in 1984. Approximately 152 hectares (376 acres) were designated as critical habitat for the species on Guam, and 2,552 hectares (6,033 acres) of critical habitat were designated on Rota (USFWS 1984, pp. 33,881-33,885; USFWS 2004, pp. 62,944-62,990). Though not designated as critical habitat, habitat essential to the long-term conservation of this species is present within the Guam National Wildlife Refuge Overlay on military lands in northern and southern Guam (USAF and USFWS 1994, p. 1; USN and USFWS 1994, pp. 1-2; USFWS 2004, pp. 62,953-62,967). Mariana crow use primary and secondary limestone forests, coastline forest, ravine forest, agricultural forests, and coconut plantations for foraging, and shelter; while nests have only been located in native tree species (USFWS 2005a, pp. 12-15). Breeding likely occurs all year on Rota, while peak nesting activity generally occurs between August and February (USFWS 2005a, p. 18).

In 1976, Mariana crows were considered relatively common and widely distributed on Rota (Pratt *et al.* 1979, p. 234). The first island-wide survey for crows on Rota was conducted in 1982, and resulted in a population estimate of 1,318 individuals (Engbring *et al.* 1986, p. 95). Subsequent surveys in 1995 and 1998 indicated the population had declined to 592 individuals and 234 breeding adults, respectively (Fancy *et al.* 1999, p. 3; Plentovich *et al.* 2005, p. 211). Currently, the population is estimated to be approximately 120 breeding adults (Ha *et al.* 2008, p. 9).

Mariana crows were also once considered abundant and widely distributed throughout Guam (Baker 1951, p. 246). However, by the mid-1960s, Mariana crows had disappeared from the southern region of Guam, and by the mid-1970s, they were absent from central Guam (Jenkins 1983, p. 32). By 1981, the population was restricted to northern Guam and consisted of less than 400 individuals (Engbring and Ramsey 1984, p. 30). Ten years later, in 1991, fewer than 50 individuals were found on Guam (Wiles *et al.* 1995, p. 34). Between 1997 and 2003, a total of 31 Mariana crows were translocated from Rota and released on Guam (USFWS 2005a, pp. 45-46). Currently, the Guam population consists of only two male crows (Quitigua 2009, pers. comm.). The recent decrease in population size after the translocations is not believed to be related to military training.

No training will occur on Rota in areas supporting Mariana crow or its critical habitat (see conservation measure 4.4). Effects to designated critical habitat and essential habitat were reviewed above. The ISR Strike biological opinion reviewed potential impacts to the Mariana crow from the proposed action and determined that project implementation would not jeopardize the survival and recovery of the Mariana crow (USFWS 2006b, 73 pp.). Conservation measures and terms and conditions were incorporated into the ISR Strike biological opinion to minimize impacts to the crow and its essential habitat. While the ISR Strike biological opinion anticipated the loss of essential habitat for the crow, no take of individual crows was expected or authorized. The MIRC project description incorporates the ISR Strike biological opinion (including the conservation measures and terms and conditions) by reference. No additional activities are planned or authorized beyond those already considered within the ISR Strike biological opinion and MIRC will follow all the requirements within the ISR Strike biological opinion (see conservation measures 4.5.1; 4.5.2; 4.5.3; 4.5.4; 4.5.5; 4.5.11; and 4.5.12). Therefore, we concur that the non-jeopardy determination from the ISR Strike biological opinion is still appropriate because: the analysis completed within the ISR Strike biological opinion is still accurate; all requirements within the ISR Strike biological opinion will be followed by MIRC; and there are no additional anticipated impacts to the Mariana crow from the implementation of MIRC. Therefore, the Mariana crow will not be considered further within this biological opinion.

Mariana Fruit Bat

The Guam population of the Mariana fruit bat (Mariana flying fox) (*Pteropus mariannus mariannus*) was federally listed as endangered in 1984 (USFWS 1984, p. 33,881). However, in 2005, the subspecies was listed as threatened throughout the Mariana archipelago and downlisted to threatened on Guam (USFWS 2005b, pp. 1,190-1,191). Approximately 152 hectares (376 acres) of land was designated as critical habitat for the Mariana fruit bat on Guam (USFWS 2004, p. 62,944). Though not designated as critical habitat, habitat essential to the long-term conservation of this species is present within the Guam National Wildlife Refuge Overlay on Military lands in northern and southern Guam (USAF and USFWS 1994, p. 1; USN and USFWS 1994, pp. 1-2; USFWS 2004, p. 62,953-62,967). The Recovery Plan for the Mariana fruit bat was finalized in 1990 (USFWS 1990, 63 pp.); however, this recovery plan is currently in revision. A five-year status review was completed in 2007 (USFWS 2007c, 4 pp.).

The Mariana fruit bat is endemic to the Mariana archipelago (Guam and the CNMI), where it is found on most of the fifteen major islands. General population data are available but should be considered with caution as survey methods have varied by island. The following represents the species range (and approximate number of individuals): Guam (less than 100); Rota (1,600); Aguiguan (40 – 60); Tinian (transient bats only); Saipan (50); Farallon de Medinilla (transient, only one bat has been observed); Anatahan (1,000); Sarigan (300 – 400); Guguan (550); Alamagan (100); Pagan (1,500); Agrihan (1,000); Asuncion (800); Maug (50) (Boland 2009, pers. comm.; Brooke 2008, p. 1 and references within; Brooke 2009a, p. 1; CNMI DFW 2000b, p. 4; CNMI DFW 2000c, p. 35; Johnson 2001, p. 19; USN 2009b, p. 89; Wiles and Johnson 2004, p. 585). There are no known records of the presence of Mariana fruit bats on Uracas (as Farallon de Pajaros in Wiles *et al.* 1989, p. 69).

The Mariana fruit bat uses several forest types for foraging, roosting, and breeding, including native primary and secondary limestone forest, volcanic (or ravine) forest, old coconut plantations, and groves of *Casuarina equisetifolia* (Glass and Taisacan 1988, pp. 6-13; Worthington *et al.* 2001, pp. 137-138; Wiles and Johnson 2004, pp. 589-591). Most of these habitats are dominated by a variety of native trees, with introduced trees present in lower abundance. On islands inhabited by humans, bat colonies usually occur in remote sites, especially near or along cliff lines. *Pteropus* bats are strong fliers and traverse long distances

(Eby 1991, p. 554; Wiles and Johnson 2004, p. 593 and references within). The Mariana fruit bat likely flies between islands in the archipelago (Wiles and Glass 1990, pp. 2-4; Wiles and Johnson 2004, p. 593 and references within). Reproduction in Mariana fruit bat may occur throughout the year (Glass and Taisacan 1988, p. 6). Juveniles are flightless and females carry their young after the young are born (Eby 1991, pp. 547-548; Esselstyn *et al.* 2006, p. 535). Once the juveniles are too large to carry, they are left at their roost at night while the majority of adult bats leave the roost to forage (Eby 1991, p. 548). These juveniles are still flightless and dependent upon the female until nursing ceases (Eby 1991, p. 548).

The Marina fruit bat is considered transient on Farallon de Medinilla because it has been observed only once on the island and the habitat available is considered unsuitable for supporting Mariana fruit bat populations (USN 2009b, pp. 37, 89; Wiles *et al.* 1989, p. 71). Mariana fruit bats have been observed to fly between islands and could rest upon Farallon de Medinilla after a catastrophic event (e.g., typhoon, volcanic eruption) affects other northern islands within the Marianas (USN 2009b, p. 89). The USN cannot train shortly after a catastrophic event due to safety conditions. We anticipate that any bats using Farallon de Medinilla after a catastrophic event will have left the island in search of food sources by the time the USN safety conditions have been met. Therefore, we expect that any potential affects to Mariana fruit bat from training on Farallon de Medinilla are extremely unlikely to occur.

Saipan supports a small population of Mariana fruit bats. The bats are typically seen as a few individuals at multiple sites, rather than a colony at a single site, and are likely using forested habitats across the island (Johnson 2001, p. 4). The mixed limestone forest area along the southern border of the Marpi Maneuver Area provides suitable habitat for the Mariana fruit bat and is near areas known to be used by the bat (Saipan Upland Mitigation Bank, Tanapag, As Matuis) (CNMI DFW 2009, p. 6; Johnson 2001, p. 4). Training in the Marpi Maneuver Area is infrequent and limited to pedestrian land navigation training that occurs within the open areas and (USN 2009b, p. 90). Conservation measures for this area (see conservation measures 1.0 and 4.2.2) will avoid and minimize impacts to Mariana fruit bats and the habitats they use.

Mariana fruit bats are considered transient on Tinian and have been observed in the Kastiyu Forest, the cliff line forest near Maga, and flying over the island (USN 2009b, p. 72). Transient bats have been observed using the native limestone forest within the MIRC action area on Tinian (i.e., cliff line forest near Maga). MIRC training activities that occur in the native limestone forest habitats within the Tinian action area are restricted as this is a "no wildlife disturbance area" (see 4.4.3) in the native limestone forest habitats within the Tinian action area and therefore effects from training will be avoided or minimized (see conservation measures 1.0, 4.3.3 and 4.3.4).

Rota supports a large population of Mariana fruit bats; however, MIRC will not initiate any action requiring the removal, trimming, or pruning of any tree (other vegetation species) known to support breeding, roosting, or foraging habitat for the bat. No training activities will occur near or within habitats that may be suitable for endangered or threatened species (see conservation measures 1.0 and 4.4). Effects to critical habitat on Rota were reviewed previously in this document.

Guam supports a small population of Mariana fruit bats. Individuals have been detected at multiple locations within the MIRC action area on Guam, including all of Andersen Air Force Base, Naval Computer and Telecommunications Station Finegayan, and Naval Munitions Site (USN 2009b, pp. 71-71, 89; Brooke 2008, p. 1). Suitable habitat within the MIRC action area is also present on the USN Main Base, and USN Barrigada and may support solitary bats that were not detected due to survey limitations (Brooke 2008, p. 1). One colony persists on Guam at Pati Point, Andersen Air Force Base (Brooke 2008, p. 2). Effects to critical habitat and essential habitat on Guam were reviewed previously in this document.

Sightings of bats in the USN Munitions site and Naval Computer and Telecommunications Station Finegayan is limited to a few individuals flying during daytime or low light conditions (Brooke 2008, p. 1). While these sightings are not representative of a population count, it is unlikely that large numbers of bats are using these areas due to their accessibility by the public (Brooke 2008, p. 1; Wiles 1987, pp. 153-156). The MIRC training activities in these areas will produce noise; however, it is unlikely that an individual bat will be using a specific training area. If a bat is present it is likely to be solitary and capable of flying to another area that is not within the disturbance zone. The flushing of a solitary bat from these areas, is not likely to increase the risk of predation, poaching pressure, or stress such that take in the form of harassment occurs. Flight restrictions are also in place over the USN Munitions site which will further minimize impacts to the bat (see conservation measure 4.5.6).

Effects to Mariana fruit bat individuals and the colony from training on Andersen Air Force Base (i.e., Northwest Field and Andersen Main Base) were reviewed under the ISR Strike biological opinion (USFWS 2006b, 73 pp.). Conservation measures and terms and conditions were incorporated into the ISR Strike biological opinion to minimize impacts to the bat and its essential habitat and a non-jeopardy determination was made for the proposed project. The ISR Strike biological opinion authorized take of 21 fruit bats from Guam and 36 bats from Rota (all residing at the Pati Point colony). The MIRC project description incorporates the ISR Strike biological opinion (including the actions, conservation measures, and terms and conditions) by reference (see conservation measures 4.5.1; 4.5.2; 4.5.3; 4.5.4; 4.5.5). Recent monitoring at the Pati Point colony (2009 data) indicates the colony is ranging in size from 12 to 30 individuals (mean = 21); however, the bats appear to have shifted their roost location and additional bats have been detected flying around the cliff from the traditional roosting area (Brooke 2009b, pers. comm.). Using these data we estimate that up to 19 Mariana fruit bats may have been taken from implementation of the ISR Strike (i.e., estimated maximum colony size at the time of the ISR Strike biological opinion minus the average number of bats detected during 2009, equals the estimated take [40-21 =19]). The average number of bats detected is used to estimate take because of the variability in count data. Based upon these data, we do not believe the take authorized in the ISR Strike biological opinion has been exceeded. However, the ISR Strike is not fully implemented at this time and additional take may occur. To ensure that take does not exceed that previously authorized, the UASF will continue to monitor the population as outlined in the ISR Strike biological opinion and the USN has proposed to further assess the behavioral changes in the bat colony (see conservation measure 4.5.16).

All training areas have the risk of invasive species being unintentionally transported among them which could affect the Mariana fruit bat by increasing predation or by altering their forging, breeding, or roosting habitats. The USN has proposed conservation measures as a part of the MIRC project description that will reduce the risk of introduction, spread, and establishment of non-native invasive species due to MIRC actions (see conservation measure 1.0). We believe that the implementation of invasive species interdiction and control reduces the risk of additional habitat degradation from invasive plants and predation from new invasive species within Mariana fruit bat habitats in the MIRC action area.

No additional activities are planned or authorized on Andersen Air Force Base beyond those already considered within the ISR Strike biological opinion and MIRC will follow all the requirements within the ISR Strike biological opinion. Therefore, we concur that the non-jeopardy determination from the ISR Strike biological opinion is still appropriate because: the analysis completed within the ISR Strike biological opinion is still accurate; all requirements within the ISR Strike biological opinion will be followed by MIRC; and there are no additional anticipated impacts to the Mariana fruit bat from the implementation of MIRC on Andersen Air Force Base. Additionally, there is a low likelihood that any one individual will be present in the other action areas on Guam and within the CNMI during training. The low likelihood of presence in conjunction with the conservation measures proposed for those action areas should adequately avoid or minimize any potential affects to the species such that they are extremely unlikely to occur. Therefore, the Mariana fruit bat will not be considered further within this biological opinion.

Micronesian megapode
The Micronesian megapode (*Megapodius laperouse laperouse*), once referred to as LaPerouse's megapode, was federally listed as endangered in 1970 (USFWS 1970, p. 8,496). No critical habitat has been designated for this species. The recovery plan for the Micronesian megapode was finalized in 1998 (USFWS 1998b, pp. 62) and a five-year status review is currently underway (USFWS 2008b, p. 23,264).

The Micronesian megapode is endemic to Guam, CNMI, and Palau. Populations on Guam and Rota are considered extirpated (USFWS 1998b, p. 3; Stinson 1992, p. 220; Amidon and Kessler, 2009; pers. comm.). The population on Anatahan appears to have been extirpated due to recent and ongoing volcanic activity (Kessler 2006, p. 3; Kessler 2009b, pers. comm.). Currently megapodes from Micronesia and Palau are considered different races of the same species, *M. l. laperouse* and *M. l. senex*, respectively (USFWS 1998b, p. 4-5).

In general, the population status and range-wide trends of the Micronesian megapode are difficult to assess, in that population data have been collected and estimates made using a variety of methods at differing time periods. Increases and decreases in population numbers may be indicative of population trends or may reflect detection bias from implementing different survey and data analysis methods. Currently only a few individuals persist on Saipan and individuals on Tinian are likely transient (Radley 2009, pers. comm.; Camp *et al.* 2009, p. 12; USFWS 2009e, p. 124; USFWS 1998b, p. 19; Mosher 2009 pers. comm.; SWCA and MES 2008, pp. 10-12). On Alamagan, only two individuals were detected during recent surveys; however, juvenile and adult megapodes were singing and calling in ravine forest areas that were not surveyed (CNMI DFW 2000a, pp. 9-12). No recent survey data are available for Maug. Farallon de Medinilla and Aguiguan have moderate sized megapode populations that are likely stable with the reported increase in the population largely being attributed to improved survey methods and differences in data analysis (USFWS 2009e, p.124; Vogt 2009a, p. 3). However, it is also possible that the increase on Farallon de Medinilla is due to dispersal from Anatahan due to the recent volcanic eruptions (Vogt 2009a, p. 4). Large numbers of Micronesian megapodes occur only on the islands of: Sarigan, Guguan, Pagan, and Agrihan where changes in population estimates may be a function of sampling method or, in the case of Sarigan, a result of ungulate eradication improving potential megapode habitat (CNMI DFW 2008, pp. 3-26 through 3-38; CNMI DFW 2000c, p. 11; CNMI DFW 2000d, p. 10; CNMI DFW 2000e, p. 11-12). The Micronesian megapode was incidentally observed once on the island of Uracus (USFWS 1998b, p. 35). The island does not support forest habitat and experiences volcanic activity on a sporadic basis, thus the likelihood of the island supporting a population is low (USFWS 1998b, p. 35). Based upon these data, we have estimated the total population of the Micronesian megapode to be a minimum of 1,585 individuals.

Micronesian megapodes can use a variety of habitat types. Typically, native and secondary forest are considered the primary habitats for foraging while nesting may occur in forests, open fields, cinder and ash fields, and coastal strand edges with sand substrates. The Micronesian megapode is generally restricted on Saipan and Tinian to native limestone forest remnants along and below cliff lines and in secondary forest adjacent to limestone forest (USFWS 1998b, p. 11). However, the association with cliff lines is likely an artifact of the location of the native forest as these uneven areas are generally the only native forest strands that were not disturbed during the long history of habitat removal on Saipan and Tinian (USFWS 1998b, p. 11). Micronesian megapodes were also observed using tangantangan forests on Saipan (Glass and Aldan 1988, p. 142). On Aguiguan, megapodes are typically found in limestone and secondary forests, and have been observed in *Lantana* sp. scrub, but not in open areas of weeds (USFWS 1998b, p. 11; Amidon and Kessler 2009; pers. comm.). On Farallon de Medinilla there are stunted trees (2 to 4 meters) but no forest habitat (Vogt 2009a, p. 5). Micronesian megapodes were detected on Farallon de Medinilla wherever tree or shrub cover was present (Vogt 2009a, p. 5). Megapodes on islands north of Farallon de Medinilla are found in forested habitats, including coconut forest and other native vegetation (USFWS 1998b, pp. 11-12).

The Micronesian megapode is vocal and has been documented to duet (USFWS 1998b, pp. 5-6 and references within). Duetting in birds is correlated with year-round territoriality and prolonged monogamous pair bonds (Farabaugh 1982, p. 93). Duetting for the Micronesian megapode has been observed in each month of the year (USFWS 1998b, p. 6 and references within; Amidon and Kessler 2009; pers. comm.). Glass and Aldan (1988, p. 141) reported that megapodes on Saipan appeared to remain together throughout the year in territories that are advertised and defended at least part of the year. Territory size was estimated between one hectare (2.47 acres) and approximately 3.8 hectares (9.4 acres) depending on habitat type (Glass and Aldan 1988, pp. 141-142; USFWS 2009e, p. 124 and 126). Dispersal between islands of the CNMI is not well documented. On Palau, megapodes are known to fly several kilometers between islands (Pratt *et al.* 1980, p. 121) and other species of megapodes are considered strong fliers (Dekker 1989, p. 317 and references within). We expect that the Micronesian megapode could fly between Saipan and Tinian (4.6 kilometers; 2.9 miles) or Tinian and Aguiguan (8.9 kilometers; 5.5 miles) (USFWS 1998b, pp. 9-10). The northern islands are 30 to 60 kilometers (18 to 37 miles) apart. Regular migrations of this distance are not documented (USFWS 1998b, pp. 9-10). Glass and Aldan (1988, p.135) indicated that megapodes may have been transported by humans between islands within the CNMI, which may have assisted in maintaining the widespread distribution.

The Micronesian megapode is omnivorous and forages under ferns, branches, and leaf litter on the forest floor and in trees within bird's nest ferns (*Asplenium nidus*) (Glass and Aldan 1988, p. 142). Diet includes seeds and other plant matter, beetles, ants, ant larvae, and other insects and crabs (Glass and Aldan 1988, p. 142; Pratt *et al.* 1980, p. 121; Stinson 1992, p. 230).

The reproductive cycle of the Micronesian megapode is not well understood. Megapodes, including the Micronesian megapode, do not incubate their nests with their own body heat. Instead, megapodes will construct burrows or mounds at beaches and cinder fields, or at geothermal sites. Micronesian megapodes will also make burrows or mounds in between the roots of trees and in soil with decomposing vegetation where heat generated from decomposing organic materials incubates the eggs (Decker *et al.* 2000, p. 2; Wiles and Conry 2001, p. 270; Glass and Aldan 1988, pp. 135-137). Micronesian megapodes lay large eggs (approximately 18 percent of the female body weight); however, the total number of eggs per breeding season, interval between laying eggs, and the incubation period are unknown (USFWS 1998b, p. 9 and references within). Other species of megapodes lay between 10 and 13 eggs per year (USFWS 1998b, p. 9 and references within). Eggs are laid one at a time, with each egg laid between 9 and 13 days apart (USFWS 1998b, p. 9 and references within). Megapode chicks are precocial and able to fly upon emergence from the egg and nest (USFWS 1998b, p. 9).

Breeding has been observed (eggs, chicks, and juveniles) on Anatahan, Sarigan, Guguan, Pagan, Agrihan, and Maug during all months except October, November, and December (USFWS 1998b, pp. 6-7 and references within; Amidon and Kessler 2009; pers. comm.). The absence of breeding activity in October, November, and December is more likely a reflection of the lack of surveys during these months, and difficulty in finding megapodes during traditional avian surveys (Amidon and Kessler 2009; pers. comm.).

The Micronesian megapode is threatened by habitat loss and degradation due to agriculture, military operations, urban development, volcanic activity, wildfire, invasive vegetation species, overgrazing by feral ungulates (USFWS 1998b, pp. 35-38); predation by dogs, cats, monitor lizards, pigs, and possibly rats (Dekker 1989, pp. 318-320; Dekker *et al.* 2000, p. 5 and references within; USFWS 1998b, p. 37); and human exploitation (Dekker *et al.* 2000, p. 2; USFWS 1998b, p. 37; Vogt 2009c, p. 5; Amidon and Kessler 2009; pers. comm.). Threats from competition and disease are not well understood, but are possible. Competition for nesting and foraging areas would be possible if introduced game birds and domestic or feral chickens (which forage on the same prey items as megapodes) become established in megapode habitats (USFWS 1998b, p.38; Vogt 2009c, p. 6). Additionally, the import of game birds or chickens and existing feral chicken colonies (on Rota, Tinian, Saipan, Anatahan, Alamagan, and Pagan) could expose megapodes to avian diseases (USFWS 1998b, pp. 38-39), as many of these species are susceptible to west Nile virus (UC Davis 2009, pp. 2-3).

Farallon de Medinilla is leased by the DoD from the CNMI and is approximately 73 hectares (183 acres) in size (USN 2009a, p. 3.11-29). Habitat used by the Micronesian megapode on

Farallon de Medinilla is characterized as predominantly dense herbaceous communities, scrubby brush, stunted trees, grasslands, and bare earth and include the following plant species: *Wollastonua biflora*, *Mariscus javanicus*, *Capparis spinosa*, *Ipomoea pes-caprae*, *Boerhavia* spp., *Portulaca lutea*, *Operculina ventricosa*, and stunted *Pisonia grandis* (Lusk *et al.* 2000, p. 24; USN 2009a, p. 3.11-30). The habitat is maintained in a low to mid-successional stage due to wind conditions (northern portion) and previous military readiness training (middle and southern portion) (USN 2009a, p. 3.11-61). A small population of Micronesian megapodes occurs on Farallon de Medinilla. An estimated 21 pairs and 4 individuals (46 total individuals) are currently present on Farallon de Medinilla (Vogt 2009a, pp. 3-5; USN 2009b, p. 89). These data include the observation of a chick and a juvenile, indicating reproduction may be occurring on the island (Vogt 2009a, pp. 3, 5). Based upon the size of Farallon de Medinilla and potential territory size, Vogt (2009a, p. 4) estimated that the island could likely support a population of 50 megapodes.

On Saipan, the Army Reserve Center and Commonwealth Port Authority actions areas do not support habitat for the Micronesian megapode, nor have megapodes been detected within these action areas. The Marpi Maneuver Area is located on the northern portion of the island approximately one mile north and below the cliff line from the Saipan Upland Mitigation Bank (USN 2009a, p. 3.11-24). Craig (1993, pp. 99-100) summarized the habitat disturbance on Saipan and noted the Marpi area, except some of the limestone escarpments, was cleared for sugarcane (*Saccharum officinarum*) cultivation and developed for military operations during World War II. In areas where vegetation was allowed to re-grow post World War II, non-native species are the dominant vegetation. Currently, the Marpi Maneuver Area is still characterized by elephant grass (*Pennistum purpureum*) meadows and tangantangan thicket (USN 2009a, p. 3.11-24 through 3.11-25) and a remaining area of limestone forest (USN 2009b, p. 14) and is used to support recreation and tourism, agricultural leases, and homesteads. Between the cliff line and the Marpi Maneuver Area is a 17.4-hectare (43-acre) Micronesian megapode protected area (USEPA 2009, pp. 2, 8). The protected area is known to support at least one Micronesian megapode (Rounds 2009; pers. comm.). Other areas including tangantangan thickets adjacent to limestone forests and elephant grass meadows adjacent to the Marpi Maneuver Area are known to support Micronesian megapodes as well (Mosher 2009; USFWS 2002, p. 8; CNMI DFW 2009, p. 5). The Micronesian megapode may be using scattered tangantangan strands within the Marpi Maneuver Area for feeding, resting, and as a corridor between limestone forests. Because of recent observations in the Marpi Maneuver Area and continued sightings of the Micronesian megapode in adjacent limestone forest, we have determined that the Micronesian megapode is reasonably certain to occur within the Marpi Maneuver Area on Saipan.

The action area on Tinian includes the Exclusive Military Use Area which consists of 3,080 hectares (7,600 acres) of land in the northern one-third of Tinian (USN 2009a, p. 3.11-26). The Exclusive Military Use Area is leased by DoD from the CNMI. The action area on Tinian also includes the Military Lease Back Area which includes the central one-third of the island and consists of 3,150 hectares (7,800 acres) (USN 2009a, p. 3.11-27). Habitats on Tinian pre-World War II were extensively altered for agriculture. Military actions (both bombing during World War II, reconstruction, and ongoing training), fire, and invasive vegetation species encroachment continue to shape the habitat. Currently, both military areas support lowland habitats consisting of native forest, tangantangan thickets, secondary growth forests, and open fields (USN 2009a, pp. 3.11-26, 3.11-28). Although Micronesian megapodes were not detected on Tinian during 2008 (USFWS 2009e, p. 124), both action areas on Tinian support foraging and roosting habitat for the Micronesian megapode (USN 2009a, pp. 3.11-26, 3.11-44). Incidental reports and regular sightings (1995 to 2005) of the Micronesian megapode on Tinian indicates that either a small but persisting population of Micronesian megapodes exists on Tinian or that Micronesian megapodes routinely use habitats on Tinian when flying between Aguiguan and Tinian or Tinian and Saipan (USFWS 1998b, pp. 10, 18; USN 2009a, p. 3.11-44). Due to the presence of suitable habitat and the occasional but routine observations of Micronesian megapodes on Tinian, we have determined that the Micronesian megapode is at least transient and reasonably certain to occur within the Military Lease Area on Tinian.

Micronesian megapodes were extirpated from Guam and Rota in the ninetieth and early twentieth centuries (USFWS 1998b, p. 3 and 15) and are not expected to be in the action areas. Therefore, we will not consider effects to megapode from training on Guam and Rota within this biological opinion.

STRESSORS AND EFFECTS FROM THE ACTION

The USN expects that the implementation of MIRC may produce multiple stressors to Micronesian megapodes and their habitats within the action areas on Farallon de Medinilla, Saipan, and Tinian (USN 2009b, pp. 83-85). Specifically, implementation of the MIRC may result in: direct strike; pedestrian and vehicular disturbance that can alter habitats or crush nests; habitat degradation, fragmentation, and loss; increased noise; increased risk of non-native invasive species introductions and spread; wildfire and prescribed burning. Toxicants (herbicides and pesticides) will also be used during the implementation of MIRC.

Direct Strike

Military training can result in direct strike of wildlife and their nests with munitions (including ultrasound waves, percussive force) (Demarais *et al.* 1999, p. 387; Larkin *et al.* 1996, p. 12). Direct strike of wildlife also routinely occurs with civilian and military aircraft and civilian vehicles (Klope 2009, p. 1; Huijser *et al.* 2008, p. 57; Erickson *et al.* 2005, pp. 1,030-1,031); and therefore, it is possible for vehicular strike to also occur from military trucks, tanks, and other vehicles used for maneuver and convoy training. Micronesian megapode nests will not be impacted due to vehicle or pedestrian navigation (trampling or crushing a burrow or mound) or from support activities that involve earth moving (trenching, bivouac, etc.). No direct strikes to Micronesian megapodes have been reported from either civilian or military training vehicles. The USN has proposed conservation measures to reduce the likelihood of direct strike to the Micronesian megapode from vehicles (see conservation measures 4.2.2 and 4.3.3). Military vehicles used in convoy and maneuver training travel at a slow pace and will be used only on existing roads and trails on Tinian. No training occurs in the limestone forest on Tinian where the Micronesian megapode has been previously detected. Because the megapode is considered transient on Tinian, we do not expect nesting to occur on Tinian; therefore, we do not anticipate any nest destruction due to military training on Tinian. No vehicle maneuver training occurs on Saipan or Farallon de Medinilla. On Saipan, pedestrian land navigation training and earthmoving activities will not occur in the limestone forest habitats, thereby avoiding the risk of damaging potential nests.

Bird aircraft strikes are not expected to occur between Micronesian megapodes and military aircraft. The training areas on Tinian subject to aircraft takeoffs and landings are on established runways that are a minimum of 300 meters (984 feet) from the limestone forest area where Micronesian megapodes were last sighted. Overflights above Farallon de Medinilla are at altitudes greater than Micronesian megapodes have been observed to use during flight (Kessler 2009c, pers. comm.).

Approximately five pairs of Micronesian megapodes (extrapolated from survey data) may be using the area around the inert and live-fire target areas on Farallon de Medinilla and are at risk for a direct strike from ordnance (USN 2009b, p. 89). Explosions within close proximity of megapodes are expected to produce shock waves, shrapnel, and fire blasts, all of which would result in mortality of an individual. Cratering in a nesting area would destroy the nest; however, no nesting is suspected below the "No Drop Zone" on Farallon de Medinilla. Shock waves from sonic booms are not likely to break eggs or reduce hatching success (Larkin *et al.* 1996, p. 50 and references within). The USN has proposed conservation measures to minimize the potential for direct strike from munitions by protecting the northern portion of the island and by implementing targeting and weapons restrictions (see conservation measure 4.1). Therefore, we anticipate that five Micronesian megapode pairs (ten individuals) may be taken as a result of inert and live-fire training on Farallon de Medinilla.

Habitat Degradation, Fragmentation, and Loss

Habitat degradation is the primary cause of extinction and endangerment of wildlife (Groom and Vynne 2006, p.173). Habitat degradation and loss is caused by various human activities including: agriculture, mining, forestry, fisheries, aquaculture, groundwater extraction, fires, infrastructure development, dams, urbanization, industry, pollution (including light, noise, and toxic chemicals), and changes in community and ecosystem structure due to invasive species (Groom and Vynne 2006, p. 174). Habitat fragmentation is a change in habitat configuration with the remaining habitat occurring in patches among areas of non-habitat (Noss *et al.* 2006, p. 213) and can occur via the activities listed above. When vegetation is affected by activities, edges (a type of habitat fragmentation) are created. Edges form the boundary of a habitat and have differing properties than the habitat itself. For example, edges often have different microclimate patterns which are drier, less shaded, and warmer than forest interiors. Edge habitats are generally areas of increased predation and the entry point for invasive vegetation, pests, and pathogens to encroach within native habitats (Noss *et al.* 2006, p. 228). Habitat degradation, fragmentation, and loss can result in localized extinctions, shifts in community composition (including increases in invasive species), increased predation, and can result in suitable habitat becoming unsuitable due to pollution, invasive species, physical size (for species that are area-sensitive), or barriers blocking access to habitats (including distance or lack of corridors and stepping stones, etc.) (Noss *et al.* 2006, 38 pp.; Groom and Vynne 2006, p. 174). Habitat loss on Saipan and Tinian has occurred due to agriculture development and military operations during World War II (USFWS 1998b, p. 35). More recently, habitats on Tinian and Saipan are being converted to more urbanized and agricultural landscapes. Since listing, the USFWS has reviewed development projects on Tinian (n = 2) and Saipan (n = 4) that may affect the Micronesian megapode; however, the projects' proponents agreed to avoid loss of native forests to minimize degradation, fragmentation, and loss of habitat for the Micronesian megapode. Anatahan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, and Uracus are all subject to volcanic activity (Glass and Aldan 1988, p. 134) and recently habitat has been lost on Anatahan and Pagan due to volcanic activity (USFWS 1998b, p. 27; USFWS 2009e, p. 120). While Tinian, Saipan, and Farallon de Medinilla are not subject to volcanic activity, other natural phenomena (drought and typhoon activity) may contribute to habitat loss as well. For example, drying of nesting soils or thick vegetative growth after a typhoon can limit the suitability of megapode nesting habitat. In addition, the forest habitat on Tinian and Saipan has been degraded from overgrazing by feral ungulates. Overgrazing changes vegetation communities (increases opportunities for growth of non-native vegetation), increases erosion, and changes soil moisture content (Kessler 2002, pp. 132, 137-139), all of which can reduce nest site potential and change the forage community available for megapodes (USFWS 1998b, p. 35).

In addition to agriculture, urbanization, and other natural phenomena, military training and preparation can result in habitat degradation, loss, and fragmentation, (Machlis and Hanson 2008, p. 732 and references within). Habitat on the northern portion of Farallon de Medinilla is considered low quality and is somewhat stunted due to excessive wind (Lusk *et al.* 2000, p. 32 and references within; Vogt 2009a, p. 4). Habitat degradation and loss has also occurred on Farallon de Medinilla due to previous military bombardment on the central and southern portions of the island. During the Vietnam era, as much as 22 tons of ordnance per month was dropped on Farallon de Medinilla for training purposes (Lusk *et al.* 2000, p. 32 and references within). Surveys of the island in 1997, after a recent training activity, revealed up to 50 fresh bomb craters and a large section of the island burned to bare earth (Lusk *et al.* 2000, p. 32 and references within). These surveys demonstrate the ability of active training with live and inert ordnance to alter the habitat from a medium-height, relatively closed canopy forest, to one dominated by open areas with intermittent patches of low forest (Lusk *et al.* 2000, p. 32). Demarais *et al.* (1999, p. 387 and references within) summarized disturbances and effects caused by military training which are described below in the context of actions proposed by MIRC on Tinian, Saipan, and Farallon de Medinilla.

Mechanized maneuver regimes are designed to simulate actual mechanized combat and will be used on Tinian and Saipan. These types of activities are characterized by vehicle movements across the terrain. Constructed defenses typically include anti-tank ditches to prevent vehicles from crossing an area. Trucks, heavy vehicles, and tracked vehicles, primarily result in altered soil conditions leading to soil compaction, erosion, and pulverizing surface particles. Soil compaction reduces soil aeration and nutrient uptake and can limit root growth and seedling emergence. Vegetation can be impacted by breaking limbs and branches, uprooting, crushing or otherwise damaging or destroying trees, shrubs, and grasses. Frequent, short-term, minor events can result in trampling of vegetation and soil compaction such that soils and plants do not recover rapidly, if at all. This type of vegetation disturbance can result in existing habitat becoming unsuitable for foraging, nesting, or roosting. On Tinian, mechanized maneuvers will include vehicle land navigation and convoy training. No mechanized maneuver training will occur within the Marpi Maneuver Area on Saipan or on Farallon de Medinilla.

Infantry maneuver training is designed to train infantry units to fight in dispersed formations and often results in cutting vegetation for camouflage, digging fox holes, and pedestrian navigation. Pedestrian land navigation will occur within the Marpi Maneuver Area on Saipan and force-on-force airfield defensive and offensive training will occur on Tinian. No infantry maneuver training will occur on Farallon de Medinilla.

Command and support training includes staging areas for headquarters, supplies, maintenance, and other non-combat support systems, typically in bivouac positions. Bivouac activities generally result in soil excavation for fortification of the position, soil compaction, removal of low-level vegetation, and damage or removal of trees. On Tinian, command and support activities include command and control training, air traffic control, logistics, and bivouac. No command and support training will occur within the Marpi Maneuver Area on Saipan or on Farallon de Medinilla.

Engineering regime training is used to construct and destroy obstacles, and implement other construction activities (bridge building, use of earth moving equipment, and explosives for demolitions). On Tinian, armament, fuels, rapid runway repair, and other airfield-related engineering requirements will be implemented. No engineering regime training will occur in the Marpi Maneuver Area on Saipan on Farallon de Medinilla.

Live and inert fire training uses a variety of ordnance including demolitions, grenades, small arms, mortars, missiles, cannons, artillery, and bombs. These munitions often contain high explosives, chemical obscurants, ball ammunition, and illumination rounds. Large quantities of ordnance can lead to contamination of soils, groundwater, vegetation (Machlis and Hanson 2008, p. 731), unexploded ordnance issues, soil displacement (e.g., cratering), erosion, vegetation damage, and fires. Contamination of soils and vegetation from munitions waste can result in harm and mortality to wildlife (Machlis and Hanson 2008, p. 731). No live-fire or inert ordnance training occurs on Saipan. On Tinian, military operations in urban terrain activities and live-fire occur only within North Field World War II structures and the old Japanese Headquarters Building using small arms and bullet traps. Large quantities of live and inert ordnance will be used on Farallon de Medinilla through ship-to-shore bombing and aerial bombardment.

The USN has proposed multiple conservation measures for Tinian and Saipan to avoid and minimize impacts from mechanized maneuvers, infantry maneuvers, command and support training, engineering regimes, and live-fire to limestone forest habitats that could be used by Micronesian megapodes resting, foraging, and nesting. These measures include: invasive species interdiction and control, best management practices for erosion control and hazardous waste management, training restrictions within native limestone forest habitats, and fire prevention and management (see conservation measures 1.0; 2.0; 3.0; 4.2; 4.3.3; 4.3.4; and 4.3.7). We anticipate the implementation of these measures will ensure that these limited habitats remain physically the same size (i.e., no loss or further fragmentation) and in similar quality so that they will continue to be suitable for foraging, resting, and potentially nesting. Therefore, we do not anticipate the implementation of MIRC will result in any population-level effects (i.e., further range reductions, decreases in fitness, reduction in reproductive success) because we do not expect habitat degradation, fragmentation, or loss on Tinian or Saipan. We also anticipate that the existing habitat for Micronesian megapodes will not be at any greater risk of degradation, fragmentation, or loss from the indirect effects of natural disasters (typhoons and droughts) than currently, due to the implementation of these conservation measures.

On Farallon de Medinilla, Micronesian megapodes use habitats within the target areas (estimated five pairs) and the "No Drop Zone" (estimated 16 pairs) (USN 2009b, p. 89; Vogt 2009a, p. 3). We also believe that megapodes are reproducing on Farallon de Medinilla, due to the presence of a chick, a juvenile, and habitat manipulation that is suggestive of megapode burrows within the "No Drop Zone" (see Lusk *et al.* 2000, p. 29). The USN has proposed multiple conservation measures for Farallon de Medinilla to reduce the degradation and loss of habitat including: invasive species interdiction and control, best management practices for erosion control and hazardous waste management, target and weapons restrictions, range maintenance, and the continued implementation of the "No Drop Zone" (see conservation measures 1.0; 2.0; 3.0; and 4.1). Additionally, the USN will implement rodent eradication on Farallon de Medinilla as rodents likely rely on the vegetation for a food source, water source, and nest materials. Removing the rodents is expected to improve habitat conditions on the island especially within the "No Drop Zone"; however, we anticipate that habitats within the inert and live-fire target areas will continue to be degraded, fragmented, and possibly lost due to MIRC training as described above and the potential for wildfire and prescribed burns as described below. We also expect that training will make habitats within the inert and live-fire areas more prone to the confounding effects from drought and typhoons. Therefore, we anticipate habitat for approximately five pairs (10 individuals) of Micronesian megapodes will become unsuitable or lost through MIRC training activities. This habitat is that associated with the same five pairs (10 individuals) that we anticipate may be taken through direct strike.

Due to the implementation of the conservation measures, we anticipate that the "No Drop Zone" will remain in the same condition or possibly improve due to rodent control and may be able to support additional pairs of megapodes (i.e., those that were displaced or new recruits). We also anticipate that the "No Drop Zone" will continue to be suitable (or suitability may increase) for foraging, resting, and potentially nesting. Therefore, we do not anticipate population-level effects (i.e., further range reductions, decreases in fitness, reduction in reproductive success) will occur as a result of habitat degradation, fragmentation, and loss due to MIRC. We also anticipate that the existing habitat for the Micronesian megapode within the "No Drop Zone" will not be at any greater risk of degradation, fragmentation, or loss from the indirect effects of natural disasters (typhoons and droughts) than currently, due to the implementation of these conservation measures.

Noise

The proposed training will result in noise (i.e., vibrations at differing frequencies) from the use of a variety of vehicles (fixed-wing aircraft, helicopters, trucks, tanks, other convoy vehicles) and weapons (demolitions, grenades, small arms, mortars, missiles, cannons, artillery, bombs), fire suppression, and loud voices. Micronesian megapodes on Tinian, Saipan, and Farallon de Medinilla will be exposed to varying levels of noise due to the different types of training. Therefore, the information below is presented as a background of noise impacts, and then a summary of exposure to the megapode by action areas.

Wildlife can be very sensitive to sounds in some circumstances and insensitive to sounds in other situations. Larkin *et al.* (1996, 107 pp.) in a recent literature review summarized the research related to effects from noise associated with military training to wildlife. Larkin *et al.* (1996, pp. 12-18, and references within) describes audio frequencies (i.e., the range of sound we can hear between infrasound and ultrasound), ultrasound, and infrasound. High frequency sounds (or ultrasound) diminishes very rapidly in air with distance from the source and terrestrial animals that are close enough to be adversely affected by the ultrasound produced by military training are likely close enough to be adversely affected by shrapnel, flying rock, or direct strikes. Therefore, ultrasound receives little attention in the terrestrial environment and we will assume that birds close enough to experience impacts from ultrasound will be directly affected by weapons use (i.e., direct strike). Effects from direct strike are analyzed above.

Infrasound (present in blast and helicopter noise, but not heard by humans) attenuates less in air than audible sound which means these noises can affect wildlife at longer distances. Birds may use infrasound for communication; however, the extent to which birds are affected by infrasound is speculative. Infrasound can result in damage to the ears which may affect the species' ability to hear and may also mask biologically meaningful infrasonic communication between individuals.

Noise can result from impacts (one object striking another), blasts (explosions which result in shock waves), bow shock waves (pressure waves from projectiles flying through the air), and substrate vibrations (combinations of explosion, recoil, or vehicle motion with the ground). Noise may be continuous (i.e., lasting for a long time without interruption) or impulse (i.e., short duration). Continuous impulses (helicopter rotor noise, bursts from rapid-fire weapons) represent an intermediate type of sound and, when repeated rapidly, may resemble continuous noise. These types of sound are distinguished here as they differ in their effects. Continuous sounds can result in hearing damage while impulses typically elicit physiological or behavioral responses.

Additionally, continuous or repetitive loud noise appears to cause stress and vascular alteration (including structural damage) in the ear and could be harmful when animals are already under metabolic stress. Sound levels over 85 A-weighted decibels (dBA) are considered harmful to inner ear hair cells; 95 dBA is considered unsafe for prolonged periods; and extreme damage occurs as a result of brief exposure to 140 dBA (Hamby 2004). Hearing loss in birds is difficult to characterize because birds, unlike mammals, regenerate inner ear hair cells, even after substantial loss (Corwin and Cotanche 1988, pp. 1,772-1,774; Stone and Rubel 2000, pp. 11,714-11,721). Recovery from metabolic ear stress can often occur after ten hours (mammals) post loud impulse noise, even before ear structures are fully recovered. Repeated trauma may prolong the course of hearing sensitivity recovery; however, longer-term recovery from hearing loss is generally expected in birds due to cell regeneration. However, lifelong hearing loss (threshold shifts) can occur in birds and about half the duration of noise is needed to produce a threshold shift in birds as opposed to mammals.

Severe noise, even if the noise is short in duration, can result in tympanum rupture, bone fracture, other damage to the ear, and deterioration of brain cells. These impulse noises can cause physical damage at lower intensity than continuous or rapidly-repeating noises due to the ear reflex mechanism. For example, common canaries (*Serinus canaria*) exposed to continuous loud noises experienced changes in hearing thresholds, especially at high frequencies (Larkin *et al.* 1996, p. 30, and references within). While a study with budgerigars (*Melopsittacus undulates*) indicated that a permanent threshold shift (lifelong hearing loss) was experienced at low frequencies only and nearly absent at higher frequencies (Larkin *et al.* 1996, p. 30, and references within). Many birds appear to tolerate noise that can cause pain in humans, for example: seabirds at airports, wild turkeys (*Meleagris gallopavo*) near a rocket testing plant in

Florida, and ospreys (*Pandion haliaetus*) at the Naval Surface Warfare Center, Dahlgren (Larkin *et al.* 1996, p. 31, and references within).

These varied responses are often attributed to habituation, where after a period of exposure to a stimulus, an animal stops responding to the stimulus. In general, a species can often habituate to human-generated noise when the noise is not followed by an adverse impact. Even when a species appears to be habituated to a noise, the noise may produce a metabolic or stress response (increased heart rate results in increased energy expenditure) though the response may or may not lead to changes in overall energy balance.

In addition to physical damage to the ear, noise also produces other physiological and behavioral responses. The behavioral effects of military related noise to wildlife have been investigated numerous times with mixed results (VanderWerf *et al.* 2000, p. 3) and it is therefore difficult to generalize predictions about potential responses of Micronesian megapode to noise based upon other species. The following information is summarized from Larkin *et al.* (1996, p. 21-52), unless otherwise stated and is meant to provide an overview of the types of responses that have been documented for avian species from military noise or related noise (i.e., commercial fixed wing flights vs. military fixed-wing flights).

Noise from small arms is unlikely to affect animals in terms of hearing loss; however, those species that are commonly hunted will likely demonstrate behavioral (e.g., flushing, startle response) or physiological responses (e.g., increased heart rates, increased respiration rates). However, blast noise includes shock waves. Red-cockaded woodpeckers (*Picoides borealis*) successfully raised young near an active bombing range in Mississippi; while other birds at other sites did not. Oahu elepaio (*Chasiempis sandwichensis ibidis*) did not respond in statistically significant or biologically meaningful ways to noise generated by training with 155 and 105 millimeter howitzers, 60 and 81 millimeter mortars, hand grenades, and demolition of unexploded ordinance (VanderWerf *et al.* 2000, pp. 18-19). Prairie falcons (*Falco mexicanus*) responded to blasts from ongoing civilian construction where the nests sites were not normally exposed to blasting; however, one northern harrier (*Circus cyaneus*) appeared to preferentially hunt near a location where 24-pound bombing occurred. Anecdotal observations indicate the burrowing owl (*Athene cunicularia floridana*) continues to be persistent at Eglin Air Force Base on a bombing range where a variety of inert ordnance (rockets, missiles, and bombs including the MOAB [a 21,700-pounds massive ordnance air blast bomb]) has been used over the last 24 years (Hagedorn 2009, pers. comm.).

Noise from helicopters is complex and wildlife response may depend on the model of the helicopter. Touch-and-go landings, bombing runs, helicopter sorties, and artillery practice are impulse activities that repeat at short enough intervals to constitute a continuous exposure. In a literature review of waterfowl response to aircraft, avian response to aircraft was (cautiously) generalized as more intense with helicopters than fixed-wing aircraft, and stronger with slower fixed-wing aircraft than fast fixed-wing aircraft (Plumpton 2006, p. 3-1, 3-2). Increasing horizontal distance resulted in lower response than increasing altitude (Plumpton 2006, p. 3-1, 3-2). Raptors have varied behaviors in response to helicopters and responded similarly to explosions: by remaining on a nest, flushing from an area, and attacking the helicopter. American black ducks (*Anas rubripes*) reacted to 39 percent of military aircraft overflights on their first day of exposure, but after two weeks they responded only six percent of the time (Conomy *et al.* 1998, pp. 1,135-1,142). However, wood ducks (*Aix sponsa*) in the same study continued to respond to aircraft noise (Conomy *et al.* 1998, pp. 1,135-1,142). Survival of captive black duck chicks was lower in a noisy area than control area; however adults were largely unaffected. Sandhill cranes (*Grus canadensis*) were noted to stay on their nests when helicopter activity was within 40 meters above them and bald eagles remained on their nests until helicopters approached closely (distance not defined). On Farallon de Medinilla, adult birds (presumably various species of seabirds) flushed from their nests in response to helicopter landings; however, some returned to their nests within 15 minutes after the disturbance stopped (Lusk *et al.* 2000, p. 32).

Vehicles also differ from one another in sound and appearance. Vehicle noise impacts to wildlife are difficult to quantify as other factors (emissions, topography, and vegetation, etc.) generally confound analyses. Vegetation and topography can reduce vehicle traffic noise. In one study, when traffic increased, burrowing owls exhibited alert responses or moved. Though these behaviors did not result in changes to nesting productivity. A study of sandhill cranes noted that the birds nested within 4 meters of a road, while in a study of off-road vehicles, birds (species not defined) flushed and flew distances of 3.2 kilometers at the sound of approaching vehicles. As summarized in Larkin *et al.* (1996, 107 pp.) other studies have noted species-specific decreases in breeding densities close to roads.

Human-produced noise also elicits responses in birds. Incubating herring gulls (*Larus argentatus*) and great black-backed gulls (*L. marinus*) habituated to the continual presence of humans, but were disturbed when they perceived a human walking directly toward their nests (Burger and Gochfeld 1981, pp. 242-267). On Farallon de Medinilla, Micronesian megapodes flushed in response to humans (Lusk *et al.* 2000, p. 29). Upon flushing, the birds called and flew 30 to 50 meters before dropping back into thick vegetation (Lusk *et al.* 2000, p. 29).

As demonstrated above, noise can produce a variety of physiological impacts and behavioral responses in wildlife. The response to noise not only affects an individual but can affect the overall population as well. Hearing impairment, both temporary and permanent, can decrease viability or reproductive success particularly when mate attraction and territory protection depend on calling or singing normally. Hearing impairment can also decrease the ability to detect and warn others of predators. Behavioral responses (startle response, alert or alarm response, and flushing) to noise are often examined as these response actions result in: birds expending excess energy that is not directed towards reproduction; nest exposure increasing the risk of predation, nest cooling or nest heating which can result in egg and juvenile mortality; or accidently kicking eggs or juveniles out of the nest. Behavioral responses can also include lower breeding densities in suitable habitats that are subject to noise; therefore, suitable habitat may become otherwise unsuitable due to noise. Wildlife response to noise may also be more intense at night, if the species rely more on auditory cues than visual cues at night. Additionally, young animals may be more susceptible to hearing loss from noise exposure than adults; however, an experiment with common canaries did not show a differential response with age (Larkin *et al.* 1996, p. 25, 30 and references within). Response of Micronesian megapode to noise has not been evaluated under scientific investigation. Micronesian megapodes are vocal and presumably find mates and defend territories by duetting (USFWS 1998b, pp. 5-6 and references within).

Therefore, noise may affect the Micronesian megapode if it physically damages the ears such that: an individual cannot hear and locate a mate; produces abnormal calls (hearing impaired learning) and cannot attract a mate; or is unable to defend a territory.

Other concerns from noise impacts to avian species are related to nesting and impacts to eggs or chicks (i.e., mortality through kicking eggs or young out of the nest during flushing, exposing young to temperature changes, failing to feed and care for young during nest flushing, exposing eggs and young to increased predation). Micronesian megapodes generally bury their eggs in mounds in which temperature is controlled by sources other than the bird (Decker *et al.* 2000, p. 2; Wiles and Conry 2001, p. 270; Glass and Aldan 1988, p. 135-137). Chicks are precocial and are able to fly upon emergence from the egg and do not require parental care (USFWS 1998b, p. 9). Therefore, behavioral responses typical to other avian species are not likely to result in adverse impacts to eggs, chicks, or juveniles of Micronesian megapodes.

On Tinian, Micronesian megapodes are transient and when present, typically use the native limestone cliff habitat in the Military Lease Area. As a conservation measure, this area is designated as a "No Wildlife Disturbance Area" where the following activities are prohibited: cross-country, off-road vehicle travel, vehicle parking unless it is on cleared shoulders of existing roads or trails; pyrotechnics, demolitions, or breaching charges; digging or excavation without prior approval; open fires; mechanical vegetation clearing; live ammunition; firing of blanks; flights below 305 meters (1,000 feet) above ground level; and helicopter landings except in designated landing zones (of which there are none in the megapode habitat). No training occurs within the limestone forest habitat and live-fire is limited to small arms. Therefore, we would expect noise from adjacent land navigation training (vehicle and pedestrian), fixed-wing and helicopter overflights, small arms use, and humans. Only one road abuts the limestone forest habitat. The majority of roads and trails are greater than 100 meters (328 feet) from the forest edge. Additionally, the megapode habitat is on the cliff line and elevated plateaus and not on the same plane as the roads. As stated above, altitude of overflights is restricted.

Micronesian megapodes are unlikely to be present on Tinian during training due to their transient behaviors. However, if they were present, we would expect noise to attenuate to a level that does not cause physical harm to the Micronesian megapode due to the distance from the training; the reduction of noise due to vegetation; and topography (Larkin *et al.* 1996, p. 41 and references within).

On Saipan, at least one Micronesian megapode has been detected in the limestone cliff forest across the road from and within the Marpi Maneuver Area and in the tangantangan habitats within the Marpi Maneuver Area. Only pedestrian land navigation training occurs in the Marpi Maneuver Area and no training will occur in the native limestone forest habitat (see conservation measure 4.3.2). Pedestrian land navigation training is designed for the service member to navigate to a location undetected; thereby the goal is to produce as little noise as possible. Civilian traffic, tour buses, tourists and homesteads are all present around the action area and the native limestone forest. We anticipate that land navigation training noise will be implemented such that noise impacts to the human environment are low. We also expect training noise to attenuate through the forest. Therefore, we do not anticipate that noise from training in the Marpi Maneuver Area will result in adverse affects or physical harm to Micronesian megapodes.

Training on Farallon de Medinilla involves numerous overflights of fixed-wing planes while firing inert and live-fire ordnance from air to shore and ship to shore (USN 2009b, p. 26). The ordnance varies in size (small arms to bombs under 2,000 pounds) and all will generate noise. Most ordnance used is expected to generate shock waves. Training, including the use of approximately 2,000 live and inert ordnance has been occurring on a routine basis on Farallon de Medinilla since at least 1999 (USFWS 1999, 43 pp.). The proposed training is of the same nature (type of ordnance, aircraft, and ships); however, ordnance use will increase to 3,000 munitions per year. Farallon de Medinilla supports a dense population of Micronesian megapodes within the "No Drop Zone". Training restrictions are in place on Farallon de Medinilla (see conservation measures 4.1) to reduce training impacts to Micronesian megapodes, mainly by avoiding the "No Drop Zone" and using only inert ordnance in Target Area 1 below the area "No Fire Line."

Densities of Micronesian megapode in the northern portion of Farallon de Medinilla are comparable to other islands in the CNMI with large megapode populations and no military training or human populations. Though no studies have been implemented to determine population status and trends on Farallon de Medinilla, we believe the Micronesian megapode population is reproducing on the island based upon observation of chicks and juveniles (Vogt 2009a, p. 3) and the presence of possible megapode burrows (Lusk *et al.* 2000, p. 29) rather than maintaining the population through immigration. Although chicks are capable of flying they have not been documented to fly long distances (i.e., between islands). During routine monitoring of megapodes on Farallon de Medinilla, individuals responded to playback calls as expected based on surveys on other islands and no abnormal calls were detected (Vogt 2009d, pers. comm.). These anecdotal data indicate that no hearing loss which affects observable behaviors has occurred. However, the megapode could be experiencing hearing loss through temporary or permanent threshold shifts that have not resulted in observable behavioral differences.

We expect that the vegetation provided by the "No Drop Zone" is acting as an effective barrier for noise attenuation. Therefore, based upon high Micronesian megapode densities, no observable behavioral changes associated with hearing impairment, and noise attenuation in vegetation, we do not believe temporary or permanent hearing impairment (harm or injury), changes in population dynamics, or mortality will occur from training noise within the "No Drop Zone". We do anticipate that noise may harm or injure the five pairs (ten individuals) of Micronesian megapodes that may be using the area around the inert and live-fire target areas, although the megapodes occupying this area have not demonstrated behavioral characteristics indicative of hearing damage. We determined injury or harm from noise is more likely to occur in this area and it is within the direct line of strike and vegetative noise buffers are generally not present. These five pairs (ten individuals) of Micronesian megapodes are the same pairs we believe will be adversely affected from direct strike and habitat loss.

Invasive Species Pathways

Along with the implementation of MIRC, there is an associated risk of introducing or spreading non-native terrestrial and aquatic invasive species including plants, animals, and microbes. Pathways associated with anthropogenic activities have a relative risk of introducing and dispersing non-native invasive species. Hulme *et al.* (2008, 14 pp.) described three broad mechanisms for non-native species introductions: importation as a commodity (e.g., purposeful importation as biocontrol, pet trade), arrival via transport vector, and natural dispersal. Of these mechanisms, Hulme *et al.* (2008, 14 pp.) further described a framework for introductions that is supported by six principal pathways of which two could potentially occur via the implementation of MIRC: contaminant of a specific commodity and stowaway (independent of a commodity, like ballast water or airfreight). The pathways of contaminant and stowaway include, but are not limited to species transported via: construction equipment, personal protective equipment, delivery of materials or goods, foot traffic, vehicles or vessel traffic. Invasive species introduced as contaminants and stowaways are done so because of inadequate harborage, sanitation, and inspection prior to movement. The repeated or routine movement of equipment and people is a transportation route which allows for repeated introductions over time and this pressure increases the potential for a non-native invasive species to become established.

The results that follow the introduction and spread of a non-native invasive species can be difficult to predict (Courchamp *et al.* 2003, 37 pp.); however, there is scientific documentation of the impacts to threatened and endangered species due to invasive species. These studies suggest that the threats and impacts related to invasive species are second only to the impacts from habitat destruction (Wilcove *et al.* 1998, p. 609). Non-native invasive species could have impacts that alter the existing terrestrial ecosystem and may then expand out into adjacent areas after the initial introduction. Impacts that have been documented for non-native invasive species generally include direct predation; habitat alteration; illness, injury, or death due to disease; and competition for resources. The types of impacts are determined by characteristics of the native species as well as the non-native species. Below we have provided examples of impacts from non-native invasive species (mammals, reptiles, invertebrates, and disease) introductions to avian and other species to highlight the risk and potential impacts from accidental invasive species introductions.

Introduced rats have affected island wildlife. During field trials on the uninhabited island of Surprise Island, New Caledonia, Caut *et al.* (2008, p. 434) documented predation by the black rat (*Rattus rattus*) on ground nesting seabirds. The authors noted a dietary shift in the rats when seabird eggs and chicks were not present. As the abundance in seabird eggs and chicks declined, predation by black rats shifted to skinks, sea turtles, and insects (Caut *et al.* 2008, 10 pp).

On Guam, the non-native invasive brown treesnake has been documented as a predator on various species of vertebrates. Wiles *et al.* (2003, 11 pp.) examined bird data from Guam and stated that 22 out of 25 species of birds were affected by the brown treesnake. Of these species, 17 of the 18 native bird species were severely impacted, and 12 species have been extirpated from Guam. In addition, Wiles *et al.* (2003, pp. 1,355-1,356) provided reference to observations of Mariana swiftlet predation by brown treesnakes on Guam as a regular event. The brown treesnake has been linked to the extirpation or extinction of numerous bird, bat, and reptile species on Guam (Fritts and Rodda 1998, p. 114).

Another example of a non-native invasive species with documented impacts to avifauna is the red imported fire ant (*Solenopsis invicta*). The northern bobwhite quail (*Colinus virginianus*) is a ground-nesting and ground-foraging bird in North America. Allen *et al.* (1995, 8 pp.) describe impacts from red imported fire ant observed during field experiments with northern bobwhite quail in Texas. Red imported fire ant preyed upon pipping chicks. Other impacts to chicks included weight loss from exposure to red imported fire ant venom. Red imported fire ants also affect insect communities through competition which indirectly affected the diet of northern bobwhite quail resulting in lowered fitness of chicks and adult females (Allen *et al.* 1995, pp. 632, 636 and references within).

Mosquitoes have also been associated with the decline of biodiversity of species, especially birds. Specific accounts and historical documentation of the introduction and spread of mosquitoes and various bird diseases in the Hawaiian islands is covered in great detail by Warner (1968, 20 pp.). In particular, the vectors (differing mosquito species) and avian diseases are illustrated by authoritative accounts and field trials. Warner (1968, p. 116) discusses the ability for certain bird species to inhabit higher elevations (i.e., above 600 meters) where it is mosquito-free and thus allows some bird species to persist. Juliano and Lounibos (2005, 24 pp. and references within) provide an overview of mosquito species, invasiveness, pathways for introduction, and associated impacts of these species on human and wildlife populations.

It is important to understand that the "risk" of introduction and establishment of invasive species is highly variable across taxa and habitats. Identifying and analyzing risk for all the species that could be moved via MIRC activities is not practicable. Instead, a more efficient approach is to address pathways where numerous species from different taxa may be inadvertently introduced and implement prescriptive measures to control risks from the pathways. A pathway risk assessment will provide a structure for assessing where the greatest "risk" for a non-native species introduction occurs and locations where managing ingress or egress of these species is most efficient for control. Pathways must be controlled because repetition of an action has a direct effect on propagule pressure which as stated above increases the likelihood of a species to become established.

The Micronesian megapode and its habitats are subject to the risk of effects from the introduction and spread of existing and novel invasive species via MIRC. To reduce the risk of introduction and spread of non-native, invasive species via MIRC activities, the USN has proposed to implement a variety of conservation measures (see conservation measures 1.0) throughout all the MIRC action areas. The USN has targeted specific actions to prevent the spread of the brown treesnake from Guam to other islands (100 percent inspection of outgoing vessels and aircraft, quarantine areas, research to enhance snake detection procedures, and environmental education of all personnel). The USN will also require each individual service member (or other employee or contractor associated with range maintenance activities, biological surveys, etc.) to complete self inspections (including equipment and gear) to avoid movement of invasive species between different islands and within different areas of the same island. The USN will also conduct a pathway analysis for each activity (or type of activity training, range maintenance, etc.) conducted under MIRC to determine and implement appropriate risk avoidance procedures. The USN will develop Standard Operating Procedures for each activity (or type of activity) that incorporate the appropriate risk avoidance procedures and will conduct after action reviews to assess and revise Standard Operating Procedures and avoidance procedures to ensure the risks from invasive species introductions are addressed. Additionally, the USN commits to implementing actions from the Regional Biosecurity Plan (once developed) that will further reduce or eliminate risk of transporting invasive species via MIRC activities.

With the possible exception of rats (see below), we are not specifically aware of any non-native invasive species that are currently impacting the Micronesian megapode or its habitat. We believe implementation of the conservation measures proposed for invasive species interdiction and control should reduce the risk of invasive species adversely affecting the Micronesian megapode or its habitat.

Wildfire and Prescribed Burning

Military training with live-fire and incendiary materials, bivouacing with campfires, cigarette smoking, and vehicular malfunctions can result in the ignition of wildfires. The USN plans to conduct prescribed burns on Farallon de Medinilla to clear vegetation in order to complete range maintenance activities (USN 2009c, p. 2). Fires can lead to a variety of direct, indirect, and interrelated affects to wildlife and their habitats.

Direct effects to birds from fires are not routinely documented (Epanchin *et al.* 2002, p. 139). However, eggs, nestlings, ground nesting birds and flightless birds (including waterfowl during wing molt) are susceptible to fire (Erwin and Stasiak 1979, pp. 247-248). In general, adult birds fly away from fire (Vogl 1973, p. 336; Erwin and Stasiak 1979, p. 248), although some species have been documented to purposely forage near the fire line (Smallwood *et al.* 1982, p. 171; Erwin and Stasiak 1979, p. 248; Vogl 1973, p. 336). Epanchin *et al.* (2002, p. 141) noted direct mortality of white ibis (*Eudocimus albus*) after a wildfire in the Everglades. They hypothesized that the fire moved quickly through the area and suggested that the ibis may have been trapped by low overhead smoke or smoke inhalation, purposely foraging close to the fire line, or seeking refuge from the smoke and flames (Epanchin *et al.* 2002, p. 141). Smoke inhalation can also adversely affect birds as smoke can result in irritation and inflammation of the respiratory tract. In a severe case documented for a captive bird, smoke inhalation (from multiple kitchen fires) caused wheezing, respiratory distress, weakness, infections, behavioral changes (including decreased vocalization and activities), inability to coordinate voluntary muscle movements, collapse, and eventually death (Simone-Freilicher 2008, pp. 138-145).

Fire can indirectly affect endangered and threatened species by changing physical and biological characteristics of the area which subsequently results in secondary habitat degradation and loss of forage base. Physical features that will be exposed to heat and flames include soil structure and microclimate conditions. Fire will increase soil temperatures, alter soil moisture holding capacity, and modify soil rainfall infiltration (DeBano *et al.* 1979, pp. 2-7; Wells *et al.* 1979, p. 17; Neary *et al.* 2005, p. 2). These physical features will be indirectly exposed to post-fire erosion and alterations of light and shade, temperature, humidity, and wind as a result of vegetation destruction (Rice 1973, p. 30). Light levels, temperatures, and wind speeds will increase with destruction of canopy plants, and relative humidity will decrease (DeBano *et al.* 1979, p. 4; Rothermel and Rinehart 1983, p. 5; Hoffmann *et al.* 2003, p. 4-4). Because vegetation cover affects erosion rate, soil erosion may occur after fire except where rapid establishment of non-native invasive grasses are prevalent. Grass invasion may occur following removal of shrub and tree canopy (D'Antonio and Vitousek 1992, p. 63; Tunison *et al.* 2001, pp. 123-126). Chemical features that will be exposed to heat, flames, smoke, and ash include soil nutrients and water, which will be indirectly exposed to post-fire changes in content and cycling rates. Soil nutrient availability will be altered through volatilization of certain elements to the atmosphere in smoke (e.g., carbon, nitrogen, and sulfur), conversion to more available forms in the ash (e.g., potassium, phosphorus, and divalent cations), wind dispersal of the ash, and surface erosion (Clayton 1976, p. 162, 164; Agee 1993, pp. 160-163).

Biotic features of the habitat that will be exposed to heat, flames, smoke, and ash include all living organisms in the exposure area, litter layers on the forest floor, organic matter within the surface soil horizon, and seeds within the litter and surface soil. These types of organic matter are typically used in megapode nests for incubation of eggs via heat from decomposition. Forage organisms will be directly exposed to injury or death, and seeds, litter, and organic matter will be directly exposed to destruction and loss (Kinnaird and O'Brien 1998, p. 955). These effects in turn will indirectly expose soils to long-term changes in fertility and structure as a result of disrupted decomposition and nutrient cycling processes, reduced nutrient and water retention by organic matter, increased nutrient losses in runoff and leaching, and reduced ecosystem primary production due to loss of leaf area and photosynthesis (Kinnaird and O'Brien 1998, p. 955).

In order to avoid and minimize direct, indirect, and interrelated effects from fire to the Micronesian megapode, the USN proposes to implement multiple actions (see conservation measures 4.1.1; 4.2.2; 4.3.3; and 4.3.4). For example, the training that occurs on Tinian in habitats that support transient Micronesian megapodes is restricted. These areas are designated "no wildlife disturbance areas" where are types of pytrotechnics and potential fire starting activities are restricted. Furthermore, no live-fire (except indoors with bullet traps) or tracer rounds will be used on Tinian. The use of incendiary materials and other potential fire-starting activities must be conducted on existing, cleared runways and in accordance with the Fire Prevention Plan. Additionally, military fire response efforts will be augmented by the Tinian Fire Department. On Saipan, no incendiary materials or other potential fire-starting activities (including campfires or cooking during bivouac activities) will occur. Smoking is not permitted during training activities and fire-safe portable receptacles for cigarette butts are used during periods of rest between training activities. We do not anticipate adverse effects from fire to Micronesian megapodes on Tinian or Saipan from MIRC.

On Farallon de Medinilla, live-fire weapons are restricted in that cluster bombs, live cluster weapons, live scatterable munitions, fuel-air explosives, incendiary devices, and bombs greater than 2,000 pounds are prohibited. The live-fire weapons allowed are used only in two specific areas and targets are placed to reduce the potential for wildfire. The areas for target placement support only low growing vegetation due to long-term training with explosives. Due to the lack of fuels in the area, explosions have not resulted in wildfires. Dense vegetation grows on the northern portion of the island within the "No Drop Zone" which could create a wildfire if weapons are misfired. However, none of the military training to date has resulted in wildfires on Farallon de Medinilla or any other action area within the MIRC (USN 2009b, p. 32).

The USN plans to use prescribed fire on Farallon de Medinilla to facilitate target installation and maintenance and reduce potential migration of munitions constituents off-range (USN 2009c, p. 2). Specific procedures will be followed to ensure the prescribed burn does not escape (USN 2009c, p. 3). Conservation measures (4.1.2) will also be implemented to minimize effects from prescribed burning. We anticipate the effects of an escaped prescribed burn to be analogous to those of a wildfire; therefore, we have not completed an additional effect analysis to evaluate the impacts of smoke and flames from prescribed burning to the Micronesian megapode or its habitat. As a conservation measure the USN will aerially-apply a fire retardant powder, foam, or gel before the prescribed burn to prevent escape. Therefore, the use of fire retardants is interrelated and interdependent to prescribed burning and is discussed below as fire retardant may affect wildlife and their habitats.

Approximately five pairs (ten individuals) of Micronesian megapodes (extrapolated from survey data) may be using the area around the inert and live-fire target areas on Farallon de Medinilla and are at risk from a fire (USN 2009b, p. 89). We believe that a training-related wildfire or a prescribed burn is unlikely to spread to the "No Drop Zone" due to the lack of historical wildfires, lack of vegetative fuel in the target areas, and the conservation measures proposed for prescribed burns. Behavior of Micronesian megapodes during a fire event has not been documented. In the event of a fire, we anticipate Micronesian megapodes would fly to the "No Drop Zone" or other nearby islands thereby avoiding direct effects from flames. While we anticipate that Micronesian megapode would flee from smoke, exposure to smoke inhalation could result in similar initial symptoms (respiratory distress and excessive blinking) (Simone-Freilicher 2008, p. 138). However, we do not expect the symptoms to escalate as with the captive bird. Therefore, we anticipate that take of five pairs (10 individuals) of Micronesian megapodes could occur in the form of harm and injury due to smoke inhalation from training related fires or prescribed burning.

Fire Retardants

Historically, the use of fire retardants has resulted in negative environmental effects such as soil sterilization and adverse impacts to human health; however, because of these impacts older generation fire retardants are no longer in use (Kalabokidis 2000, p. 130). The USN proposes to use Flame Guard Gel as a fire retardant and the main components of the fire retardant include ammonium polyphosphate, diammonium phosphate, diammonium sulfate, monoammonium phosphate, attaplugus clay and guar gum (USN 2009c, 12 pp. + Appendix E). Fire retardants using these chemicals are similar to agricultural fertilizers and generally are considered to have minimal toxicological or ecological effects (Kalabokidis 2000, p. 134). Fire retardants can benefit plants by adding nutrients to the soils; however, overapplication can result in leaf death (Kalabokidis 2000, pp. 130, 134). Kalabokidis (2000, p. 134) noted that a risk assessment indicated there could be possible adverse effects (not described) from toxicity of long-term use of retardants to blue jays (*Cyanocitta cristata*), wild turkeys, and quail (*Callipela spp.*). During drought conditions or in low light, high temperature conditions, herbivorous mammals could experience nitrate poisoning from consumption of plant material that has incorporated the nitrogen from the fire retardants (Kalabokidis 2000, p. 134). Humans report skin and eye irritation as a result of prolonged contact with fire retardants (Kalabokidis 2000, p. 130). Flame Guard Gel is reported by the manufacturer to be biodegradable and non-toxic in accordance with U.S. Forest Service tests (Flame Guard Gel, 2009); however, the material safety data sheet indicates exposure could result in respiratory tract irritation, skin irritation with prolonged exposure, and digestive tract irritation from ingestion.

Approximately five pairs (ten individuals) of Micronesian megapodes (extrapolated from survey data) may be using the area around the inert and live-fire target areas on Farallon de Medinilla and are at risk from a fire (USN 2009b, p. 89). Therefore, we anticipate that these five pairs (ten individuals) of Micronesian megapodes could be exposed to the use of fire retardant through inhalation, skin exposure, and ingestion resulting in temporary harm due to irritation of the respiratory and digestive tracts, and possible skin irritation. However, application of the fire retardant will be restricted to one small area along the north end of the island, just south of the "No Drop Zone". The use of retardant is limited and is only used when a prescribed burn will be necessary to complete range maintenance. We anticipate that range maintenance will occur no more than once every two to five years. Conservation measures will be implemented to attempt to avoid birds (via pre-application surveys) and ensure retardant application is appropriate (see conservation measure 4.1.2). We anticipate that megapodes will leave the area due to human disturbance (i.e., the pre-application surveys); however, harm through exposure to fire retardant is possible. Again these are the same five pairs (ten individuals) that we anticipate will be adversely affected by other stressors and actions described above.

Herbicide Use

The USN must clear range debris and replace targets on Farallon de Medinilla on a regular basis to facilitate training (USN 2009c, p. 2-3). Clearing the range debris requires vegetation removal in a small portion (3.3 hectares; 8.3 acres) of Impact Area 1. Vegetation will be cleared using herbicides and prescribed burns (see Fire above).

The Impact Area 1 site is relatively flat and the vegetation is dominated by dense herbaceous communities that are used by the Micronesian megapode. Based upon observations during biological surveys of Farallon de Medinilla, we anticipate there may be approximately five pairs of megapodes surrounding or within the area where targets are located and range debris must be cleared (USN 2009b, p. 89; contrary to USN 2009c, p. 3 which estimates four pairs). The USN proposes to use the glyphosate-based, Dow Rodeo brand herbicide, which is designed and approved for use in or near aquatic ecosystems and is approved for use in wildlife habitat areas throughout the United States (Dow AgroSciences 2002, p. 2).

Rodeo does not affect underground rhizomes or root stock (Dow 2002, p. 2); therefore, we anticipate that vegetation will return after range clearing and target replacement are completed. The herbicide degrades readily in the environment, does not bioaccumulate in terrestrial or aquatic animals, is not anticipated to kill terrestrial invertebrates (based on aquatic invertebrate studies), and is largely non-toxic to animals, including birds (Monheit 2003, 10 pp. and references within). Therefore, we do not anticipate direct harm to Micronesian megapodes from the use of Rodeo. Habitat for shelter and potentially nesting will be degraded from the use of Rodeo and subsequent vegetation removal. Additionally, forage items may become limited in the immediate area of treatment (i.e., plant and seed material will be unsuitable, insects will move to new habitat patches; see Moneheit 2003, p. 7 and references within). We anticipate that the estimated five pairs (ten individuals) of Micronesian megapodes will leave the area prior to application of the herbicide and temporarily forage and shelter elsewhere on the island.

Training and range maintenance activities cannot occur at the same time; therefore, temporarily displaced megapodes would not be at greater risk for a direct strike. In addition, conservation measures (see 4.1.2) will be used to ensure herbicide use attains maximum efficiency with minimal chemical use. Herbicide use will be completed during conditions where drift will be minimized thereby reducing affects to adjacent habitats. Based upon these data and the implementation of associated conservation measures, we anticipate that the use of herbicides and vegetation removal on Farallon de Medinilla may affect five pairs (ten individuals) of Micronesian megapodes through temporary displacement; however, we do not anticipate that these affects will rise to the level of take. Herbicides will not be used by the USN on Tinian or Saipan; therefore, the application of herbicide in these action areas is not analyzed in this biological opinion.

Pesticide Use

As a conservation measure, the USN has proposed to eradicate rats (likely *Rattus exulans*) from Farallon de Medinilla. Documentation of the effects that rats are having on the Farallon de Medinilla ecosystem is lacking. However, it is likely that their impact is similar to impacts reported elsewhere for *R. exulans*, including predation of bird eggs, seed predation, and the stripping of vegetation for moisture (Lindsay *et al.* in press, p. 5; Towns and Broome 2003, pp. 378-379).

The use of rodenticide may adversely affect the Micronesian megapode through lethal or sublethal impacts. The megapode is omnivorous (Glass and Aldan 1988, p. 142) and could be exposed to the rodenticide through both direct ingestion of pellets and through secondary poisoning via contaminated insects, crabs, and possibly scavenging on dead rats. Eisemann and Swift (2006, pp. 424-426, 429-430) used three methods to calculate the lethal and sublethal exposure risk to various avifauna, including the Hawaiian owl (*Asio flammeus sandwichensis*) and Hawaiian crow (*Corvus hawaiiensis*), from aerially broadcast diphacinone pellets. At 350 grams, the Micronesian megapode's weight is identical to that of the Hawaiian owl, and the megapode's omnivorous diet is analogous to that of the Hawaiian crow. Therefore, the calculations completed by Eisemann and Swift (2006, pp. 429-430) to assess the risk to the Hawaiian owl and Hawaiian crow from aerial broadcast of diphacinone can be applied to examine the exposure risk to the Micronesian megapode on Farallon de Medinilla.

Extrapolating from Eisemann and Swift (2006, 20 pp.) and acute diphacinone toxicity testing completed on avian test species (USEPA 1998, pp. 60-61 and references within), a megapode would need to consume at least 2.8 kilograms of bait (0.005 percent diphacinone), 27.94 kilograms of contaminated invertebrates containing 5.01 milligrams diphacinone per kilogram, or 45.60 kilograms of rodents containing 3.07 parts per million diphacinone in one day to ingest a dose equivalent to the lethal dose for half of the individuals (LD50). We do not have data indicating the consumption rates of food items for Micronesian megapode. However, the amount of forage items or pellets a megapode would need to consume within one day to reach the extrapolated LD 50 is well above the body weight of a megapode. Therefore, we believe the risk of mortality from consumption of pellets or contaminated forage items extremely low.

A megapode would need to consume at least 4.2 grams of bait (0.005 percent diphacinone), 41.9 grams of contaminated invertebrates containing 5.01 milligrams diphacinone per kilogram, or 68.40 grams of rodents containing 3.07 parts per million diphacinone per day for multiple days to be exposed to a dose of diphacinone equivalent to the lowest dietary dose causing mortality in test species. These rates of consumption are much lower than those needed to reach an LD50. However, diphacinone breaks down rapidly in the environment (USEPA 1998, p. 77). Therefore, we believe the risk of mortality from consumption of pellets or contaminated forage items over time is low.

Risk calculations for sublethal exposure (i.e., increased time for blood clotting) show that a megapode would only need to eat 0.77 grams of bait, 7.68 grams of contaminated invertebrates containing 5.01 milligram diphacinone per kilogram, or 12.54 grams of rodent tissue containing 3.07 parts per million diphacinone, per day for multiple days to be affected. These rates of consumption are very low (i.e., foraging on less than one bait pellet or one rodent per day). Therefore, we believe sublethal effects to megapodes through primary exposure to bait or secondary exposure to invertebrates and rodents are likely. The duration of the sublethal effects are not known. Increased duration for blood clotting could result in subsequent mortality if a bird were wounded. However, wounded birds would be subject to mortality in the absence of rat control.

The diphacinone pellets weigh approximately 1 to 2 grams, and are unlikely to cause mortality in Micronesian megapode due to a direct strike. A similar application of aerial broadcast of diphacinone pellets was recently completed on the island of Lehua, Hawaii, which supports a seabird colony (Nelson and Kessler 2009, pers. comm.). No avian mortality was observed during monitoring efforts immediately after application (i.e., no evidence of direct strike) of the diphacinone pellets (Nelson and Kessler 2009, pers. comm.). Additionally, no avian mortality was observed seven and fourteen days after the diphacinone application indicating no other lethal effects as well (Nelson and Kessler 2009, pers. comm.). Monitoring for sublethal affects was not implemented.

We anticipate that diphacinone will be applied evenly across the island. We also anticipate that multiple applications of diphacinone will be necessary as the island has many cavities for rats to hide and store forage materials within which would subsequently reduce their exposure to the toxicant. Therefore, we anticipate that all Micronesian megapodes (n = 46) on Farallon de Medinilla are at risk from sublethal effects and therefore could be harmed due to diphacinone consumption or foraging on contaminated materials. We do not expect mortality from the application of diphacinone, from the consumption of diphacinone or contaminated forage items. Removing rats from Farallon de Medinilla would likely result in increased vegetation cover. Increases in vegetation cover could indirectly benefit Micronesian megapodes in that additional cover and organic matter would be available for foraging, developing nest sites, and for shelter. If rats are preying upon megapode eggs, an increase in the megapode population is expected. Pesticides will not be used on Saipan or Tinian; therefore, the application of pesticide in these action areas is not analyzed in this biological opinion.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Recreation and tourism occur within the Military Lease Area on Tinian. In general, the tourists are bused to historical sites, while some use rental cars. These tourism activities are not anticipated to result in effects to the Micronesian megapode as the species is transient on Tinian and the majority of the sites are not in habitats that would be used by the megapode. There are no historical landmarks in the area where megapodes were last detected.

Recreation and tourism, motorcross racing, charcoal harvesting, and homesteading all occur in or adjacent to the Marpi Maneuver Area, Saipan. As with Tinian, tourism is for visits to historical sites and shrines and is typically via rental car or tour bus. These activities are not anticipated to adversely impact the megapode. Motorcross racing occurs in a previously disturbed area that does not support habitat for the megapode. Citizens of Saipan will remove tangantangan by hand for use as charcoal. We do not believe this activity will affect the Micronesian megapode as the megapode would be expected to avoid people entering the tangantangan and is not likely to use this habitat for nesting.

Homesteading occurs and may continue to occur in the Marpi Maneuver Area. Homesteading often results in clearing land or grazing land or bringing in other avian species (i.e., game birds, chickens). One analysis suggests that Megapodiidae distribution is limited by competitive exclusion from members of the Phasianidae family (e.g., pheasant, quails, and francolins), all of which are in the same Order as megapodes (Olsen 1980, p. 21). Competition for nesting and foraging areas would be possible if introduced game birds and domestic or feral chickens (which forage on the same prey items as megapodes) become established in megapode habitats (USFWS 1998b, p. 38; Vogt 2009c, p. 6). Due to the size of the area and the low number of megapodes, we do not believe competition would be a limiting factor at this time. Additionally, the import of game birds or chickens and existing feral chicken colonies could expose megapodes to avian diseases (USFWS 1998b, pp. 38-39), as many of these species are susceptible to west Nile virus (UC Davis 2009, pp. 2-3). We believe at least one Micronesian megapode uses the Marpi Maneuver Area and would be subject to increased risk of avian diseases. No avian diseases have been detected on Saipan to date and avian disease will continue to be monitored in the Pacific (Fisher 2009, pers. comm.).

Human exploitation via hunting and egg collecting has been documented for megapodes (Dekker *et al.* 2000, p. 2; USFWS 1998b, p. 37). Though Federal and local laws are in place to prohibit hunting and egg collecting, poaching and sustenance egg collecting is still reported from many islands (Vogt 2009c, p. 5; Amidon and Kessler 2009, pers. comm.). It is possible that eggs or adults could be poached from the Marpi Maneuver Area; however, poaching has not been reported on Saipan, most likely due to the difficultly in locating adult megapodes and the lack of observed nesting.

No non-Federal actions are expected to occur on Farallon de Medinilla. It is possible that citizens may poach eggs or adults. However, due to unexploded ordnance and the difficulty accessing Farallon de Medinilla; we consider poaching unlikely to occur.

CONCLUSION

We reviewed the MIRC to determine if any additional affects to Mariana crow and Mariana fruit bat are anticipated from implementation of the proposed action and determined that no additional activities are planned or authorized beyond those already considered within the ISR Strike biological opinion and MIRC will follow all the requirements within the ISR Strike biological opinion. Therefore, we concur that the non-jeopardy determination from the ISR Strike biological opinion is still appropriate because: the analysis completed within the ISR Strike biological opinion is still accurate; all requirements within the ISR Strike biological opinion will be followed by MIRC; and there are no additional anticipated impacts to the Mariana crow or the Mariana fruit bat from the implementation of MIRC.

After reviewing the current status of the Micronesian megapode, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that implementation of MIRC, as proposed, is not likely to jeopardize the continued existence of the Micronesian megapode. No critical habitat has been designated for this species; therefore, none will be affected.

We further support this determination based upon the following information:

1. We estimate the total mortality of Micronesian megapodes over five years due to the implementation of MIRC to be five pairs (ten individuals) on Farallon de Medinilla. The total range-wide Micronesian megapode population is estimated at minimum of 1,585 individuals. Therefore the proposed project will affect less than 1 percent of the total megapode population. If we assume that all individuals (n = 46) on Farallon de Medinilla are harmed by the consumption of rodenticide or rodenticide contaminated forage items, implementation of the MIRC will adversely affect approximately 3 percent of the total megapode population. Mortality of less than 1 percent of the total population or harm to 3 percent of the total population is not considered significant at this time.

2. Recovery goals include a stable or increasing population of 50 individuals on Saipan or Tinian (USFWS 1998b, p. 43). While neither island currently supports a Micronesian megapode population of this size; implementation of the MIRC will not preclude this goal from being achieved as avoidance and minimization measures will reduce impacts to the Micronesian megapode on Tinian and Saipan to a level that is insignificant or discountable. As a conservation measure, megapode life history research will be conducted on Saipan and Sarigan. These data will provide insight into improving management of small populations thereby contributing to overall recovery.

3. The avoidance and minimization on Farallon de Medinilla are designed to protect the area of the island densely occupied by the Micronesian megapode ("No Drop Zone"). Lusk *et al.* (2000, p. 33) believed that the vegetation and avian communities had not changed substantially since 1974. While these data were not specific to the megapode, we believe this is an indication that the avoidance and minimization measures are providing some level of protection to the species and its habitats while military training occurs. Though we believe the avoidance and minimization measures are providing

benefits to the species, we do anticipate that take of Micronesian megapode will occur. The island of Farallon de Medinilla is not necessary for recovery (USFWS 1998b, pp. 42-42). However, we appreciate the USN commitment to the avoidance and minimization measures because the island: (a) currently supports a dense population of Micronesian megapodes; (b) may provide a genetic link between northern and southern populations; and (c) may function as a rest stop for dispersing birds (Lusk *et al.* 2000, p. 29). Conservation measures implemented on Farallon de Medinilla (i.e., rat control) may further increase the megapode population on the inland by eradicating a potential predator and competitor for food, shelter, and nesting resources. Additional research conducted on the life history of megapodes on Sarigan will provide insight into improving management of large populations, thereby contributing to overall recovery.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)4 and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the USN so that they become binding conditions of any grant, permit, or permissions issued by the USN, as appropriate, for the exemption in section 7(o)(2) to apply. The USN has a continuing duty to regulate the activity covered by this incidental take statement. If the USN (1) fails to assume and implement the terms and conditions or (2) fails to require the adherence to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit, grant document, or other permissions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USN must report the progress of the action and its impact on the species as specified in the Incidental Take Statement.

Amount or Extent of Take Anticipated
The Incidental Take Statement from the ISR Strike biological opinion is still valid for the Mariana crow and Mariana fruit bat and is incorporated into this biological opinion and Incidental Take Statement by reference. No additional take of Mariana crow or Mariana fruit bat is authorized.

The USFWS anticipates incidental take of the Micronesian megapode will be difficult to quantify because access to the island and subsequent surveys and monitoring are conducted infrequently due to the unexploded ordnance on Farallon de Medinilla. Additionally, the number of nests, eggs, and juveniles are unknown. Due to the difficulty in quantifying the number of total individuals that will be taken as a result of the proposed action, we quantified take incidental to the project as the number of observed adults and juveniles and estimated number of eggs. Therefore, we anticipate the following forms of incidental take will occur between 2010 and 2015 from implementation of MIRC:

1. An estimated five pairs (ten individuals) of Micronesian megapodes have been detected using the area around the inert and live-fire target areas on Farallon de Medinilla. These five pairs (ten individuals) are subject to harassment, harm, injury, or mortality through direct strike, habitat loss, fire, and noise from ordnance impact and range maintenance (i.e., herbicide and fire retardant use).

2. All Micronesian megapodes (n = 46) on Farallon de Medinilla will be subject to harm and harassment, but not mortality, from the consumption of rodenticide or rodenticide-contaminated forage items.

3. We do not anticipate take of Micronesian megapodes will occur from the introduction or spread of non-native invasive species due to the conservation measures for interdiction and control proposed within this biological opinion.

Effect of the Take
In the accompanying biological opinion, the USFWS determined this level of anticipated take is not likely to result in jeopardy to the Micronesian megapode. No critical habitat has been designated for the Micronesian megapode; therefore none will be adversely modification of critical habitat.

Reasonable and Prudent Measures
The USFWS believes that no more than five pairs or 10 individuals over five years will be killed as a result of the proposed action and no more than 46 individuals over five years will be harmed and harassed from the use of rodenticide for conservation purposes. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of the incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. In addition, the action that caused the taking must cease; the action agency must immediately provide an explanation of the causes of the taking; and must review with the USFWS the need for possible modification of the reasonable and prudent measures. The following reasonable and prudent measures are necessary and appropriate to minimize the effect of take on the Micronesian megapode. The measures described below are non-discretionary and must be implemented.

1. Further minimize impacts from training, range maintenance, and rodent control to Micronesian megapodes.

2. The baseline condition for the Micronesian megapode on Farallon de Medinilla shall be adequately tracked to ensure that no unauthorized take occurs.

Terms and Conditions
In order to be exempt from the prohibitions of section 9 of the Act, the USN must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1.1 Pre- and post-monitoring surveys for Micronesian megapodes will be conducted to ensure no unanticipated impacts occur from each implementation of range maintenance and rodent control activities.

2.1 The USN will conduct Micronesian megapode population trend surveys at least every five years to evaluate incidental take. Micronesian megapode surveys will follow standard procedures currently implemented by the USN, including playback calls. In addition, a subset of megapodes (no less than 20 percent; n= 8 is ideal) will be captured and banded to estimate population size, recruitment, resilience and persistence. The use of playbacks will help assess effects from noise. Ideally these population surveys will occur every time range maintenance is completed (anticipated every two to five years).

2.2 After the completion of the megapode life history study and the first population trend survey (see 2.1 above), the USN will present the results to the Service. If it is determined that estimated carrying capacity (Vogt 2009a, p 4.) is exceeded and if a take greater than 5 pairs or 10 individuals is needed, the Navy will work with the Service to facilitate a translocation of these birds to other islands within the CNMI, such that increased take is not needed for the military training. This commitment to facilitate a translocation requires USN coordination to access the island and Explosive Ordnance Disposal (EOD) team support so that the USFWS or other designated personnel may have access to remove the birds. The USN may provide any other support as desired, but additional support beyond access allowance and EOD safety is not required.

2.3 In coordination with the USFWS, the USN will develop a standard efficacy and compliance reporting template and submit annual reports to the USFWS on the first of October of each year beginning 2010 through 2015. The purpose of the reporting template is to ensure report preparation time is limited, while still concisely discussing the successes and failures of all avoidance, minimization, and conservation measures and terms and conditions listed in this biological opinion (except those for invasive species control and interdiction) in relation to the anticipated and observed impacts and incidental take.

2.4 Using a standard template, the USN will develop and submit semi-annual reports to the USFWS on the first of October and the first of April of each year beginning 2010 through 2015. The October report will be combined with the report required under 2.2 above. The purpose of the reporting template is to ensure report preparation time is limited, while still concisely discussing the successes and failures of all avoidance, minimization, and conservation measures and terms and conditions listed in this biological opinion for invasive species control and interdiction in relation to the anticipated and observed impacts and incidental take. The report will include details regarding which cargo was inspected or un-inspected, potential level of risk associated with each cargo type, and where the cargo was shipped from training related actions only. The reports should include explanations if specific cargo shipments were missed and document all snake detections or other high risk incidents and the method used for the detection for training related actions only. The report will also include the number of brown treesnake kills during training actions.

2.5 The USN will convene an annual coordination meeting prior to 31 December of each year (2010 through 2015) to discuss findings within the compliance report and adapt avoidance, minimization, and conservation measures to further reduce incidental take.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" has been defined as: (1) discretionary measures a Federal agency can take to minimize or avoid the adverse effects of a proposed action on listed or proposed species, or designated or proposed critical habitat; (2) studies, monitoring, or research to develop new information on listed or proposed species, or designated or proposed critical habitat; and (3) suggestions on how an action agency can assist species conservation as part of their action and in furtherance of their authorities under section 7(a)(1) of the ESA.

1. We recommend you collect and analyze genetic samples from Micronesian megapodes to evaluate population attributes including but not limited to dispersal and movement among islands. We recommend that you collect the samples during routine monitoring of Micronesian megapodes on Farallon de Medinilla, while implementing life history studies on Sarigan and Saipan, and during other routine monitoring or surveys (i.e., INRMP implementation). We recommend that if samples are collected by outside parties (i.e., from biological surveys of the Northern Islands) that you incorporate these data into your analysis to understand relationships among Micronesian megapode populations on different islands.

2. The USN has sponsored ungulate eradication on Sarigan and Anatahan (USN 2009b, p. 89). These efforts have been highly successful in restoring habitat for endangered and threatened species and increasing population numbers of Micronesian megapodes (USN 2009b, p. 89). The ungulates have been completely removed from Sarigan (Kessler 2002, p. 132). Only a few ungulates remain on Anatahan; however, without complete removal the existing population will grow and the conservation effort expended on this island will be ineffective. We recommend that you complete the ungulate eradication on Anatahan.

3. Because ungulate eradication has been so successful on Sarigan, we recommend that you implement ungulate eradication on all northern islands to improve habitat for the Micronesian megapode.

4. Upon determination of success for the rodent eradication proposed for Farallon de Medinilla, we recommend you eradicate rodents on all the northern islands to improve habitat for, reduce competition with, and eliminate potential predation of, Micronesian megapodes.

5. To further their recovery, we recommend that you outplant endangered and threatened plants in protected areas on Guam.

REINITIATION-CLOSING STATEMENT

This concludes formal consultation on the Mariana Islands Range Complex 2009 through 2014. As provided for in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law), and if (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take should cease pending reinitiation.

Sincerely,

Gina M Shultz

for Loyal Mehrhoff
Field Supervisor

REFERENCES CITED

Agee, J.K. 1993. Fire ecology of Pacific northwest forests. Island Press, Washington, D.C. 493 pp.

Allen, C.R., R.S. Lutz, S. Demarais. 1995. Red imported fire ant impacts on northern bobwhite populations. Ecological Applications 5(3):632-638.

Amidon, F. and C. Kessler. 2009. Email correspondence dated February 18, 2009, regarding an internal meeting between Holly Herod, Curt Kessler, and Fred Amidon to discuss Micronesian megapode. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 3 pp.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution and distribution. University of Kansas Publication 3(1):13-59.

Boland, J. 2009. Electronic mail correspondence dated February 19, 2009, regarding Mariana fruit bat population numbers on Rota. CNMI DFW, Lower Base, Saipan. 3pp.

Bowen, B.W. 1995. Tracking marine turtles with genetic markers. BioScience 45(8):528-534.

Brooke, A. 2008. Mariana fruit bat surveys on Navy properties, Guam, 2008. Unpublished report to NAVFAC Marianas. 5 pp.

Brooke, A. 2009a. Mariana fruit bat on Tinian and Aguiguan. 9 pp.

Brooke, A. 2009b. Electronic mail correspondence dated January 20, 2009, regarding Navy actions on Sarigan and Anatahan. U.S. Navy, Guam. 3 pp.

Brooke, A. and G. Grimm. 2008. Mariana common moorhen surveys on Fena Reservoir, Naval Munitions Site, Guam (FY2004-2008). U.S. Navy, NAVFAC Marianas Environmental, Guam. 3 pp.

Brown Treesnake Technical Working Group (BTS TWG) 2009. Draft Brown Treesnake Control Plan. April 2009. 37 pp. + Appendix.

Burger, J., and M. Gochfeld. 1981. Age-related differences in piracy behavior of four species of gulls, *Larus*. Behavior 77:242-267.

Camp, R.J., T.K. Pratt, A.P. Marshall, F. Amidon and L.L. Williams. In press. Recent status and trends of the land bird avifauna on Saipan, Mariana Islands, with emphasis on the endangered Nightingale Reed-Warbler *Acrocephalus luscinia*. Bird Conservation International. 72 pp.

Camp, R. J., T. K. Pratt, F. Amidon, A. P. Marshall, S. Kremer, and M. Laut. 2009. Status and trends of the land bird avifauna on Tinian and Aguiguan, Mariana Islands. Appendix 3.1 *in* Terrestrial Resource surveys of Tinian and Aguiguan, Mariana Islands, 2008. Working Draft. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, HI. 65 pp.

Caut, S., E. Angulo, and F. Courchamp. 2008. Dietary shift of an invasive predator: rats, seabirds and sea turtles. Journal of Applied Ecology 45:428-437.

Chaloupka, M., K.A. Bjorndal, G.H. Balazs, A.B. Bolten, L.M. Ehrhart, C.J. Limpus, H. Suganuma, S. Troeng, and M. Yamaguchi. 2008. Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Global Ecology and Biogeography 17(2): 297-304.

Clayton, J.L. 1976. Nutrient gains to adjacent ecosystems during a forest fire: an evaluation. Forest Science 22(2):162-166.

CNMI Division of Fish and Wildlife (CNMI DFW). 2000a. Wildlife and vegetation surveys Alamagan 2000. 2000 Technical Report #4. 37pp. + Appendices.

CNMI Division of Fish and Wildlife (CNMI DFW). 2000b. Wildlife and Vegetation Surveys, Anatahan 2000. Technical Report #6. CNMI-DFW, 47 pp. + Appendices.

CNMI Division of Fish and Wildlife (CNMI DFW). 2000c. Wildlife and vegetation surveys Agrihan 2000. 2000 Technical Report #8. 40 pp. + Appendices.

CNMI Division of Fish and Wildlife (CNMI DFW). 2000d. Wildlife and vegetation surveys Guguan 2000. 2000 Technical Report #3. 40pp. + Appendices.

CNMI Division of Fish and Wildlife (CNMI DFW). 2000e. Wildlife and vegetation surveys Pagan 2000. 2000 Technical Report # 7. 44 pp. + Appendices.

CNMI Division of Fish and Wildlife (CNMI DFW). 2008a. Management plan for nightingale reed-warblers in the Saipan Upland Mitigation Bank, CNMI. May 2009. 25 pp. + Appendices.

CNMI Division of Fish and Wildlife (CNMI DFW). 2008b. Wildlife and vegetation surveys of Sarigan Island April 13-25, 2006. 2008 Technical Report #14. xx pp.

Conomy, J.T., J.A. Dubovsky, J.A. Collazo, and W.J. Fleming. 1998. Do black ducks and wood ducks habituate to aircraft disturbance? Journal of Wildlife Management 62(3):1135-1142.

Corwin, J.T., and D.A. Cotanche. 1988. Regeneration of sensory hair cells after acoustic trauma. Science 240:1772-1774.

Courchamp, F., J.L. Chapuis, and M. Pascal. 2003. Mammal invaders on islands: impact, control and control impact. Biological Review 78:347-383.

Craig, R.J. 1992. Territoriality, habitat use, and ecological distinctness of an endangered Pacific island reed-warbler. Journal of Field Ornithology 63: 436-444.

Craig, R.J. 1993. Regeneration of native Mariana Island forest in disturbed habitats. Micronesica 26(2):99-108.

Craig, R.J. 1996. Seasonal population surveys and natural history of a Micronesian bird community. Wilson Bulletin 108(2): 246-267.

Cruz, J.B., S.R. Kremer, G. Martin, L.L. Williams, and V.A. Camacho. 2008. Relative abundance and distribution of Mariana swiftlets (Aves: Apodidae) in the Northern Mariana Islands. Pacific Science. 62(2):233-246.

D'Antonio, C.M. and P.M. Vitousek 1992. Biological invasions by exotic grasses, the grass fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.

DeBano, L.F., R.M. Rice, and C.E. Conrad. 1979. Soil heating in chaparral fires: effects on soil properties, plant nutrients, erosion, and runoff. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Research Paper PSW-145. 21 pp.

Dekker, R.W.R.J. 1989. Predation and the western limits of megapode distribution (Megapodiidae; Aves). Journal of Biogeography 16(4):317-321.

Dekker, R.W.R.J., R.A. Fuller, and G.C. Baker (eds.). 2000. Megapodes. Status survey and conservation action plan 2000-2004. WPA/BirdsLife/SSC Megapode Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK, and the World Pheasant Association, Reading, UK. vii + 39 pp.

Demarais, S., D.J. Tazik, P.J. Guertin, and E.E. Jorgensen. 1999. Disturbance associated with military exercises. P. 385-396 *in* Walker, L.R. (ed.) Ecosystems of the World 16: Ecosystems of Disturbed Ground. Pp. xii + 868.

Dow AgroSciences. 2002. Specimen label Rodeo herbicide. Revised May 29, 2002. 13 pp.

Eby, P. 1991. Seasonal movements of grey-headed flying-foxes, *Pteropus poliocephalus* (Chiroptera: Pteropodidae), from two maternity camps in northern New South Wales. Wildlife Research 18: 547-559.

Eggleston, C. 2009. Mariana common moorhen Fena Reservoir, Naval Munitions Site, Guam, April 2009. 3 pp.

Eisemann, J.D., and C.E. Swift. 2006. Ecological and human health hazards from broadcast application of 0.005% diphacinone rodenticide baits in native Hawaiian ecosystems. Proceedings of the 22nd Vertebrate Pest Conference. Pp. 413-433.

Engbring, J., and F. L. Ramsey. 1984. Distribution and abundance of the forest birds of Guam: results of a 1981 survey. U.S. Fish and Wildlife Service FWS/OBS-84/20. 54pp.

Engbring, J., F.L. Ramsey, and V.J. Wildman. 1986. Micronesian forest bird survey, 1982: Saipan, Tinian, Agiguan, and Rota. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 143 pp.

Epanchin, P.N., J.A. Heath, and P.C. Frederick. 2002. Effects of fires on foraging and breeding wading birds in the Everglades. Wilson Bulletin 114(1): 139-141.

Erickson, W.P., G.D. Johnson, and D.P. Young, Jr. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions. U.S. Division of Agriculture Forest Service General Technical Report PSW-GTR-191: 1029-1042.

Erwin, W.J. and R.H. Stasiak. 1979. Vertebrate mortality during the burning of a reestablished prairie in Nebraska. American Midland Naturalist 101(1): 247-249.

Esselstyn, J. A., A. Amar, D. Janeke. 2006. Impact of post-typhoon hunting on Mariana fruit bats (*Pteropus mariannus*). Pacific Science 60(4): 531-539.

Fancy, S. G., M. R. Lusk, and D. J. Grout. 1999. Status of the Mariana crow population on Rota, Mariana Islands. Micronesica 32(1):3-10.

Farabaugh, S.M.. 1982. The ecological and social significance of duetting. In Kroodsma, D.E. and E.H. Miller (eds). Acoustic Communication in Birds., Vol 2. Pp. 85-124. Academic Press, New York.

Fisher, J. 2009. Electronic mail dated February 7 and 9, 2009, and September 24, 2009, regarding avian diseases for megapodes and in the Marianas. 3pp.

Flame Guard Gel. 2009. US Forest Service test results and product information. www.flameguardgel.com. 9 pp.

Fritts, T.H. and G.H. Rodda. 1998. The role of introduced species in the degradation of island ecosystems: a case history of Guam. Annual Review of Ecology and Systematics 29:113-140.

Glass, P. and D. Aldan. 1988. Micronesian megapode surveys and research. Pp. 131-154 Five-year Progress Report, Fiscal Year 1982-87. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Glass, P. and E.M. Taisacan. 1988. Marianas fruit bat surveys and research. Pp. 1-22 *in* Five-year Progress Report, Fiscal Year 1982-87. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Grimm, G. 2008. Mariana swiftlet surveys on Naval Munitions Site, Guam. Report to NAVFAC Marianas Environmental, Guam. 6 pp.

Grimm, G. and J. Farley. 2008. DRAFT Sea turtle nesting activity on Navy Base Guam 2007-2008. NAVFAC Marianas Report. 7 pp.

Groom, M.J. and C.H. Vynne. 2006. Habitat degradation and loss. Pp. 173-212 *in* Groom, M.J., G.K. Meffe, and C. R. Carroll (eds.) Principles of Conservation Biology, Third Edition. Sinauer Associates, Inc. Sunderland, Massachusetts. 793 pp.

Ha, R. R., L. Berry, and J. C. Ha. 2008. Annual report (July 1, 2007 – June 30, 2008) on the Mariana crow (*Corvus kubaryi*) and Rota bridled white-eye (*Zosterops rotensis*) on the Pacific island of Rota. Report to CNMI DFW. University of Washington, Seattle, WA. 52pp.

Hagedorn, B. 2009. Electronic mail correspondence dated September 23-October 1, 2009, regarding the presence of burrowing owls on Eglin Air Force Base. 4 pp.

Hamby, W. 2004. Ultimate Sound Pressure Level Table. http://www.makeitlouder.com/Decibel%20Level%20Chart.txt.

Hoffmann, W.A., W. Schroeder, and R.B. Jackson. 2003. Regional feedbacks among fire, climate, and tropical deforestation. Journal of Geophysical Research – Atmospheres. 108(D23): AR4721 ACL 4-1 – 4-11.

Huijser, M.P., P. McGowen, J. Fuller, A. Hardy, A. Kociolek, A.P. Clevenger, D. Smith, and R. Ament. 2008. Wildlife-vehicle collision reduction study: report to Congress. Report number FHWA-HRT-08-034. 251 pp.

Hulme, P.E., S. Bacher, M. Kenis, S. Klotz, I. Kuhn, D. Minchin, W. Nentwig, S. Olenin, V. Panov, J. Pergl, P. Pysek, A. Roques, D. Sol, W. Solarz, and M. Vila. 2008. Grasping at the routes of biological invasions: a framework for integrating pathways into policy. Journal of Applied Ecology 45:403-414.

Ilo, L., G.P. Camacho, and C. Alepuyo. 2005. 2005 sea turtle nesting and in-water assessment report for the Commonwealth of the Northern Mariana southern inhabitant islands of Saipan, Tinian, and Rota. CNMI Division of Fish and Wildlife Report. 23 pp.

Ilo, L.I. and J.M. Manglona. 2001. Rota turtle assessment report. Division of Fish and Wildlife, CNMI. 22 pp.

Ilo, L.I. and J.M. Manglona. 2002. Sea turtle assessment report for the Island of Anatahan. Division of Fish and Wildlife, CNMI. 16 pp.

Jenkins, J. M. 1983. The native forest birds of Guam. Ornithological Monographs no. 31. 61 pp.

Johnson, N.C. 2001. A survey of Mariana fruit bats in the Mariana Islands, including recent minimum population estimates, July 2001. Unpublished report to the Commonwealth of the Northern Mariana Islands, Division of Fish and Wildlife. 41 pp.

Juliano, S.A. and L.P. Lounibos. 2005. Ecology of invasive mosquitoes: effects on resident species and on human health. Ecological Letters 8(5):558-574.

Kalabokidis, K.D. 2000. Effects of wildfire suppression chemicals on people and the environment – a review. Global Nest: the International Journal 2(2):129-137.

Kelly, I. 2009. Electronic mail dated May 6, 2009, regarding sea turtle activity within the Commonwealth of the Northern Mariana Islands and Guam.

Kessler, C.C. 2002. Eradication of feral goats and pigs and consequences for other biota on Sarigan Island, Commonwealth of the Northern Mariana Islands. Pp. 132-140, *In* Veitch, C.R. and Clout, M.N. (eds.). Turning the tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland. & Cambridge, UK. 414 pp.

Kessler, C.C. 2006. Report on the Anatahan feral ungulate eradication project for Micronesian megapode habitat improvement for the years 2005 and 2006. USFWS unpublished report submitted to: US Navy COMNAVMARIANAS, Guam. 16 pp.

Kessler, C.C. 2009a. Electronic mail dated May 20, 2009 regarding sea turtle nesting habitat within the Northern Islands of the Commonwealth of the Northern Mariana Islands.

Kessler, C.C. 2009b. Electronic mail correspondence dated February 3, 2009, regarding the extirpation of Micronesian megapode on Anatahan.

Kessler, C.C. 2009c. Phone conversation regarding the observed altitude of Micronesian megapode flights.

Kinnaird, M.F. and T.G. O'Brien. 1998. Ecological effects of wildfire on lowland rainforest in Sumatra. Conservation Biology 12(5):954-956.

Klope, M.W. 2009. Bird aircraft strike hazard (BASH) prevention program. Naval Safety Center. http://safetycenter.navy.mil/aviation/operations/bash/newsletter.htm. 3 pp.

Kolinski, S.P., R.K. Hoeke, S.R. Holzwarth, L.I. Ilo, E.F. Cox, R.C. O'Conner, and P.S. Vroom. 2006. Nearshore distribution and an abundance estimate for green sea turtles, *Chelonia mydas,* at Rota Island, Commonwealth of the Northern Mariana Islands. Pacific Science 60(4):509-522.

Kolinski, S.P., R.K. Hoeke, S.R. Holzwarth, and P.S. Vroom. 2005. Sea turtle abundance at isolated reefs of the Mariana Archipelago. Micronesica 37(2):287-296.

Kolinski, S.P., L.I. Ilo, and J.M. Manglona. 2004. Green turtles and their marine habitats at Tinian and Aguijan, with projections on resident turtle demographics in the southern arc of the Commonwealth of the Northern Mariana Islands. Micronesica 37(1):97-118.

Kolinski, S.P., D.M. Parker, L.I. Ilo, and J.K. Ruak. 2001. An assessment of the sea turtles and their marine and terrestrial habitats at Saipan, Commonwealth of the Northern Mariana Islands. Micronesica 34(1):55-72.

Larkin, R.P., L.L. Pater, and D.J. Tazik. 1996. Effects of Military noise on wildlife: a literature review. U.S. Army Corps of Engineers. USACERL Technical Report 96/21. January 1996. 107 pp.

Lindsay, G.D., S.C. Hess, E.W. Campbell III, and R.T. Sugihara. *In press.* Small mammals as predators and competitors. Ch 11 *in* Hawaiian Forest Birds. Yale University Press.

Lusk, M.R., P. Bruner, C. Kessler. 2000. The avifauna of Farallon de Medinilla, Mariana Islands. Journal of Field Ornithology 71(1):22-33.

Machlis, G.E. and T. Hanson. 2008. Warfare ecology. BioScience 58(8):729-736.

Monheit, S. 2003. Glyphosate-based aquatic herbicides an overview of risk. 10pp. http://www.ceres.ca.gov/tadn/control_manage/docs/glyphosate_aqua_risk.pdf

Mosher, S.M. 2006. Ecology of the endangered nightingale reed-warbler (*Acrocephalus luscinia*) on Saipan, Micronesia. Master's thesis, University of Idaho, Moscow. 124 pp.

Mosher, S. 2009. Email correspondence dated March 31, 2009, regarding the presence of a banded megapode during March 2007, in the Cow Town area of Saipan. Private Consultant, Honolulu, Hawaii. 1 pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 1998a. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD. 95 pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 1998b. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*). National Marine Fisheries Service, Silver Spring, MD. 95pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 2007a. Green sea turtle (*Chelonia mydas*) 5-year review: summary and evaluation. 105 pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 2007b. Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: summary and evaluation. 93 pp.

Neary, D.G., K.C. Ryan, and L.F. DeBano. 2005. Wildland fire in ecosystems: effects of fire on soils and water. General Technical Report RMRS-GTR-42, Vol. 4. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, Utah. 250 pp.

Nelson, J. and C. Kessler. 2009. Electronic mail dated September 24-25, 2009, regarding seabird monitoring on Lehua, Hawaii.

Noss, R., B. Csuti, and M.J. Groom. 2006. Habitat fragmentation. Pp. 213-251 *in* Groom, M.J., G.K. Meffe, and C. R. Carroll (eds.) Principles of Conservation Biology, Third Edition. Sinauer Associates, Inc. Sunderland, Massachusetts. 793 pp.

Olson, S.L. 1980. The significance of the distribution of the Megapodiidae. Emu 80(1):21-24.

Plentovich, S., J. M. Morton, J. Bart, R. J. Camp, M. Lusk, N. Johnson, and E. Vanderwerf. 2005. Population trends of Mariana crow *Corvus kubaryi* on Rota, Commonwealth of the Northern Mariana Islands. Bird Conservation International 15:211-224.

Plumpton, D. 2006. Review of studies related to aircraft noise disturbance of waterfowl. A technical report in support of the supplemental environmental impact statement (SEIS) for introduction of F/A-18 E/F (super hornet) aircraft to the east coast of the United States. Prepared for U.S. Department of the Navy, Naval Facilities Engineering Command Atlantic, Norfolk, Virginia. 93 pp.

Pratt, H. D., P. L. Bruner, and D. G. Berrett. 1979. America's unknown avifauna: the birds of the Mariana Islands. American Birds 33(3):227-235.

Pratt, H.D., J. Engbring, P.L. Bruner, and D.G. Berrett. 1980. Notes on the taxonomy, natural history, and status of the resident birds of Palau. The Condor 82(2):117-131.

Pultz, S., D. O'Daniel, S. Krueger, H. McSharry, and G. Balazs. 1999. Marine turtle survey on Tinian, Mariana Islands. Micronesica 31(2):85-94.

Radley, P.. 2009. Electronic mail correspondence dated January 29, 2009, regarding the presence of Micronesian megapodes in breeding bird surveys on Saipan. CNMI DFW, Lower Base, Saipan. 4 pp.

Reichel, J.D., G.J. Wiles, and P.O. Glass. 1992. Island extinctions: the case of the endangered nightingale reed-warbler. Wilson Bulletin 104(1): 44-54.

Rice, R.M. 1974. The hydrology of chaparral watersheds. In M. Rosenthal (ed.), Symposium on living with the chaparral. Riverside, California. March 30-31, 1973.

Ritter, M.W. 1994. Notes on nesting and growth of Mariana common moorhens on Guam. Micronesia 27 (1/2):127-132.

Ritter, M.W. and J.A. Savidge. 1999. A predictive model of wetland habitat use on Guam by endangered Mariana common moorhens. The Condor 101(2):282-287.

Rodda, G.H. and J.A. Savidge. 2007. Biology and impacts of Pacific Island invasive species. 2. Boiga irregularis, the brown tree snake (Reptilia: Colubridae). Pacific Science 61(3): 307-324.

Rothermel, R.C. and G.C. Rinehart. 1983. Field procedures for verification and adjustment of fire behavior predictions. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, General Technical Report INT-142. 25 pp.

Rounds, R. 2009. Electronic mail correspondence dated August 9, 2009, regarding the presence of Micronesian megapodes near the Last Command Post. 1 pp.

Simone-Freilicher, E. 2008. Recurrent smoke-induced respiratory infections in a ruby blue-headed pionus parrot (*Pionus menstruus rubrigularis*). Journal of Avian Medicine and Surgery 22(2):138-145.

Smallwood, J.A., M. Woodrey, N.J. Smallwood, and M.A. Kettler. 1982. Foraging by cattle egrets and American kestrels at a fire's edge. Journal of Field Ornithology 53(2):171-172.

Steadman, D.W. 1999. The prehistory of vertebrates, especially birds, on Tinian, Aguiguan, and Rota, Northern Mariana Islands. Micronesica 31(2):319-345.

Stinson, D. 1992. Micronesian megapode research. *In*: Division of Fish and Wildlife Progress Report: 1987-1992. CNMI Division of Fish and Wildlife, Saipan, pp. 217-233.

Stinson, D.W., M.W. Ritter, and J.D. Reichel. 1991. The Mariana common moorhen: decline of an island endemic. The Condor 93:38-43.

Stone, J.S., and E.W. Rubel. 2000. Cellular studies of auditory hair cell regeneration in birds. Proceedings of the National Academy of Sciences of the United States of America 97(22):11,714-11,721.

SWCA Environmental Consultants and Micronesian Environmental Services (SWCA and MES) 2008. Biological assessment of the Marpi Point Village Homestead Site, Saipan, CNMI. Report to AMPRO Consultants. June 2008. 41 pp.

Takano, L.L. and S.M. Haig. 2004a. Distribution and abundance of the Mariana subspecies of the common moorhen. Waterbirds 27(2):245-250.

Takano, L.L. and S.M. Haig. 2004b. Seasonal movement and home range of the Mariana common moorhen. The Condor 106:652-663.

Towns, D.R., and K.G. Broome. 2003. From small Maria to massive Campbell: forty years of rat eradications from New Zealand islands. New Zealand Journal of Zoology 30:377-398.

Tunison, J.T., C.M. D'Antonio, and R.K. Loh. 2001. Fire and invasive plants in Hawaii Volcanoes National Park: in K.E.M. Galley and T.P. Wilson (eds.), Proceedings of the Invasive Species Workshop: The role of fire in the control and spread of invasive species, Fire Conference 2000, The First National Congress on Fire Ecology, Prevention, and Management. Miscellaneous Publication No. 11, Tall Timbers Research Station; Tallahassee. Pp. 122-131.

University of California at Davis Wildlife Health Center (UC Davis). 2009. Species affected by West Nile Virus. February 2009. 6 pp. www.vetmed.ucdavis.edu/whc/pdfs/wnvaffectedspecies.pdf

U.S. Air Force and U.S. Fish and Wildlife Service (USAF and USFWS). 1994. Cooperative agreement between the U.S. Air Force and the U.S. Fish and Wildlife Service for the establishment and management of the Guam National Wildlife Refuge, Guam. 24pp.

U.S. Environmental Protection Agency (USEPA). 1998. Reregistration Eligibility Decision (RED): Rodenticide Cluster. U.S. Environmental Protection Agency, EPA-738-R-98-007. 296 pp.

U.S. Environmental Protection Agency (USEPA). 2007. Diphacinone-50: pelleted rodenticide bait for conservation purposes. 4 pp.

U.S. Environmental Protection Agency (USEPA). 2009. Letter dated September 24, 2009, from USEPA to USFWS regarding the establishment of an additional Micronesian megapode protected area on Saipan. 9 pp.

U.S. Fish and Wildlife Service (USFWS). 1970. Conservation of endangered species and other fish or wildlife. Federal Register 35(106): 8,491-8,498.

U.S. Fish and Wildlife Service (USFWS). 1984. Endangered and threatened wildlife and plants; determination of endangered status for seven birds and two bats of Guam and the Northern Mariana Islands. Federal Register 49 (167):33,881-33,885.

U.S. Fish and Wildlife Service. 1990. Guam Mariana fruit bat and little Mariana fruit bat recovery plan. Portland, Oregon. 63 pp.

U.S. Fish and Wildlife Service (USFWS). 1991a. Recovery plan for the Mariana common moorhen (= Gallinule) (*Gallinula chloropus guami*). U.S. Fish and Wildlife Service, Portland, Oregon. 55 pp.

U.S. Fish and Wildlife Service (USFWS). 1991b. Recovery plan for the Mariana Islands population of the Vanikoro swiftlet, *Aerodramus vanikorensis bartschi*. U.S. Fish and wildlife Service, Portland, Oregon. 49 pp.

U.S. Fish and Wildlife Service (USFWS). 1996. Characteristics of Mariana common moorhens and wetland habitats within the U.S. Department of the Navy's military lease area and exclusive military use area on the island of Tinian, Commonwealth of the Northern Mariana Islands, July 1994 – August 1995. 26 pp. + Appendix.

U.S. Fish and Wildlife Service (USFWS). 1997. Biological opinion of the U.S. Fish and Wildlife Service for Gunnery and Aerial bombardment practice at Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. Service File Number 1997-F-0005. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 1998a. Recovery plan for the nightingale reed-warbler, *Acrocephalus luscinia*. Portland, Oregon. 62 pp.

U.S. Fish and Wildlife Service (USFWS). 1998b. Recovery plan for the Micronesian megapode (*Megapodius laperouse laperouse*). U.S. Fish and Wildlife Service, Portland, Oregon. 65 + pp.

U.S. Fish and Wildlife Service (USFWS). 1998b. Biological opinion of the U.S. Fish and Wildlife Service for airport improvements at the Tinian International Airport Commonwealth of the Northern Mariana Islands. Service File Number 1998-F-0006. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. Biological opinion and conference report for Military Training in the Marianas. Service File Number 1998-F-0007. 43 pp.

U.S. Fish and Wildlife Service (USFWS). 2002. Amended biological opinion for the Marpi Landfill and Transfer Station, Saipan, Commonwealth of the Northern Mariana Islands. Service File Number 2000-F-0005-A. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2004. Endangered and threatened wildlife and plants; designation of critical habitat for the Mariana fruit bat and Guam Micronesian kingfisher on Guam and the Mariana crow on Guam and in the Commonwealth of the Northern Mariana Islands; final rule. Federal Register 69(208):62,944-62,990.

U.S. Fish and Wildlife Service (USFWS). 2005a. Draft revised recovery plan for the aga or Mariana crow, *Corvus kubaryi*. Portland, Oregon. x + 147 pp.

U.S. Fish and Wildlife Service (USFWS). 2005b. Endangered and threatened wildlife and plants; Mariana fruit bat (*Pteropus mariannus mariannus*): reclassification from endangered to threatened in the Territory of Guam and listing as threatened in the Commonwealth of the Northern Mariana Islands. Federal Register 70(4):1,190-1,210.

U.S. Fish and Wildlife Service (USFWS). 2006a. Request for informal section 7 consultation for the beddown of training and support initiatives at Northwest Field Project on Andersen Air Force Base, Guam. Service File Number 2006-I-0281. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2006b. Biological opinion on the establishment and operation of an intelligence, surveillance, reconnaissance, and strike capability project on Andersen Air Force Base, Guam. Service File Number 2006-F-0266. 73 pp.

U.S. Fish and Wildlife Service (USFWS). 2007a. Technical assistance regarding the Notice of Intent to develop an Environmental Impact Statement-Overseas Environmental Impact Statement for the Mariana Islands Range Complex (MIRC). Service File Number 2007-FA-0116. 2 pp.

U.S. Fish and Wildlife Service (USFWS). 2007b. Informal consultation request for the proposed establishment and operation of the Mariana Islands Range Complex and for the relocation of the U.S. Marine Corps forces to Guam Service File Number 2007-I-0347. 9 pp.

U.S. Fish and Wildlife Service (USFWS). 2007c. 5-Year review short form summary Mariana fruit bat (*Pteropus mariannus mariannus*). U.S. Fish and Wildlife Service. 4pp.

U.S Fish and Wildlife Service (USFWS). 2008a. Technical assistance regarding reclearing of the Cargo Drop Zone (Area 2), Northwest Field, Andersen Air Force Base, Guam. Service File Number 2009-TA-0039. 30 pp.

U.S. Fish and Wildlife Service (USFWS). 2008b. Endangered and threatened wildlife and plants: initiation of 5-year status reviews for 70 species in Idaho, Montana, Oregon, Washington, and the Pacific Islands. Federal Register 73(83): 23,264-23,266.

U.S. Fish and Wildlife Service (USFWS). 2009a. Review of the Draft Environmental Impact Statement-Overseas Environmental Impact Statement for the Mariana Islands Range Complex. Service File Number ER 09/127. 19 pp.

U.S. Fish and Wildlife Service (USFWS). 2009b. Initiation of formal consultation for the proposed Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands. Service File Number 2009-F-0345. 10 pp.

U.S. Fish and Wildlife Service (USFWS). 2009c. Reinitiation of informal section 7 consultation regarding beddown of training and support initiatives at Northwest Field, Andersen Air Force Base, Guam. Service File Number 2009-I-0112. 5 pp.

U.S. Fish and Wildlife Service (USFWS). 2009d. Second reinitiation of informal section 7 consultation for the beddown of training and support initiatives at Northwest Field, Andersen Air Force Base, Guam. Service File Number 2009-I-0294. 6 pp.

U.S. Fish and Wildlife Service (USFWS). 2009e. Terrestrial Resource Surveys of Tinian and Aguiguan, Mariana Islands, 2008. Working Draft dated January 6, 2009.

U.S. Navy (USN). 2005. COMNAVMARIANAS instruction 5090.10A brown treesnake control and interdiction plan. 28 pp.

U.S. Navy (USN). 2009a. Mariana Islands range complex draft environmental impact statement/overseas environmental impact statement. Prepared for Commander, U.S. Pacific Fleet, Executive Agent. Volume 1 of 2. 868 pp. and Volume 2 of 2. 576 pp.

U.S. Navy (USN). 2009b. Biological assessment for the Mariana Islands Range Complex terrestrial species consultation. Prepared for Department of the Navy. 120 pp. + appendices.

U.S. Navy (USN). 2009c. Farallon de Medinilla (FDM) Impact Area 1 Range Maintenance Plan. 12 pp. + Appendices.

U.S. Navy and Commonwealth of the Northern Mariana Islands (USN and CNMI). 1999. Dedication of Tinian military retention area land for wildlife conservation. 3 pp.

U.S. Navy and U.S. Fish and Wildlife Service (USN and USFWS). 1994. Cooperative agreement between the U.S. Navy and the U.S. Fish and Wildlife Service for the establishment and management of the Guam National Wildlife Refuge, Guam. 24pp.

VanderWerf, E.A., Y. Ebisu and Associates, and W. Chee-Planning, Inc. 2000. Final report a study to determine the effects of noise from military training on the endangered Oahu elepaio. Report to U.S. Army Engineer District, Honolulu, Hawaii. Contract Number DACA83-96-D-0007. 42 pp. + Appendices.

Vogl, R. J. 1973. Effects of fire on the plants and animals of a Florida wetland. American Midland Naturalist 89(2):334-347

Vogt, S. 2008. Fiscal Years 2007 and 2008 Report for 61755NR410 wildlife surveys on military leased lands, Tinian CNMI. DRAFT. U.S. Navy, NAVFAC Pacific. 10 pp.

Vogt, S. 2009a. Micronesian megapode (*Megapodius laperouse laperouse*) surveys on Farallon de Medinilla, Commonwealth of the Northern Marianas Islands. 12 pp.

Vogt, S. 2009b. Fiscal years 2006-2007 annual report for 61755NR410 wildlife surveys on military leased lands, Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. NAVFAC Pacific, Honolulu, Hawaii. 13 pp.

Vogt, S. 2009c. Micronesian megapode (*Megapodius laperouse laperouse*) surveys on Tinian and Aguijan, Commonwealth of the Northern Mariana Islands. 9 pp.

Vogt, S. 2009d. Electronic mail dated September 17, 2009, from Holly Herod to Scot Vogt, summarizing Mr. Vogt's observations on Micronesian megapode responses to playback calls. 1 pp.

Warner, R.E. 1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. The Condor 70:101-120.

Wells, C.G., R.E. Campbell, L.F. DeBano, C.E. Lewis, R.L. Fredriksen, E.C. Franklin, R.C. Froelich, and P.H. Dunn. 1979. Effects of fire on soil: state-of-knowledge review. U.S. Department of Agriculture, Forest Service, Report WO-7, Washington, D.C. 34 pp.

Wiles, G.J. 1987. The status of fruit bats on Guam. Pacific Science 41(1-4):148-157.

Wiles, G.J., C.F. Aguon, G.W. Davis, and D.J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. Micronesica 28(1):31-49.

Wiles, G.J. and P.J. Conry. 2001. Characteristics of nest mounds of Micronesian megapodes in Palau. J. Field Ornithology 72(2):267-275.

Wiles, G.J., J. Bart, R.E. Beck, Jr., and C.F. Aguon. 2003. Impacts of the brown tree snake: patters of decline and species persistence in Guam's avifauna. Conservation Biology 17(5):1,350-1,360.

Wiles, G. J. and P. Glass. 1990. Interisland movements of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Atoll Research Bulletin 343:1-6.

Wiles, G.J. and N.C. Johnson. 2004. Population size and natural history of Mariana fruit bats on Sarigan, Mariana Islands. Pacific Science 58(4):585-596.

Wiles, G.J., T.O. Lemke, and H.H. Payne. 1989. Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Conservation Biology 3(1):66-76.

Wiles, G.J. and D.H. Woodside. 1999. History and population status of Guam swiftlets on Oahu, Hawaii. Elepaio 59(7):57-61.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience 48(8):607-615.

Worthington, D.J. 1998. Inter-island dispersal of the Mariana common moorhen: a recolonization by an endangered species. Wilson Bulletin 110(3):414-417.

Worthington, D.J., A.P. Marshall, G.J. Wiles, and C. Kessler. 2001. Abundance and management of Mariana fruit bats and feral ungulates on Anatahan, Mariana Islands. Pacific Conservation Biology 7:134-42.

Wusstig, S. 2008a. Electronic mail dated March 5, March 18, and March 26, 2008.

Wusstig, S. 2008b. Electronic mail dated March 27, 2008, providing information regarding sea turtle data for Guam.

Wusstig, S. 2009. Electronic mail dated May 6, 2009 through May 13, 2009, regarding nesting and movement of green sea turtles detected on or near Guam.

Appendix A

Existing and proposed training levels within the MIRC action area (USN 2009b, p. 21 and 25).

Training Activity			Training Levels		Training Area	
Exercise	**Platform**	**System or Ordnance**	**Existing Levels**	**Proposed Levels**	**Primary**	**Secondary**
Strike Warfare (STW)						
BOMBEX (LAND)	Fixed Wing Aircraft, e.g. FA-18; AV-8B; B-1; B-2; B-52; F-15; F-16; F-22; A-10	High Explosive Bombs: < 500 lbs	400 annually	500 annually	FDM	-NA-
		High Explosive Bombs: 750 / 1,000 / 2,000 lbs	1,600 annually	1,650 annually		
		Inert Bomb Training Rounds: ≤ 2,000 lbs	1,800 annually	2,800 annually		
		Total sorties (1 aircraft per sortie)	1,000 sorties	1,300 sorties		
MISSILEX (A-G)	Fixed Wing and Rotary Aircraft, e.g FA-18; AV-8B; F-15; F-16; F-22; A-10; MH-60R/S; SH-60B; HH-60H; AH-1	TOW; MAVERICK; HELLFIRE; ROCKETS < 5"	30 annually	60 annually	FDM	-NA-
GUNEX (A-G)	Fixed Wing and Rotary Aircraft, e.g FA-18; AV-8B; F-15; F-16; F-22; A-10; MH-60R/S; SH-60B; HH-60H; AH-1; AC-130	20 or 25 mm Cannon	16,500 rounds	20,000 rounds	FDM	-NA-
		30 mm Cannon (A-10)	0	1,500 rounds		
		40mm or 105mm CANNON (AC-130)	100 rounds	200 rounds		
Combat Search and Rescue (CSAR)	MH-60S; HH-60; MH-53	Night vision flight training	30 Sorties	60 Sorties	Tinian North Field; AAFB Northwest Field; Navy Munitions Site	Orote Point Airfield; Rota International Airport
Amphibious Warfare (AMW)						
FIREX (Land)	CG, DDG	5" Guns and (HE) shells	4 (400 rounds)	8 (800 rounds)	FDM	-NA-
Amphibious Assault Marine Air Ground Task Force (MAGTF)	1 LHA or LHD, 1 LPD, 1 LSD, 1 CG or DDG, and 2 FFG.	4-14 AAV/EFV or LAV/LAR; 3-5 LCAC; 1-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8; Includes temporary Forward Arming and Refueling Point (FARP Construction	1 event (assault, offload, backload)	5 events (assault, offload, backload)	Tinian Military Leased Area; Unai Chulu,Dankulo and Babui (beach) and Tinian Harbor; North Field	Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Sumay Cove and MWR Ramp; Tipalao Cove and Dadi Beach
Amphibious Raid Special Purpose MAGTF	1 LHA or LHD, 1 LPD, and 1 LSD. Tailored MAGTF.	4-14 AAV/EFV or LAV/LAR; 0-5 LCAC; 0-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	0	2 events (raid, offload, backload)	Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Field; Sumay Cove and MWR Marina Ramp; Tipalao Cove and Dadi Beach	Tinian Military Leased Area; Unai Chulu; Dankulo, and Babui (beach) and Tinian Harbor; North Field
Expeditionary Warfare						
Military	USMC Infantry	5.56 mm	2 events, 7-21	5 events of 7-	AAFB South	Tinian, Rota, Saipan

Training Activity			Training Levels		Training Area	
Exercise	Platform	System or Ordnance	Existing Levels	Proposed Levels	Primary	Secondary
Operations in Theatre Training (MOUT)	Company: AH-1, UH-1; H-46 or MV-22; H-53; AAV, LAV, HMMWV, TRUCK	Blanks/Simunitions	days/event	21 days/event	Finegayan Communication Annex; Barrigada Housing; Northwest Field	
	USAF RED HORSE SQUADRON: TRUCK, HMMWV; MH-53; H-60		2 events, 3-5 days/event	4 events, 3-5 days/event		
	Navy NECC Company: HMWWV, TRUCK		2 events, 3-5 days/event	4 events, 3-5 days/event		
	Army Reserve/ GUARNG Company; HMWWV, TRUCK		2 events, 3-5 days/event	4 events, 3-5 days/event		
Special Warfare						
Direct Action	SEAL Tactical Air Control Party (TAC-P); RHIB; Small Craft.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm HE)	2 (2,000 rounds)	3 (3,000 rounds)	FDM	-NA-
	SEAL Platoon/Squad; NECC Platoon/Squad; USMC Platoon/Squad; ARMY Platoon/Squad; USAF Platoon/Squad	5.56 mm blanks/Simunitions 9mm (Orote Pt. Combat Qualification Center - OPCQC) 1.5 lb NEW C4 (Navy Munitions Site Breaching House)	32 (12,500 9mm) (10.5 lb NEW C4)	40 (15,000 9mm) (15 lb NEW C4)	OPCQC and Navy Munitions Site Breacher House	Tarague Beach CQC and Navy Munitions Site Breacher House
MOUT	SEAL Platoon/Squad; EOD Platoon/Squad; HMWWV; TRUCK	5.56 mm Blanks/Simunitions	6 events of 3-5 days/event	8 events of 3-5 days/event	Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Navy Munitions Site Breacher House	Tinian, Rota, Saipan
Parachute Insertion	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad USAF Platoon/Squad; C-130; CH-46; H-60	Square Rig or Static Line	6	12	Orote Pt. Airfield; Northwest Airfield; Orote Pt. Triple Spot	Finegayan DZ; Apra Harbor; Navy Munitions Site Breacher House
Insertion / Extraction	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY, USMC, USAF Platoon/Squad: RHIB; Small Craft; CRRC; H-60; H-	Square Rig or Static Line; Fastrope; Rappel; SCUBA	104	150	Orote Pt. Airfield; Northwest Field; Orote Pt. Triple Spot; Apra Harbor; Gab Gab Beach	Orote Pt. CQC; Finegayan DZ; Haputo Beach; Navy Munitions Site Breacher House; Polaris Pt. Field; Orote Pt. KD Range

Training Activity			Training Levels		Training Area	
Exercise	Platform	System or Ordnance	Existing Levels	Proposed Levels	Primary	Secondary
	46/ MV-22					
Breaching (Buildings and Doors)	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad;	Breach House (1.5 lbs NEW C4 max/door)	10	20	Navy Munitions Site Breacher House	-NA-
Special / Expeditionary Warfare						
Land Demolitions (IED Discovery / Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	IED Shapes	60	120	Guam, Orote Pt. Airfield; Orote Pt. CQC; Polaris Pt. Field; Andersen South; Northwest Field	Northern/Southern Land Navigation Area; Navy Munitions Site Breacher House; Tinian MLA
Land Demolitions (UXO Discovery / Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	UXO	100	200	Navy Munitions Site EOD Disposal Site (limit 3000 lbs NEW per UXO event)	AAFB EOD Disposal Site (limit 100 lbs per event) and Northwest Field (limit 20 lbs NEW per event)
Seize Airfield	SEAL Company/ Platoon USMC Company/ Platoon ARMY Company/ Platoon USAF Squadron C-130; MH-53; H-60; HMWWV;	5.56 mm blank/Simunitions	2	12	Northwest Field	Orote Pt. Airfield; Tinian North Field; Rota International Airport
Airfield Expeditionary	USAF RED HORSE Squadron. NECC SEABEE Company. USMC Combat Engineer Company USAR Engineer Dozer, Truck, Crane, Forklift, Earth Mover, HMMWV. C-130; H-53.	Expeditionary Airfield Repair and Operation (includes temporary FARP construction operation)	1	12	Northwest Field	Orote Pt. Airfield; Tinian North Airfield
Intelligence, Surveillance, Reconnaissance (ISR)	SEAL, ARMY, USMC, USAF Platoon/Squad;	Night Vision; Combat Camera; 5.56 mm blanks/Simunition	12	16	Guam; Northwest Field; Barrigada Housing; Finegayan Comm. Annex; Orote Pt. Airfield.	Tinian, Rota, Saipan
Field Training Exercise (FTX)	ARMY Company/ Platoon NECC SEABEE Company/ Platoon	Tents; Trucks; HMMWV; Generators	100 events, 2-3 days per event	100 events, 2-3 days per event	Guam, Northwest Field; Northern Land Navigation Area	Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field
Non-Combatant Evacuation	ARG Amphibious	HMMWV; Trucks; Landing Craft	1 event, 3-5 days	2	Apra Harbor; Reserve Craft	Tinian MLA, Unai Chulu, Dankulo and

Training Activity			Training Levels		Training Area	
Exercise	**Platform**	**System or Ordnance**	**Existing Levels**	**Proposed Levels**	**Primary**	**Secondary**
Operation (NEO)	Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	(LCAC/ LCU); AAV/ LAV; H-46 or MV-22			Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp	Babui (beach) and Tinian Harbor; North Field, Rota International Airport/West Harbor
Maneuver (Convoy; Land Navigation)	USMC Company/ Platoon ARMY Company/ Platoon	Trucks; HMWWV; AAV/LAV	8	16	Northwest Field; AAFB South; Northern and Southern Land Navigation Area; Tinian MLA; Saipan Marpi Maneuver Area	Finegayan Annex; Barrigada Annex; Orote Pt. Airfield
Humanitarian Assistance/ Disaster Relief Operation (HADR)	ARG Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 Or MV-22	1 event, 3-5 days	2	Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp	Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field, Rota International Airport/West Harbor
Force Protection / Anti-Terrorism						
Embassy Reinforcement	SEAL Platoon ARMY Platoon USMC Company/ Platoon Trucks; HMMWV; C-130; H-60; H-53	5.56 mm Blanks/Simunitions	42 events, 1-2 days per event	50 events, 2-3 days per event	Orote. Pt. Airfield Inner Apra Harbor; Northern and Southern Land Navigation Area	Orote Pt. Triple Spot; Orote Pt. CQC; Kilo Wharf; Rota
Force Protection	USAF Squadron/ Platoon NECC SEABEE Company/ Platoon USAR Engineer Company/ Platoon Tents; Trucks; HMMWV; Generators	5.56 mm Blanks/Simunitions	60 events, 1-2 days per event	75 events, 1-2 days per event	Guam, Northwest Field; Northern Land Navigation Area; Barrigada Annex	Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field; Rota
Anti-Terrorism	Navy Base Security USAF Security Squadron USMC FAST Platoon Trucks; HMMWV; MH-60	5.56 mm Blanks/Simunitions	80 events, 1 day/event	80 events, 1 day/event	Tarague Beach Shoot House and CATM Range; Polaris Pt.; Northwest Field	Kilo Wharf; Finegayan Comm. Annex; Navy Munitions Site; AAFB Munitions Site; Rota

APPENDIX D

TRAINING OPERATIONS DESCRIPTIONS

This appendix describes in general detail the training operations conducted in the MIRC; however pre-event briefing materials on specific hazards to training change frequently and necessarily reference updated briefs and instructions prepared by the scheduling authorities. Specific operator safety and environmental instructions for FDM, Guam and Tinian ranges, and all other training facilities are maintained current by the scheduling authorities. COMNAVMARINST 3500.4, Marianas Training Handbook and COMNAVMARINST 3502.1, Standard Operating Procedures for R-7201 and FDM, provide safety and environmental information for training areas on Guam and CNMI.

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF FIGURES

There are no figures in this section.

LIST OF TABLES

This page intentionally left blank.

MARIANAS RANGE COMPLEX TRAINING

In Chapter 2, Tables 2-1 through 2-5 list and describe the Mariana Islands Range Complex (MIRC) training areas and the typical training activity conducted in each area; Figures 2-1 through 2-12 show MIRC training area locations; Table 2-7 lists major exercises in the MIRC Study Area; Table 2-8 lists Annual Training Activities in the MIRC study area and the Primary (PRI) and Secondary (SEC) areas for each activity; Table 2-9 is a Summary of Ordnance Use by Training Area; and Table 2-10 is a Summary of active Sonar Activity. Appendix D provides a more detailed description of typical training activities that have or may occur in the Mariana Islands Range Complex and further details the No Action, Alternative 1, and Alternative 2 activities.

Insertion/Extraction

Personnel approach or depart an objective area using various transportation methods and covert or overt tactics depending on the tactical situation. These operations train forces to insert and extract personnel and equipment day or night.

Table D-1: Insertion/Extraction

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL WARFARE						
INSERTION/ EXTRACTION	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad; USAF Platoon/Squad: RHIB; Small Craft; CRRC; H-60; H-46 or MV-22	Square Rig or Static Line; Fastrope; Rappel; SCUBA	104 Events; 2 to 8 hours.	150 Events; 2 to 8 hours.	150 Events; 2 to 8 hours.	PRI: Orote Pt. Airfield; Northwest Field; Orote Pt. Triple Spot; Apra Harbor; Gab Gab Beach SEC: Orote Pt. CQC; Finegayan DZ; Haputo Beach; Munitions Site Breacher House; Polaris Pt. Field; Orote Pt. KD Range

Special Warfare, NECC, or Army Personnel Parachute from Fixed-winged Aircraft

Basic Phase (Unit Level Training) Scenario

A fixed-winged aircraft such as a C-130 will fly to the objective area from a land based airfield. The embarked Special Warfare, Navy Expeditionary Combat Command (NECC), or other personnel will parachute (static line or free fall) into the planned area from either a high (25,000 ft or more) or a low (1,000 ft and below) altitude; training is conducted in any altitude between the two aforementioned altitudes.

Opposition force personnel may be employed as well as small arms with blanks or live ammunition (if permitted: live ammunition on MIRC land training areas is permitted only on small arms ranges or shoot houses). Ordnance, if used, typically includes 7.62 mm, 5.56 mm and .50 cal. These operations will vary in length depending on the transportation method and systems being used, typically from 2 to 8 hours.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

Surveyed parachute drop zones in land or water range areas enhance safety.

Special Warfare, NECC, or Army Personnel from HH-60H, SH-60F, or MH-60S Helicopters

There are a number of different insertion or extraction techniques that are used depending on the mission and tactical situation:

- Helicopter Rope Suspension Training (HRST) is a collective term used for various techniques used for quickly deploying troops from a helicopter in locations where the helicopter itself is unable to touch down:
- Fast Rope uses a large diameter rope attached to the helicopter at one end and loose to the ground point of insertion. A thick rope is used so that the helicopter rotor blast does not blow it around. One simply holds onto the rope with their hands and feet and slides down. Several people can slide down the same rope almost simultaneously as long as enough room is provided for each person to get out of the way when they reach the ground so that the next person will not land on them. It is quicker than rappelling because the person is not attached to the rope.
- Rappelling is similar to the fast rope technique except that it uses a smaller diameter rope and the person wears a harness that is attached to the rope by a carabineer. It is safer than fast rope, but slower.
- Special Purpose Insertion/Extraction (SPIE) was designed for use in rough terrain as well as water. This technique inserts or extracts an entire patrol at one time. Each person wears a harness and uses a carabineer to attach to "D" rings in a rope that is attached to the helicopter. The helicopter descends or lifts vertically into/from the insertion/extraction zone while ensuring that the rope and personnel are clear of obstructions. During forward flight the rope and personnel are treated as an external load and airspeeds, altitudes, and oscillations are closely monitored.
- Cast and Recovery is a method for delivering or recovering personnel to or from the water. A helicopter flies low and slow over the water near the target point and the personnel simply jump into the water one at a time. This method is also used for inserting and extracting a Combat Rubber Raiding Craft (CRRC) and its passengers.

Basic Phase (Unit Level Training) Scenario

Helicopters with the embarked personnel approach the objective area at a low altitude, between 200 ft to 400 ft, descend quickly to the insertion position, and hover about 20 ft above the ground. Once the passengers and equipment have been inserted or extracted, the helicopter departs the area.

Opposition force personnel may be employed as well as small arms with blanks or live ammunition (if permitted). Ordnance, if used, typically includes 7.62 mm, 5.56 mm and .50 cal.

These operations will vary in length depending on the transportation method and systems being used, typically from 2 to 8 hours.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except that the procedure is done as a part of a larger operation with two or more helicopters and an assigned mission.

<u>Special Warfare or NECC Personnel from Boats</u>

Basic Phase (Unit Level Training) Scenario

Combat personnel use Combat Rubber Raiding Craft (CRRC), Rigid Hull Inflatable Boats (RHIB), and other boats to approach a hostile area ashore from points at sea to perform an assigned task such as obtain intelligence, destroy an assigned target, or complete another objective. The goal of this exercise is to get the personnel to or from the beach.

Opposition force personnel may be employed as well as small arms with blanks or live ammunition (if permitted). Ordnance, if used, typically includes 7.62 mm, 5.56 mm and .50 cal.

These operations will vary in length depending on the transportation method and systems being used, typically from 2 to 8 hours.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

<u>Special Warfare or NECC Personnel or Marines from SSN or SSGN</u>

Several methods are used by submarines and embarked personnel to move from the submarine to the objective area:

- The Lock-in/lock-out procedure allows personnel to swim out of submerged submarines.
- The SEAL Delivery Vehicle (SDV) may be used by personnel to move from the submarine to an underwater area closer to shore.
- The Advanced SEAL Delivery System (ASDS) is a longer range submersible used to move Special Warfare personnel to the shore. It is typically carried by a specially configured SSN to a special launch point where the personnel embark and use it to move to a location where they can swim to shore.

Basic Phase (Unit Level Training) Scenario

Submarines approach a hostile area and move at a very slow speed while inserting or extracting personnel by using one, or a combination of two or more, of the three procedures discussed above. Once the personnel have inserted or extracted, the submarine will leave the area.

Opposition force personnel may be employed as well as small arms with blanks or live ammunition (if permitted) once the personnel reach the beach area. Ordnance, if used, typically includes 7.62 mm, 5.56 mm and .50 cal.

These operations will vary in length depending on the transportation method and systems being used, typically from 2 to 8 hours.

Integrated and Sustainment Phase Training Scenarios

Not typically conducted in these phases.

Local Training Considerations

Insertion/extraction operations train Special Forces (Navy, Marine Corps, and Air Force) to deliver and extract personnel and equipment in challenging environments. Apra Harbor operations in FY03 were conducted by Naval Special Warfare Unit One (NSWU-1) and EODMU-5. These operations included, but were not limited to, parachute, fastrope, rappel, Special Purpose Insertion/Extraction (SPIE), combat rubber raiding craft, and lock-in/lock-out from underwater vehicles.

Parachute Insertions and Air Assault

Special Warfare and Army personnel use fixed-winged and rotary aircraft to insert troops and equipment by parachute, or use helicopters that fly directly to a specified objective area, land and off load their troops or cargo.

Special Warfare, NECC, or Army Personnel Parachute from Fixed-winged Aircraft

Basic Phase (Unit Level Training) Scenario

A fixed-winged aircraft such as a C-130, or helicopter such as a MH-60, will fly to the objective area from a land based airfield. The embarked Special Warfare, NECC, or other personnel will parachute (static line or free fall) into the planned area from either a high (25,000 ft or more) or a low (1,000 ft and below) altitude; training is conducted in any altitude between the two aforementioned altitudes.

Opposition force personnel may be employed as well as small arms with blanks or live ammunition (if permitted). Ordnance, if used, typically includes 7.62 mm, 5.56 mm and .50 cal.

These operations will vary in length depending on the transportation method and systems being used, typically from 2 to 8 hours.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Table D-2: Parachute Insertions and Air Assault

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL WARFARE						
PARACHUTE INSERTION	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad USAF Platoon/Squad; C-130; CH-46; H-60	Square Rig or Static Line	6 Events; 2 to 8 hours	12 Events; 2 to 8 hours	12 Events; 2 to 8 hours	PRI: Orote Pt. Airfield; Northwest Airfield; Orote Pt. Triple Spot SEC: Finegayan DZ; Apra Harbor; Navy Munitions Site Breacher House

Training Considerations

Surveyed parachute drop zones in land or water range areas enhance safety.

Special Warfare, NECC, or Army Personnel from HH-60H, SH-60F, or MH-60S Helicopters

Basic Phase (Unit Level Training) Scenario

Helicopters with the embarked personnel approach the objective area at a low altitude, between 200 ft to 400 ft, descend quickly to the insertion position, land and disembark or embark personnel and/or equipment. Once the passengers and equipment have been inserted/extracted, the helicopter departs the area.

Opposition force personnel may be employed as well as small arms with blanks or live ammunition (if permitted). Ordnance, if used, typically includes 7.62 mm, 5.56 mm and .50 cal.

These operations will vary in length depending on the transportation method and systems being used, typically from 2 to 8 hours.

Local Training Considerations

OPA supports personnel, equipment, and CDS airborne parachute insertions.

Mine Laying Exercise (MINEX)

The goal of the Mine Laying Exercise (MINEX) in MIRC is to precisely deploy mine shapes (inert) from fixed wing air craft e.g. MPA, FA-18, USAF bomber aircraft. Typically inert MK-62 Quick Strike Mines or Mk-56 ASW Mines (inert) are used.

Table D-3: Underwater Demolitions

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
MINE WARFARE (MIW)						
MINEX	Fixed Wing Fighter/Bomber/MPA *e.g.* B-1/ B-2/ B-52/ FA-18/P-3/P-8A	MK-62 / MK-56 (Inert)	2	3	3	PRI: W-517 SEC: MI Maritime, >12 nm from land

Local Training Considerations

Primary site for the event is W-517, and secondary site is Marianas maritime area, greater then 12nm from Guam or CNMI.

Floating Mine Neutralization - Explosive Ordnance Disposal (EOD)

Explosive Ordnance Disposal personnel use special equipment to evaluate threat mines, then explosive charges to destroy the mine in order to create a safe channel for friendly shipping.

Table D-4: Floating Mine Neutralization – Explosive Ordnance Disposal

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
MINE WARFARE (MIW)						
FLOATING MINE NEUTRALIZATION	RHIB; CRRC; Small Craft	Floating mine shape; 5 – 10 lb NEW	8 Events; (2 – 8 hours each)	20 Events; (2 – 8 hours each)	20 Events; (2 – 8 hours each)	PRI: Agat Bay SEC: Piti

<u>EOD Personnel with Mine Neutralization Charges</u>

Basic Phase (Unit Level Training) Scenario

EOD personnel detect, identify, evaluate, and neutralize mines. The EOD mission is typically to locate and neutralize mines after they have been initially located by another source, such as a MCM class ship or a MH-53 or MH-60S helicopter. Once the mine shapes are located, EOD divers are deployed from a ship via Combat Rubber Raiding Craft (CRRC) to further evaluate and neutralize the mine in the water. This is normally done with an explosive device and may involve the detonation of one or two explosive charges of up to 10 pounds of TNT equivalent.

Mine training shapes or other exercise support equipment and a range area that will support the use of live ordnance is required for a six to eight hour window. These operations are normally conducted during daylight hours for safety reasons. Mine Neutralization training in Inner Apra Harbor (IAH) typically consists of locating and neutralizing LIMPET mines (inert shapes for training). LIMPET mine training shapes are attached to a ship or object that is to be destroyed by the mine.

Local Training Considerations

This EOD event in the Agat Bay or Piti Floating Mine Neutralization Area is the location and neutralization of a floating or near surface mine by EOD divers. The neutralization of the mine (the portion of the exercise that involves the use of ordnance) is typically scheduled during daylight hours for safety reasons and completed within a two hour period. Divers deploy from RHIB, CRRC, or small craft, and a diver will place the explosive next to or on each inert mine shape. The EOD divers control the initiation of each charge. Once the neutralization charge is placed on or near the mine, the divers will return to their craft and proceed to a safe location for detonation. Based on charge size and operating conditions, EOD will determine a “safe time” and distance needed from the mine before they detonate the charge. Typically two detonations per training event are conducted, with a second charge detonated 1-2 hours after the first shot. After the detonation portion of the exercise is completed, the mine shape is recovered. Divers are redeployed to the detonation area to verify that the mine shape was destroyed or to aid in recovery of the mine shape.

Underwater Demolitions

Navy SEALS or EOD personnel use explosive charges to destroy obstacles or other structures in an underwater area that could cause interference with friendly or neutral forces and planned operations.

Table D-5: Underwater Demolitions

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
MINE WARFARE (MIW)						
UNDERWATER DEMOLITION	RHIB; CRRC; Small Craft	Bottom/mid-moored mine shape 5 – 10 lb NEW	22 Events; (2 – 8 hours each)	30 Events; (2 – 8 hours each)	30 Events; (2 – 8 hours each)	PRI: Agat Bay SEC: Apra Harbor (10lb NEW max)

<u>**NSW or EOD Personnel with Explosive Charges**</u>

Basic Phase (Unit Level Training) Scenario

NSW or EOD personnel locate mines, barriers or obstacles designed to deny access to an area, and then use explosive charges to destroy them.

Training Considerations

This training provides NSW and EOD personnel with experience in placing and detonating explosives to achieve best results.

Local Training Considerations

Underwater demolitions are designed to train personnel in the destruction of mines, obstacles or other structures in an area to prevent interference with friendly or neutral forces and non-combatants. They provide Navy Special Warfare and EOD teams experience detonating underwater explosives. Apra Harbor supports this training near the Glass Breakwater and Buoy 702, at a depth of 125 feet and using up to a 10 pound Net Explosive Weight (NEW) charge. The Agat Bay Underwater Detonation Area supports this training using up to 10 pound NEW charge. Lying outside of Apra Harbor and to the north of Glass Breakwater is the Piti Floating Mine Neutralization area.

Breaching

Special Warfare, Army, and USMC personnel use explosives to gain access to buildings where enemy personnel or material could be located or to investigate the building itself.

Breaching with Explosive Charges

Breaching operations train personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This process enables a unit to maintain its mobility by removing or reducing natural and man-made obstacles. Breaching training is designed to provide experience in knocking down doors to enter a building or structure or destroying obstacles that could block access to vehicles or personnel.

Basic Phase (Unit Level Training) Scenario

Six to 12 personnel use small unit tactics to approach a fortified building that may contain enemy personnel or material, and force is required to gain access. Explosive charges are set around door frames or other specified areas where the explosion will breach the door, wall, or other area and allow access into the building. In simple settings, a door and door frame is erected in a breaching building or demolition pit or in a MOUT where personnel practice knocking down the door using explosives that are normally no more than 1.2 pound NEW.

Local Training Considerations

Breaching operations train personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This enables a force to maintain its mobility by removing or reducing natural and man-made obstacles. In the Urban Warfare sense, breaching operations are designed to provide teams experience knocking down doors to enter a building or structure. During the conduct of a normal breach operation personnel practice knocking down the door using explosives that are no more than 3 pounds NEW and normally 1.2 pounds NEW or less. The Navy Munitions Site Breaching House is the only facility in MIRC that permits explosive breaching. Explosives at Orote Point Close Quarters Combat (OPCQC) are not permitted, which limits the value of conducting breaching training at OPCQC.

Table D-6: Breaching

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL WARFARE						
BREACHING (Buildings, Doors)	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/ Squad;	Breach House (1 lbs NEW C4 max/door)	10 Events; 2-8 hours (15 lbs NEW C4)	20 Events; 2-8 hours (30 lbs NEW C4)	20 Events; 2-8 hours (30 lbs NEW C4)	Navy Munitions Site Breacher House

Land Demolitions

EOD personnel use explosive charges to destroy land mines, explosive devices, such as improvised explosive devices, bombs, structures, or other items as required.

Table D-7: Land Demolitions

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
LAND DEMOLITIONS (IED DISCOVERY/ DISPOSAL)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	IED Shapes	60 Events; 2-8 hours	120 Events; 2-8 hours	120 Events; 2-8 hours	PRI: Guam, Orote Pt. Airfield; Orote Pt. CQC; Polaris Pt. Field; Andersen South; Northwest Field SEC: Northern/Southern Land Navigation Area; Munitions Site Breacher House; Tinian MLA
Land Demolitions (UXO Discovery/ Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	UXO	100	200	200	PRI: Navy Munitions Site EOD Disposal Site (limit 3000 lbs NEW per UXO event) SEC: AAFB EOD Disposal Site (limit 100 lbs per event) and Northwest Field (limit 20 lbs NEW per event)

EOD Personnel with Explosive Charges

Basic Phase (Unit Level Training) Scenario

EOD detachments transit to the training site in trucks or other light wheeled vehicles, sometimes conducting convoy operations or employing other unit tactics enroute to the site. A search of a suspect area is conducted to locate inert land mines buried in the sand or to locate a designated target for destruction. Buried land mines and unexploded ordnance (UXO) require the detachment to employ probing techniques and metal detectors for locating the mine or object and the use of hand tools and digging equipment to excavate them. Once they are exposed and/or properly identified, the detachment neutralizes the threats by using small amounts of simulated or live explosives (EOD land demolitions training using live explosives in the MIRC are authorized in an EOD pit only).

Integrated and Sustainment Phase Training Scenarios

Not typically conducted in these phases.

Training Considerations

Land demolitions are designed to train forces to explode and destroy enemy personnel, vehicles, aircraft, obstacles, facilities, or terrain on land. These operations are also designed to develop and hone EOD detachment mission proficiency in the location, excavation, identification and neutralization of buried land mines or other hazardous objects.

Local Training Considerations

Land demolitions training is designed to develop and hone EOD detachment mission proficiency in location, excavation, identification, and neutralization of buried land mines. During the training, teams transit to the training site in trucks or other light wheeled vehicles. A search is conducted to locate inert (non-explosively filled) land mines or Improvised Explosive Devices (IEDs) and then designate the target for destruction. Buried land mines and UXO require the detachment to employ probing techniques and metal detectors in the location phase. Use of hand tools and digging equipment is required to excavate. Once exposed and/or properly identified, the detachment neutralizes threats on site using simulated explosives only.

Land demolition training is actively conducted throughout the MIRC. Explosive Ordnance Disposal Mobile Unit (EODMU)-5 is stationed at Main Base and EOD Detachment, Marianas (DET MARIANAS) is a small unit of EOD personnel who are permanently attached to COMNAVBASE MARIANAS and are actively involved in disposing of old munitions and UXO found throughout the MIRC.

Visit, Board, Search, and Seizure (VBSS)

Helicopters and surface ships deliver boarding parties to suspect surface vessels to inspect and examine the vessel's papers or examine it for compliance with applicable resolutions or sanctions. Seizure of the vessel (that is confiscating or taking legal possession of the vessel and contraband (goods or people)) could result if the vessel is found in violation of any applicable resolutions or sanctions.

Table D-8: Visit, Board, Search, and Seizure

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SURFACE WARFARE						
Visit, Board, Search and Seizure/Maritime Interception Operation (VBSS/MIO)	RHIB, Small Craft, Ship, H-60	n/a	3 Events; 2-3 hours	6 Events; 2-3 hours	8 Events; 2-3 hours	PRI: Apra Harbor SEC: MI Maritime

CG, DDG, FFG, LPD, LSD with Shipboard or Special Forces Boarding Teams with Small Arms

Basic Phase (Unit Level Training) Scenario

Ships will typically be on patrol in a designated ocean or restricted area to watch for vessels that may need to be inspected or seized. When a suspect vessel is sighted, the ship will approach the suspect vessel at a speed of 20 kts or more while preparing to launch its organic helicopter or small boat and using its radio to talk to the suspect vessel to get it to assume an assigned course and slow speed. A cooperative boarding will allow the armed boarding party to board and conduct the inspection.

An uncooperative boarding is the more typical training scenario and may actually require a clandestine approach to the suspect vessel and use of force. An organic helo and small boat will still be used to board the suspect vessel, but shipboard or Special Forces boarding teams with armed force may be required to make the boarding. Small arms with inert blanks may be used. The entire exercise may last two to three hours.

Training Considerations

A range support vessel or other commercial style vessel can be used as the suspect vessel to be boarded and may be staffed with opposing forces to create a better training environment.

SH-60B/F, HH-60H, MH-60R/S with Machine Guns and Shipboard or Special Forces Boarding Teams with Small Arms

Basic Phase (Unit Level Training) Scenario

Helicopters supply the transportation for the boarding party from a surface ship to the suspect vessel to be boarded, as described above, and provide added fire power from onboard 7.62 mm or .50 Cal machine guns (see GUNEX (A-S)) if required in an uncooperative boarding. The helicopter will approach the suspect vessel, use an appropriate insertion/extraction method (see Insertion/Extraction - HELO) for the tactical situation to place the boarding party on the suspect vessel, and then standby in a hover or close proximity flight pattern to provide armed support as required.

Training Considerations

A range support vessel or other commercial style vessel can be used as the suspect vessel to be boarded and may be staffed with opposing forces to create a better training environment.

Amphibious Raid

Marine amphibious forces make swift incursions into or temporarily occupy a hostile territory or area for a specified purpose and a specified time, then make a planned withdrawal. Raids are often conducted against objectives requiring specific results that may not be achieved by any other means. Because of these mission requirements, the Marine Expeditionary Unit (Special Operations Capable) (MEU (SOC)) is a unit that has been specially structured to achieve specific mission requirements in unique situational settings against expected threat force structures.

A Marine amphibious raid force will consist of varying numbers of aviation, infantry, engineering, and fire support forces necessary for the specific mission to be accomplished. Because they typically lack the ability to overwhelm a forewarned and well-armed defender, the riskiest phases of an amphibious raid are the insertion and extraction phases. These phases depend on the availability of sufficient and dependable intelligence to allow the raid force to approach the target without in route engagement, complete the mission expeditiously, and withdraw before the enemy can respond.

Table D-9: Amphibious Raid

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AMPHIBIOUS WARFARE (AMW)						
Amphibious Raid Special Purpose MAGTF	1 LHA or LHD, 1 LPD, and 1 LSD. Tailored MAGTF.	4-14 AAV/EFV or LAV/LAR; 0-5 LCAC; 0-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	0	2 events (raid, offload, backload)	2 events (raid, offload, backload)	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.

<u>MEU (SOC) with Small Boats or Mechanized Assault Craft and Blank Small Arms Ammunition</u>

Basic Phase (Unit Level Training) Scenario

Typical Amphibious Raid missions might be mounted to:

- Inflict loss or damage a specified target
- Seize a port or airfield for use by “friendly” forces
- Secure intelligence information

- Evacuate combatant or non-combatant personnel
- Create a tactical diversion.

A typical Amphibious Raid force may be comprised of a reinforced company (100-150 personnel) landed by small boat or mechanized assault craft on a beachhead, or inserted by assault support aircraft into a landing zone (LZ). The company would then proceed to a designated objective area within the range complex to carry out the assigned mission. When the mission is successfully accomplished, the company would then proceed to an extraction point for return to ships in the ESG.

Because it is the foundation for MEU operations, the amphibious raid is conducted more prevalently within the Pre-deployment Training Plan. A single MEU is expected to execute 16-20 training raids for its 3 companies and attachments in the basic phase scenario

Integrated and Sustainment Phase Training Scenarios

Unlike an Amphibious Assault that is intended to establish a more permanent presence in a hostile territory, the Amphibious Raid makes a swift incursion into, or a temporary occupation of, an objective, followed by a planned withdrawal.

The procedures used during these phases are built on those developed during the Basic Phase, but the forces will accomplish their mission under the larger umbrella of the ESG and with the additional support forces available from the ESG.

Local Training Considerations

Reserve Craft Beach (RCB) is capable of supporting a small Expeditionary Raid training event followed by a brief administrative buildup of forces ashore. In FY03 up to 300 31^{st} MEU personnel and equipment were moved ashore at RCB via LCAC.

Military Operations in Urban Terrain (MOUT)

USMC, Army, Air Force, Special Warfare, and NECC personnel use combat tactics appropriate for a small city environment inhabited by noncombatants but occupied by a hostile force to search out and capture or destroy the hostile force.

<u>MOUT Personnel with Small Arms Weapons</u>

Basic Phase (Unit Level Training) Scenario

Patrols use advanced, offensive, close-quarters battle techniques to move through a hostile urban environment where noncombatants are or may be present and collateral damage must be kept to a minimum. Techniques used include: advanced breaching to enter buildings or clear rooms; clearing stairwells; selective target engagement to ensure noncombatants are not harmed; and dynamic assault techniques to ensure collateral damage is kept to a minimum.

Organizational equipment used during these operations includes 7.62 mm, 5.56 mm, 12-gauge, and 9 mm small arms, 40 mm grenades, and breaching explosive charges. Blanks from organizational equipment or "paint ball" type weapons are typically employed over different portions of the training scenario, which is usually especially tailored for a possible real world scenario.

Table D-10: Military Operations in Urban Terrain

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
EXPEDITIONARY WARFARE						
MILITARY OPERATIONS IN THEATER (MOUT) TRAINING	USMC Infantry Company: AH-1, UH-1; H-46 or MV-22; H-53; AAV, LAV, HMMWV, TRUCK	5.56 mm blanks/Simulations	2 events, 7-21 days/event	5 events of 7-21 days/event	5 events of 7-21 days/event	PRI: Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Northwest Field SEC: Tinian; Rota; Saipan
	USAF RED HORSE SQUADRON: TRUCK, HMMWV; MH-53; H-60		2 events, 3-5 days/event	4 events, 3-5 days/event	4 events, 3-5 days/event	
	Navy NECC Company: HMWWV, TRUCK		2 events, 3-5 days/event	4 events, 3-5 days/event	4 events, 3-5 days/event	
	Army Reserve/GUARNG Company; HMWWV, TRUCK		2 events, 3-5 days/event	4 events, 3-5 days/event	4 events, 3-5 days/event	
SPECIAL WARFARE						
MILITARY OPERATIONS IN THEATER (MOUT) TRAINING	SEAL Platoon/Squad; EOD Platoon/Squad; HMWWV; TRUCK	5.56 mm blanks/Simulations	6 events of 3-5 days/event	8 events of 3-5 days/event	10 events of 3-5 days/event	PRI: Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Navy Munitions Site Breaching House SEC: Tinian; Rota; Saipan

Integrated and Sustainment Phase Training Scenarios

Typically differ from the Basic Phase Scenario by the number of personnel that will be involved and the more command and control that will be used. The operation may also be supported by helicopters for insertion and extraction or close air support, and by UAVs for intelligence information.

MOUT forces in these phases are more typically geared for Marine Corps missions at company-level size operations (100-150 personnel) to battalion-level size operations (1,000 personnel).

Training Considerations

A "city" with opposing forces is required to get the most out of MOUT training and gain the experience required by the complicating factors of urban warfare which include:

- Distinguishing civilians from hostiles
- Three dimensional environment
- Limiting fields of view and fire caused by buildings
- Enhanced concealment and cover for hostiles

- Below ground infrastructure
- Booby traps
- Snipers.

MOUT training can consist of more than one type of scenario. One might be a "raid," in which small teams use MOUT tactics to seize and secure an objective, accomplish their mission and withdraw. Another might be a Marine Expeditionary Force (MEF) using MOUT tactics to seize and secure an objective for the long term. In either case, training to neutralize enemy forces must be accomplished in a built-up area featuring structures, streets, vehicles and civilian population. It is manpower intensive, requiring close fire and maneuver coordination and extensive training.

Local Training Considerations

OPCQC supports "raid" type MOUT training on a limited basis.

USMC makes extensive use of Andersen South during Training in Urban Environment Exercise (TRUEX) events.

Airfield Seizure

Special Warfare, Army and Marine Corps units use combat tactics appropriate for seizing and securing an occupied enemy airfield in order to make it available for follow-on friendly force use. Air Force and NECC units specialize in securing and repairs of a seized airfield.

Table D-11: Airfield Seizure

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
SEIZE AIRFIELD	SEAL Company/ Platoon USMC Company/ Platoon ARMY Company/ Platoon USAF Squadron C-130; MH-53; H-60; HMWWV; TRUCK	5.56 mm blank/Simulations	2 Events; 1- 3 days	12 Events; 1-3 days	12 Events; 1-3 days	PRI: Northwest Field SEC: Orote Pt. Airfield; Tinian North Field

<u>Personnel with Small Arms Weapons</u>

Basic Phase (Unit Level Training) Scenario

NSW, NECC, or Marine Corps patrols use advanced, offensive, raid and close-quarters battle techniques to move through a hostile environment where noncombatants are or may be present and collateral damage must be kept to a minimum in order to be able to use the airfield facilities after they have been seized.

The raid/seizure force typically advances from over the horizon, assaulting across a hostile territory in a combination of helicopters, VTOL aircraft, and other landing craft.

Organizational equipment used during this operation includes 7.62 mm, 5.56 mm, 12-gauge, and 9 mm small arms, 40 mm grenades, and breaching explosive charges. Blanks from organizational equipment or "paint ball" type weapons are typically employed over different portions of the training scenario, which is usually especially tailored for a possible real world scenario.

Local Training Considerations

Northwest Field (NWF) is a primary site for this training. The USAF Red Horse Squadron will frequently conduct this type of training.

Direct Action

Special Forces or NECC personnel use covert or overt small unit tactics against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material.

Table D-12: Direct Action

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL WARFARE						
DIRECT ACTION	SEAL Tactical Air Control Party (TAC-P); RHIB; Small Craft.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm HE)	2 Events; 1 day (2,000 rounds)	3 Events; 1 day (3,000 rounds)	3; events 1 day (3,000 rounds)	FDM (R-7201)
	SEAL Platoon/Squad; NECC Platoon/Squad; USMC Platoon/Squad; ARMY Platoon/Squad; USAF Platoon/Squad	5.56 mm blanks/Simulations 9mm (Orote Pt. Combat Qualification Center - OPCQC) 1.5 lb NEW C4 (Navy Munitions Site Breaching House)	32 Events; 2-8 hours (12,500 9mm) (10.5 lb NEW C4)	40 Events; 2 - 8 hours (15,000 9mm) (15 lb NEW C4)	48 Events; 2 - 8 hours (17,500 9mm) (19.5 lb NEW C4)	PRI: OPCQC and Navy Munitions Site Breacher House SEC: Tarague Beach CQC and Navy Munitions Site Breacher House.

<u>**Personnel with Small Arms Weapons and Explosive Devices**</u>

Basic Phase (Unit Level Training) Scenario

A squad or platoon size force are inserted into and later extracted from a hostile area by helicopter, Combat Rubber Raiding Craft (CRRC), or other technique, and then use small-scale offensive actions to attack hostile forces or targets. These offensive actions can include: raids, ambushes, standoff attacks by firing from ground, air, or maritime platforms, designating or illuminating targets for precision-guided munitions, providing support for cover and deception operations, and sabotage.

Opposing forces and targets within range areas are required for realism. Small arms such as 7.62 mm, 5.56 mm, 9 mm, 12-gauge, 40 mm grenades, laser illuminators, and other squad or platoon weapons may be used against live fire targets, or with blanks.

Training Considerations

This exercise may be combined with other exercises such as insertion and extraction, close air support, and others.

Local Training Considerations

NSWU-1 is capable of using small craft to island hop from Guam to Rota, Rota to Tinian, Tinian to Saipan, and Saipan to FDM. This is not a frequent event. Once at FDM, they will employ small arms, grenades, and crew served weapons in direct action against targets on the island. They may also participate in TACP/FAC training in conjunction with a Bombing Exercise (Air-to-Ground) (BOMBEX (A-G)).

NSWU-1 and visiting Special Forces training in the MIRC will frequently include training that utilizes the access provided by Gab Gab Beach to Apra Harbor and Orote Point training areas.

Maneuver

Marine Corps units practice the maneuver and employment of forces in a non live fire environment such that the forces may achieve a position of advantage over an enemy force and accomplish operational or strategic objectives.

Table D-13: Maneuver

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
MANEUVER (Convoy; Land Navigation)	USMC Company/Platoon Army Company/Platoon	Trucks; HMWWV;AAV/LAV	8 Events; 8 -24 hours	16 Events; 8 -24 hours	16 Events; 8 -24 hours	PRI: Northwest Field; AAFB South; Northern and Southern Land Navigation Area; Tinian MLA SEC: Finegayan Annex; Barrigada Annex; Orote Pt. Airfield;

<u>**Marine Corps and Army Personnel**</u>

Basic Phase (Unit Level Training) Scenario

This training may be conducted at the squad level or at the Battalion, Regiment, Division, Force, or Joint level.

Local Training Considerations

Northern Land Navigation Area and Southern Land Navigation Area support teams on foot only, no convoy training. Limited convoy training is possible at Andersen South, and Finegayan and Barrigada Annexes.

Gunnery Exercise (Surface-to-Surface) (Boat): GUNEX [S-S] (Boat)

A small boat uses a machine gun and small arms to attack and disable or destroy a surface target that simulates another ship, boat, swimmer, floating mine or near shore land targets.

A number of different types of boats are used depending on the unit using the boat and their mission. Boats are most used by NSW teams and Navy Expeditionary Combat Command (NECC) units (Naval Coastal Warfare, Inshore Boat Units, Mobile Security Detachments, and Explosive Ordnance Disposal). These units are used to protect ships in harbors and high value units, such as: aircraft carriers, nuclear submarines, liquid natural gas tankers, etc., while entering and leaving ports, as well as to conduct insertion and extractions, and various naval special warfare operations.

The boats used by these units include: Small Unit River Craft (SURC), Combat Rubber Raiding Craft (CRRC), Rigid Hull Inflatable Boats (RHIB), Patrol Craft, and many other versions of these types of boats. These boats use inboard or outboard, diesel or gasoline engines with either propeller or water jet propulsion.

Table D-14: Gunnery Exercise (Surface-to-Surface) (Boat): GUNEX [S-S](Boat)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SURFACE WARFARE (SUW)						
GUNEX Surface-to-Surface (Small arms)	CG cutters, Ship, RHIB, small craft. Barrel or Inflatable tgt.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm TP)	24 (12,000 rounds)	32 (16,000 rounds)	40 (20,000 rounds)	PRI: MI Maritime, >3 nm from land SEC: W-517

<u>Navy and Coast Guard Boats with .50 cal, 7.62 mm or 40 mm Machine Guns</u>

This exercise is usually a live fire exercise, but at times blanks may be used so that the boat crews can practice their boat handling skills for the employment of the weapons while minimizing risk to personnel and equipment associated with firing live weapons.

Basic Phase (Unit Level Training) Scenario

Boat crews may use high or low speeds to approach and engage targets simulating other boats, swimmers, floating mines, or near shore land targets with .50 cal, 7.62 mm, or 40 mm weapons.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except for the additional command and control coordination involved.

Training Considerations

The purpose of this exercise is to develop marksmanship skills and small boat handling tactics and skills required to employ these weapons. It usually lasts one to two hours.

Local Training Considerations

Surface gunnery exercises take place in the open ocean to provide gunnery practice for Navy and Coast Guard ship and small craft crews supporting NSWU-1, EODMU-5, and Mobile Security Squadron Seven (MSS-7). Local GUNEX training activity conducted typically involve only non-maneuvering targets such as a MK-42 Floating At Sea Target (FAST) or a MK-58 marker (smoke) buoy, or a steel drum. The systems employed against surface targets include the 5-inch, 76mm, 25mm chain gun, 20mm Close In Weapon System (CIWS), .50 caliber machine gun, 7.62mm machine gun, small arms, and 40mm grenade.

Gunnery Exercise (Surface-to-Surface) (Ship): GUNEX [S-S] (Ship)

Ship gun crews engage surface targets at sea with their main battery 5-inch and 76 mm guns as well as smaller surface targets with 25 mm, .50 cal, or 7.62 mm machine guns with the goal of disabling or destroying the threat ship.

Table D-15: Gunnery Exercise (Surface-to-Surface)(Ship) (GUNEX [S-S] [Ship])

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SURFACE WARFARE (SUW)						
GUNEX Surface-to-Surface (Ship)	Ships and patrol craft. Barrel, Inflatable tgt.	.50 cal MG	1 (2,400 rounds)	5 (12,000 rounds)	5 (12,000 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land
		.25 mm MG	1 (1,600 rounds)	5 (8,000 rounds)	5 (8,000 rounds)	
	CG and DDG. Barrel or Inflatable tgt. or towed sled.	5” gun	4 (160 rounds)	8 (320 rounds)	10 (400 rounds)	
	FFG. Barrel or Inflatable tgt. or towed sled.	76 mm	2 (60 rounds)	4 (120 rounds)	5 (150 rounds)	

<u>CG and DDG with 5-inch and FFG with 76 mm Guns</u>

There are three types of main battery shipboard guns currently in use: 5-inch/54 (CG and DDG), 5-inch/62 (DDG-81 and newer), and 76 mm (FFGs). Both 5-inch guns use the same types of 5-inch projectiles for training exercises. The difference between the 5-inch guns is the longer range of the 5-inch/62 because of the larger powder propulsion charge.

Basic Phase (Unit Level Training) Scenario

A slow (5 kts) or high (30 kts) speed simulated enemy ship or boat approaches the CG/DDG/FFG from about 10 nm, is detected by the ship's radar and determined to be hostile. The target is tracked by radar, and when it is within five to nine nm, it is engaged by approximately 60 rounds of 5-inch or 76 mm, fired with an offset so as not to actually hit the targets. Exercise occurs over duration of about 3 hours. Live or inert training rounds may be used. After impacting the water, the live rounds are expected to detonate within 3 ft of the surface. Inert rounds and fragments from the live rounds will sink to the bottom of the ocean.

The main battery guns have a requirement to attack high-speed, maneuvering, towed or remotely controlled surface targets such as the QST-35 Seaborne Powered Target (SEPTAR), High Speed Maneuverable Surface Target (HSMST), or a remote controlled Jet Ski. These types of targets have not been available in the MIRC.

Integrated and Sustainment Phase Training Scenarios

These two scenarios will be similar to each other and the Basic Phase Scenario, but will have more “friendly” ships (3 to 5) participating. Additional ships will increase the number of rounds fired proportionally.

While main battery guns are designed for both offensive and defensive use against larger, ship-sized targets, these smaller caliber machine guns are designed to provide close range defense against patrol boats, smaller boats, swimmers, and floating mines.

Amphibious ships, such as LHA, LHD, LPD, and LSD use 25 mm machine guns as their principal gun to provide a defensive gunfire capability for the engagement of a variety of smaller surface targets. These ships, as well as the CG, DDG, FFG, and CVN are also equipped with .50 cal or 7.62 mm machine guns.

Basic Phase (Unit Level Training) Scenario

Ships use machine guns to practice defensive marksmanship, typically against non-maneuvering floating targets. Targets are engaged after closing the target to within about 2,000 yards for 25 mm, 900 yards for .50 cal, and 400 yards for 7.62 mm; between 200 and 800 rounds are typically expended.

The target is typically a Floating At-Sea Target (FAST), a MK-58 smoke, or a steel drum. Targets are expended during the exercise and are not recovered.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])

Strike fighter and maritime patrol aircraft deliver bombs against surface maritime targets, day or night, with the goal of destroying or disabling enemy ships or boats.

Table D-16: Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SURFACE WARFARE (SUW)						
BOMBEX (Air to Surface)	Fixed Wing Fighter/Bomber/MPA (MK 58 Smoke tgt. or towed sled or small hull target)	MK-82/83/84 series and JDAM (Live Rounds)	1 round	4 / year (1 round /qrtr.)	4 / year (1 round /qrtr.)	PRI: W-517, >50 nm from land SEC: MI Maritime, >50 nm from land; ATCAAs
BOMBEX (Air to Surface) Inert Only	Fixed Wing Fighter/Bomber/MPA (MK 58 Smoke tgt. or towed sled)	MK 82 I; BDU-45; MK 76; JDAM (Inert Rounds)	16 (48 rounds)	24 (72 rounds)	30 (90 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs

<u>Fixed Wing Aircraft with Unguided or Precision-guided Munitions</u>

Unguided munitions: MK-76 and BDU-45 (inert training bombs); MK-80 series (inert or live); MK-20 Cluster Bomb (inert or live).

Precision-guided munitions: Laser-guided bombs (LGB) (inert or live); Laser-guided Training Rounds (LGTR) (inert); Joint Direct Attack Munition (JDAM) (inert or live) GPS guidance.

Basic Phase (Unit Level Training) Scenario

A flight of two aircraft will approach the target from an altitude of between 15,000 ft to less than 3,000 ft and, when on an established range, will adhere to designated ingress and egress routes. Typical bomb release altitude is below 3,000 ft and within a range of 1000 yards for unguided munitions, and above 15,000 ft and in excess of 10 nm for precision-guided munitions. Laser designators from either own aircraft, a support aircraft, or ground support personnel are used to illuminate certified targets for use with lasers when using laser guided weapons.

Integrated and Sustainment Phase Training Scenarios

Typically involves an at-sea simulated strike scenario with a flight of four or more aircraft, with or without a designated opposition force (OPFOR).

Training Considerations

Strike fighter pilots can fulfill this training requirement against either a land or water target.

Unguided munitions: Usually conducted at land ranges with inert or live ordnance, or water ranges with ship hulks available for targets. MK-76 and BDU-48 inert bombs are the most common weapon allocation.

Precision-guided munitions: The very large safety footprints of these bombs limit their employment to impact areas on large land ranges, such as the Fallon Training Range Complex, or at-sea during a Sinking Exercise (SINKEX) or BOMBEX.

P-3C and P-8A Maritime Patrol Aircraft (MPA) with Unguided Munitions

Unguided munitions: BDU-45 inert bomb; MK-82 (500 lb bomb) (inert or live); MK-20 (Rockeye cluster bomb) (inert or live); CBU-99 (cluster bomb) (inert or live).

Basic Phase (Unit Level Training) Scenario

MPA use bombs to attack surfaced submarines and surface craft that would not present a major threat to the MPA itself. The MPA is larger and slower than a strike fighter aircraft (e.g. F/A-18), so its bombing tactics differ markedly. A single MPA approaches the target at a low altitude. In most training exercises, it drops inert training munitions, such as the BDU-45 on a MK-58 smoke float used as the target.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except that a more realistic target may be available and live ordnance may be expended, such as during a SINKEX.

Training Considerations

MPA pilots can fulfill this training requirement against either a land or water target, but it is usually conducted within the Warning Area above a water range with inert ordnance against a MK-58 smoke as the target.

The annual ordnance expenditure allocation typically authorizes only a very limited number of live munitions.

Gunnery Exercise (Air-to-Surface) (GUNEX [A-S])

Strike fighter aircraft and helicopter crews, including embarked Naval Special Warfare personnel use guns to attack surface maritime targets, day or night, with the goal of destroying or disabling enemy ships, boats, or floating or near-surface mines. Typical event lasts 1 to 2 hours.

Table D-17: Gunnery Exercise (Air-to-Surface) (GUNEX [A-S])

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SURFACE WARFARE						
GUNEX Air-to-Surface	SH-60; HH-60; MH-60R/S; UH-1; CH-53; FA-18; AH-1W; F-15; F16; F-22; F-35; AV-8B; A-10 (Barrel or MK-58 smoke tgt.)	7.62 mm MG	150 (30,000 rounds)	200 (40,000 rounds)	200 (40,000 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs
		.50 cal MG	10 (2,000 rounds)	20 (4,000 rounds)	20 (4,000 rounds)	
		20 mm cannon	50 (5,000 rounds)	100 (10,000 rounds)	100 (10,000 rounds)	
		25 mm cannon	10 (1,000 rounds)	40 (4,000 rounds)	40 (4,000 rounds)	
		30 mm cannon	0	15 (1,500 rounds)	15 (1,500 rounds)	

F/A-18C/E/F with Vulcan M61A1/A2 20 mm Cannon

Basic Phase (Unit Level Training) Scenario

A flight of two aircraft will begin its descent to the target from an altitude of about 3,000 ft while still several miles away. Within a distance of 4,000 ft from the target, each aircraft will fire a burst of about 30 rounds before reaching an altitude of 1,000 ft, then break off and reposition for another strafing run until each aircraft expends its exercise ordnance allowance of about 250 rounds.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

Strike fighter pilots can fulfill this training requirement against either land (most often) or water targets, or at specially prepared floating ship hulks during the occasional Sinking Exercise (SINKEX). F/A-18s will only rarely strafe into open ocean.

MH-53, HH-60H, MH-60R/S, SH-60B/F Helicopters with Side Door-Mounted .50 cal and 7.62 mm Machine Guns

Basic Phase (Unit Level Training) Scenario

Typically, a single helicopter will carry several air crewmen needing gunnery training and fly at an altitude between 50 ft to 100 ft in a 300 ft racetrack pattern around an at-sea target. Each gunner will expend about 200 rounds of .50 cal and 800 rounds of 7.62 mm ordnance in each exercise. The target is normally a non-instrumented floating object such as an expendable smoke float, but may be a remote controlled speed boat or jet ski type target if available. Gunners will shoot special target areas or at towed targets when using a remote controlled target to avoid damaging them. The exercise lasts about 1 hour.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

HH-60H, MH-60S, and SH-60F have a mission to support NSW operations, so they will also train with embarked NSW personnel. NSW personnel use .50 cal, 7.62 mm, and hand-held weapons firing 40 mm grenades during this exercise.

Local Training Considerations

GUNEX (A-S) operations are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would use either 7.62mm or .50 caliber door-mounted machine guns. Interviews with HSC-25 (MH-60S) indicate that GUNEX (A-S) training occurs frequently in the MIRC Offshore Areas other than W-517.

Anti-Submarine Warfare (ASW) - Helicopters, Maritime Patrol Aircraft, Surface Ships, and Submarines

Maritime patrol aircraft, helicopters, surface ships, and submarines search for threat submarines with active and passive sonar and sonobuoys, develop a firing solution and use torpedoes to attack and destroy the threat submarine.

ASW Mission

The search and attack mission may be conducted by individual platforms or in various combinations of all four platform types, but the ASW prosecution will go through six specific phases to complete the search and attack mission:

- Search - As naval units move from one location to another they employ their available sensors and tactics of systematic reconnaissance to find the anticipated threat along their route or within a defined ocean area.
- Detect - The initial result of a sensor's perception of an object of possible interest, but the object's identification still needs to be determined.
- Classify - The determination that the object that has been detected by the sensor is a probable submarine.
- Localize - Tactics are used to determine the exact location of the probable submarine.
- Track - A series of sensor localizations over a period of time creates a path from which the sensor operator may determine the probable submarine's course and speed. This information is used to create a firing solution, e.g. where to send the torpedo.
- Neutralize - A torpedo is launched toward the position of the probable submarine and it is destroyed.

ASW Sensors

Hull Mounted Sonar:

- Surface ships have hull mounted sonar with both active and passive capabilities. The CG and DDG classes have the AN/SQS-53 and the FFG class has the AN/SQS-56. Both are mid-frequency active sonar.
- AN/BQQ-5 is mid-frequency active and passive bow-mounted sonar, used by SSN 688 class submarines.
- AN/BQQ-6 is a passive only sonar used by the Ohio class SSBN submarines
- AN/BQQ-10 is a sonar system upgrade to the older AN/BQQ-5 and BQQ-6 systems, and has been installed or has been scheduled for integration onto Los Angeles, Seawolf, Virginia (AN/BQQ-10(V4) model), Ohio and SSGN-class submarines. It integrates and improves towed array, hull array, sphere array, and other ship sensor processing while enhancing fidelity. Since program inception in 1998, AN/BQQ-10 systems have been installed on over 40 submarines.

Towed Array Sonar: this is a passive sonar system that is simply a long cable full of microphones that is towed behind the ship. Passive sonar is a listening device that uses hydrophones to receive, amplify, and process underwater sounds. The advantage of passive sonar is that it places no sounds in the water, so it does not reveal the location of the ship towing the sonar.

- AN/SQR-19 is the towed array sonar used by surface ships (CG, DDG, and FFG).
- TB-23 and TB-29 are towed arrays used by SSN.

Dipping Sonar:

- AN/AQS-22 Airborne Low Frequency Sonar (ALFS) is an active and passive sonar system used by the MH-60R helicopter. The active sonar operates in the mid-frequency range.
- AN/AQS-13 is an active sonar system used by the SH-60F helicopter. The sonar is deployed on a 1,575 ft cable while the helicopter hovers about 60 ft above the water.

Sonobuoys: can be either active or passive. Multiple sonobuoys are deployed at one time in different patterns depending on the tactical situation. The sonobuoys sink after their battery is exhausted.

- Active sonobuoys transmit electronic mid-frequency sound waves (sonar) that reflect off the target submarine and are received by the sonobuoy.
- Passive sonobuoys only receive target submarine noise signals transmitted through the water from equipment in the submarine, such as engine noise.
- Explosive Echo Ranging (EER) and the Improved Explosive Echo Ranging (IEER) sonobuoy systems consist of two separate sonobuoys employed together to locate a target submarine. One sonobuoy is an active “explosive” buoy that creates an acoustic sound source from the explosion of 4.2-lbs of high explosives. The active buoy contains two 4.2-lb sources that are detonated at separate times to extend the life of the buoy. The other sonobuoy is an air deployable active receiver (ADAR) passive buoy placed several miles away from the active buoy. It receives echoes reflected from the target submarine that were created by the active buoy's explosive source.
- Acoustic Extended Echo Ranging (AEER) sonobuoy (AN/SSQ-125) is a system that uses the same ADAR sonobuoy as the EER/IEER acoustic receiver and is used for a large area ASW search capability in both shallow and deep water. However, instead of using explosives as an impulsive source for the active acoustic wave, the AEER system uses a battery powered (electronic) acoustic source. AAER is intended to replace the EER/IEER's use of explosives and is scheduled to enter the fleet in 2011.
- SURTASS LFA ships may operate in support of naval strike groups in major exercises; however they typically operate independently of the naval strike group. Independent LFA activities are covered in the LFA FEIS. SURTASS LFA sonar systems are long-range sonars that operate day or night in most weather conditions in the low frequency range of 100 to 500 hertz (Hz). The SURTASS LFA system consists of an active component and a passive component. The active component of the system, LFA, is a set of low frequency acoustic transmitting source elements (called projectors) suspended by cable from underneath the ship. These projectors produce the active sonar signal or “ping.” The passive or listening component of the system is SURTASS, which detects returning echoes from submerged objects, such as Opposition Force submarines. The returning signals are received through hydrophones that are towed behind the ship on a receiving array. The long-range capability of the sensitive receiving array and onboard acoustic processing provides a large geographic area of protection and submarine detection (Department of the Navy 2001). This information is provided to naval Strike Groups to then determine the appropriate response including the possible use of ASW capable ships and other ASW capable aircraft, including helicopters and P-3 aircraft.

Radar is used by most ASW capable units to watch for periscopes and other masts that the submarine may expose.

Magnetic Anomaly Detector (MAD) is used by MPA and the SH-60B helicopter, and is a passive receiver used to detect natural and manmade differences in the Earth's magnetic field. MAD sensor operation is similar in principle to the metal detector used by treasure hunters on beaches. When the MAD sensor passes over or very near to a submarine, the submarine's disturbance of the Earth's magnetic field is detected, and the submarine's position is pinpointed.

ASW Platforms

Aircraft:

- The P-3C and P-8A Maritime Patrol Aircraft are land based, long range, fixed-winged aircraft. Their ASW sensors include radar, Magnetic Anomaly Detector (MAD), and up to 84 active, EER, and passive sonobuoys. Of these sensors, only sonobuoys enter the water.
- The SH-60B, operates from cruisers, destroyers, and frigates, has a search radar, MAD, and carries 25 active and passive sonobuoys, but usually drops only 8-14 in a given exercise.
- The SH-60F operates from aircraft carriers and employs a search radar, active or passive dipping sonar rather than MAD, and carries only 14 active or passive sonobuoys.
- The MH-60R combines the capabilities of the SH-60B and SH-60F, with search radar and active and passive sonobuoys, and employs a new, low frequency, active and passive dipping sonar, the AN/AQS-22 Airborne Low Frequency Sonar (ALFS).

Surface Ships:

- Cruisers (CG)
- Guided Missile Destroyers (DDG)
- Guided Missile Frigates (FFG).
- T-AGO class SURTASS LFA vessels.

Ship ASW sensors include passive hull-mounted and towed array sonar that put no acoustic energy in the water, active hull-mounted mid-frequency sonar, and SH-60B or MH-60R helicopters if the specific ship has a helicopter embarked.

Submarines:

- Attack Submarine (SSN)
- Guided Missile Submarine (SSGN)
- Ballistic Missile Submarine (SSBN).

The SSN is the principal ASW attack submarine, but each class submarine must train to the ASW mission. Submarine ASW sensors are principally passive hull-mounted and towed array sonar, and secondarily, hull-mounted mid-frequency active sonar, which is seldom used.

ASW Ordnance

ASW platforms use the following ordnance to neutralize enemy submarines:

Lightweight Torpedoes: The navy is phasing out the MK-46 torpedo and is expected to completely replace it with the MK-54 by 2012. The MK-54 has improved guidance and warhead systems over the MK-46. Helicopters, MPA, and surface ships all use variants of these torpedoes. Although the different launching methods will involve different supporting expendables (parachutes, rocket boosters, nose caps, etc.), the torpedo is the same once it has entered the water. There are typically two types of torpedoes used in exercises:

- Practice Torpedo Exercise Shape. The recoverable exercise torpedo (REXTORP) is just a torpedo shape with no internal propulsion or guidance mechanisms that allows crews to practice loading and launching the torpedo.
- Exercise Torpedo (EXTORP). The EXTORP is a recoverable, functional torpedo with an inert exercise warhead that contains data collection instrumentation. This exercise torpedo functions like a real torpedo, using active and passive acoustic homing to attack the target, but turns away so as not to hit the target. Once the EXTORP is recovered, the instrumentation may be accessed

at the land based torpedo shop to provide data that will give an indication as to whether the torpedo would have hit the target.

REXTORPS are used more often than EXTORPS because of a number of exercise constraints, including higher costs and safety requirements, on the use of EXTORPS.

Heavyweight Torpedo: The MK-48 exercise torpedo is used only by submarines (SSN, SSGN, SSBN) and has both an anti-surface and Anti-Submarine capability. It is wire guided (command controlled from the submarine) and has an active and passive homing capability. This torpedo is most frequently used on instrumented underwater tracking ranges to ensure the best training feedback to submarine crews. Use of the exercise MK-48 requires special recovery support assets such as special helicopters or vessels equipped for their recovery, which also requires that they be used only during daylight.

ASW Targets and Pingers

ASW training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures; (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and (3) magnetic sources to trigger magnetic detectors.

There are three principal targets used in ASW training exercises:

- One or more submarines is the most desirable target because it provides the most realistic training and can be augmented to simulate typical threat submarines that could be encountered.
- MK-39 Expendable Mobile ASW Training Target (EMATT). This expendable target is small enough to be launched by hand from a surface ship, aircraft or helicopter using the target. It provides a sound source for passive tracking, or a return echo to active sonar.
- MK-30 Mobile ASW Target. This target is principally used only on instrumented ranges as it requires range support for launching and recovery. It too provides a sound source for passive tracking, or a return echo to active sonar. The MK 30 target is a torpedo-like, self-propelled, battery powered underwater vehicle capable of simulating the dynamic, acoustic, and magnetic characteristics of a submarine. The MK-30 is 21 inches in diameter and 20.5 feet in length. It is launched by aircraft and surface vessels and can run approximately four hours depending on the programmed training scenario. The MK 30 is recovered after the exercise for reconditioning and subsequent reuse. The MK 30 has no discharges into the environment.

Any of these targets may be tasked within their capability to be non-evasive, operate on a specified track, make simple course or depth maneuvers, or be fully evasive depending on the state of training of the ASW unit and the training objectives to be achieved. The MK-39 and MK-30 targets may be used for exercise torpedo firings. Some live submarines may also be used as exercise torpedo targets, but there are special requirements and special authorizations required before a live submarine can be assigned as a target for an inert torpedo firing.

MK-84 range pingers, used in association with the Portable Undersea Tracking Range (PUTR), are active acoustic devices that allow ships, submarines, and target simulators to be tracked by means of deployed hydrophones and transponders. The signal from a MK-84 pinger is very brief (15 milliseconds) with a selectable frequency at 12.9 kHz or 37 kHz and a source level of approximately 194dB SPL.

The PUTR is a new underwater range tracking system that supports ASW TRACKEX and TORPEX training. PUTR Baseline (1) can be temporarily deployed in forward deployed training areas with 10 transponders, seven deployed on the seafloor and three held in reserve. The PUTR system includes a supporting range control boat and processing equipment. PUTR tracks up to four MK-84 pingers using seven transponders anchored in a hexagon configuration at depths between 400 meters and 3500 meters. The transponders uplink their reports to the range control processor on the range support boat. The transponder uplink frequency is selectable at either 8.8 kHz (186 dB SPL) or 40 kHz (190 dB SPL). Depending on the depth of deployment and spacing of the transponders, the range size can be between 4 nmi^2 to 100 nmi^2.

ASW Basic Training Scenarios

It is important to understand that, in most cases, all phases of ASW prosecution (search, detection, classification, localization, tracking, and neutralization) are done in both the ASW Tracking Exercise (TRACKEX) and ASW Torpedo Exercise (TORPEX); the difference is the amount of time spent in the first five phases and the last. In the ASW TRACKEX, the goal is training in the search, detection, classification, localization, and tracking process, while the goal of the ASW TORPEX is to proceed quickly through these first five phases and focus on neutralization of the target through the launching of a torpedo. Besides the training goal, the principal factors that drive this timing are usually the battery life of the torpedo target and the torpedo recovery support requirements, which include a low sea state and several hours of daylight to ensure recovery of the exercise torpedo before sunset. No torpedo is fired during an ASW TRACKEX unless it is coupled with an ASW TORPEX.

ASW Integrated and Sustainment Phase Training Scenarios

These scenarios involve coordinated ASW operations where multiple ships, helicopters, and maritime patrol aircraft operate together to prosecute an ASW threat and defend the elements of the strike group. The combination of a variety of sensors and the capability of the aircraft to cover large areas quickly and employ ASW weapons at greater ranges is a significant advantage over single platform operations.

Coordinated operations may also include a friendly submarine as part of the force. While this added sensor is extremely valuable, it adds complications to the exercise to ensure that a weapon is not dropped on the friendly submarine.

The goal of exercises conducted in these phases is to gain the experience of working with additional forces and coordinating several similar and dissimilar platforms to work together with information provided from other units to destroy the threat submarine.

One or more live submarines will typically be used as the threat for these phases. A phase could last from four to six hours during unit or sustainment training or from 12 to 16 hours or longer during major integrated ASW exercises.

Training Considerations

Basic Phase ASW TRACKEXs are preferred to be conducted on an Undersea Warfare Training Range (USWTR), but the scarcity of USWTRs, distances from homeports to those that do exist, and exigencies of deployment schedules conspire to ensure that most do not occur over an USWTR.

Integrated and Sustainment Phase ASW TRACKEXs rarely occur over USWTRs since major fleet training exercises require ocean areas much larger than an USWTR.

Anti-Submarine Warfare Tracking Exercise–Helicopter (ASW TRACKEX-Helo)

Helicopters use their sensors to search, detect, classify, localize and track a threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.

Table D-18: Anti-Submarine Warfare Tracking Exercise–Helicopter (ASW TRACKEX-Helo)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TRACKEX (HELO)	SH-60B, SH-60F SUB/ MK-30/ EMATT	AQS-22 DICASS	9 Events; 2 hours/helo	18 Events; 2 hours/helo	62 Events; 2 hours/helo	PRI: W-517 SEC: MI Maritime, >3 nm from land

<u>**SH-60B with Sonobuoys and MAD**</u>

<u>**SH-60F or MH-60R with Sonobuoys and Dipping Sonar**</u>

Basic Phase (Unit Level Training) Scenario

A single helicopter will typically drop its sonobuoys from an altitude below 3,000 ft into specific patterns designed for both the anticipated threat submarine and the specific water conditions. These patterns will cover many different size areas, depending on these two factors. Passive sonobuoys will be used first, so that the threat submarine is not alerted to the fact that someone is searching for it. Active buoys will be used as required either to locate extremely quiet submarines or to further localize and track submarines previously detected by passive buoys. The use of EER sonobuoys is similar to that of other sonobuoys except for how the field is positioned, the tactics of which are classified. The helicopter will typically operate below 3,000 ft during the entire operation, going to about 1,500 ft to monitor buoys already dropped.

The dipping sonar is employed from an altitude of about 50 ft after the search area has been narrowed from the initial passive sonobuoy search. The passive sonar from the MH-60R is used before its active mode or before the active sonar from the SH-60F is used, just as the passive sonobuoys are used before the active sonobuoys.

As the location of the submarine is further narrowed, MAD is used by the SH-60B to further confirm and localize the target's location.

The target for this exercise is either an EMATT or live submarine and may be either non-evading and assigned to a specified track, or fully evasive depending on the state of training of the helicopter. A TRACKEX-Helo usually takes one to two hours.

Integrated and Sustainment Phase Training Scenarios

Integrated and sustainment phase scenarios do not typically differ from the description of the unit level phase scenario, except that additional helicopters, maritime patrol aircraft, or surface ships may participate together, using their sensors and weapon capabilities, as a coordinated operation.

Anti-Submarine Warfare Tracking Exercise–Maritime Patrol Aircraft (ASW TRACKEX-MPA)

MPA use their sensors to search, detect, classify, localize and track a threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.

Table D-19: Anti-Submarine Warfare Tracking Exercise-Maritime Patrol Aircraft

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TRACKEX (MPA)	FIXED WING MPA SUB/ MK-30/ EMATT	DICASS EER/IEER/AEER	5 Events; 4 hours/MPA	8 Events; 4 hours/MPA	17 Events; 4 hours/MPA	PRI: W-517 SEC: MI Maritime, >3 nm from land

MPA with Sonobuoys and MAD

Basic Phase (Unit Level Training) Scenario

A single MPA drops its sonobuoys from an altitude below 3,000 ft into specific patterns designed for both the anticipated threat submarine and the specific water conditions. These patterns will cover many different size areas, depending on these two factors. Passive sonobuoys will be used first, so that the threat submarine is not alerted to the fact that someone is searching for it. Active buoys will be used as required either to locate extremely quiet submarines, or to further localize and track submarines previously detected by passive buoys. The use of EER sonobuoys is similar to that of other sonobuoys except for how the field is positioned, the tactics of which are classified. While the MPA will typically operate below 3,000 ft to drop sonobuoys, perhaps as low as 1,000 ft, it will climb to several thousand feet and fly in a pattern over the buoy field to best monitor the buoys. A MPA sonobuoy field pattern will typically be much larger than a helicopter pattern, as the MPA can carry and deploy more buoys than a helicopter, and can monitor 31 buoys at one time. The higher altitude allows monitoring the buoys over a much larger search pattern area.

MAD is used principally during the localization phase to further confirm a more exact target location moments before weapons launch, although there are no weapons used in this tracking exercise. The MPA will fly within a few hundred feet above the best estimated position of the threat submarine as close proximity is required to best employ MAD.

The target for this exercise is either an EMATT or live submarine and may be either non-evading and assigned to a specified track or fully evasive depending on the state of training of the MPA. A TRACKEX-MPA usually takes two to four hours.

Integrated and Sustainment Phase Training Scenarios

Integrated and sustainment phase scenarios do not typically differ from the description of the unit level phase scenario, except that additional helicopters, MPA, or surface ships may participate together, using their sensors and weapon capabilities, as a coordinated operation.

Anti-Submarine Warfare Tracking Exercise–Surface (ASW TRACKEX-Surface)

Surface ships use their sensors to search, detect, classify, localize and track a threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.

Table D-20: Anti-Submarine Warfare Tracking Exercise-Surface (ASW TRACKEX-Surface)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TRACKEX (SHIP)	CG/ DDG / FFG SUB/ MK-30/ EMATT	SQS-53C/D SQS-56	10 Events; 4 hours/ship	30 Events; 4 hours/ship	60 Events; 4 hours/ship	PRI: W-517 SEC: MI Maritime, >3 nm from land

CG, DDG, FFG with Hull Mounted and Towed Array Sonar

Basic Phase (Unit Level Training) Scenario

A single surface ship will operate between about 5 and 15 kts while employing its hull mounted and/or towed array sonars. Passive or active sonar will be employed depending on the type of threat submarine, the tactical situation, and sonar range of the day calculations, as determined by varying water conditions. Active sonar transmits at varying power levels, pulse types, and intervals, while passive sonar listens for noise emitted by the threat submarine. Passive sonar is typically employed first so as not to alert the threat submarine, followed by active sonar, if required, to determine a more exact location of the target. Active sonar may be employed during the search phase against an extremely quiet submarine or in situations where the water conditions do not support good passive reception. The surface ship will approach the threat submarine to between 10 nm and 1,000 yards during training.

The target for this exercise is either an EMATT or live submarine and may be either non-evading and assigned to a specified track or fully evasive depending on the state of training of the ship. There is no torpedo fired in this exercise. An ASW TRACKEX-Surface usually lasts two to four hours.

Integrated and Sustainment Phase Training Scenarios

Integrated and sustainment phase scenarios do not typically differ from the description of the unit level phase scenario, except that the surface ship will usually be working in conjunction with additional helicopters, MPA, or surface ships, using their sensors and weapon capabilities together in a coordinated operation.

Anti-Submarine Warfare Tracking Exercise–Submarine (ASW TRACKEX-Sub)

Submarines use their sonar sensors to search, detect, classify, localize and track the threat submarine with the goal of developing a firing solution that could be used to launch a torpedo and destroy the threat submarine.

Table D-21: Anti-Submarine Warfare Tracking Exercise-Submarine (ASW TRACKEX-Sub)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TRACKEX (SUB)	SSN; SSGN MK-30	BQQ	5 Events; 4 hours /sub	10 Events; 4 hours /sub	12 Events; 4 hours /sub	PRI: Guam Maritime, >3 nm from land SEC: W-517

<u>SSN, SSGN, SSBN with Hull Mounted and Towed Array Sonar</u>

Basic Phase (Unit Level Training) Scenario

A single submerged submarine operates at slow speeds and various depths while using its hull mounted and/or towed array sonar to search, detect, classify, localize, and track the submerged threat submarine. During submarine versus submarine TRACKEXs, passive sonar is used almost exclusively. Active sonar use is very rare because it reveals the tracking submarine's presence to the target submarine.

Typically, this exercise is conducted by two submarines, but in the event a second submarine is not available, a MK-30 Mobile ASW Target or EMATT may also be used as a target. If feasible this exercise may be conducted on an USWTR so that both submarines and targets can be tracked by the range and the submarine crews can be debriefed at the completion of the exercise. The debrief adds to a full understanding of what actually occurred during the exercise and improves the quality of the training received. There is no torpedo fired in this exercise. A TRACKEX-Submarine usually lasts two to four hours.

Integrated and Sustainment Phase Training Scenarios

Integrated and sustainment phase scenarios do not typically differ from the description of the unit level phase scenario, except that two or more friendly submarines or one submarine and a surface ship may operate together to prosecute the threat submarine. *Anti-Submarine Warfare Torpedo Exercise–Helicopter (ASW TORPEX-MPA/Helo)*

Helicopters or MPA deliver torpedoes against threat submarines with the goal of destroying the submarine.

Table D-22: Anti-Submarine Warfare Torpedo Exercise-Helicopter (ASW TORPEX-MPA/Helo)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TORPEX (MPA / HELO)	MPA / SH-60B/F, SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	AQS-22 / DICASS EXTORP/ REXTORP	0	4 events; 2 hours	8 events; 2 hours	PRI: Guam Maritime, >3 nm from land SEC: W-517

<u>SH-60B, SH-60F, or MH-60R or MPA with MK-46 or MK-54 REXTORP or EXTORP</u>

Basic Phase (Unit Level Training) Scenario

A single helicopter or MPA uses its sensors to localize and track the threat submarine and develop a firing solution. The aircraft then flies to a drop point about 150 ft above the water and releases the torpedo. Torpedoes are only released during the day and are recovered before sunset. A helicopter is typically based on a CG, DDG, or FFG class ship and a helicopter or MPA may conduct this range operation in conjunction with a ship's tracking or torpedo exercise. This exercise typically lasts one to two hours. It follows the same initial procedures of an ASW TRACKEX, but quickly advances into the neutralization phase with the actual drop of a REXTORP or EXTORP. The target is typically an EMATT or MK-30 target.

Anti-Submarine Warfare Torpedo Exercise–Surface (ASW TORPEX-Surface)

Surface ships deliver torpedoes against threat submarines with the goal of destroying the submarine.

Table D-23: Anti-Submarine Warfare Torpedo Exercise-Surface (ASW TORPEX-Surface)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TORPEX (SHIP)	CG/ DDG / FFG SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	SQS-53C/D SQS-56 EXTORP/ REXTORP	0	3 Events; 4 hours	6 Events; 4 hours	PRI: Guam Maritime, >3 nm from land SEC: W-517

CG, DDG, or FFG with MK-46, MK-50, or MK-54 REXTORP or EXTORP

Basic Phase (Unit Level Training) Scenario

A single surface ship uses its sensors to localize and track the threat submarine and develop a firing solution. The ship then proceeds to a position where the torpedo can be launched from either the surface vessel torpedo tube (SVTT) MK 32 or the vertical launch rocket thrown torpedo (RTT) cell. The RTT is the same torpedo as the tube launched torpedo once it enters the water, as previously discussed, but it is delivered to the water entry point by a rocket booster. Torpedoes are only released during the day and are recovered before sunset.

This exercise typically lasts about two to four hours. It follows the same initial procedures of an ASW TRACKEX-Surface, but quickly advances into the neutralization stage with the actual launch of a REXTORP or EXTORP. The target is typically an EMATT or MK-30 target.

Anti-Submarine Warfare Torpedo Exercise–Submarine (ASW TORPEX-Sub)

Submarines deliver torpedoes against threat submarines with the goal of destroying the threat submarine.

Table D-24: Anti-Submarine Warfare Torpedo Exercise-Submarine (ASW TORPEX-Sub)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI SUBMARINE WARFARE (ASW)						
ASW TORPEX (SUB)	SSN; SSGN MK-30 TRB / MH-60S	BQQ MK-48 EXTORP	5 Events; 4 hours	10 Events; 4 hours	12 Events; 4 hours	PRI: Guam Maritime, >3 nm from land SEC: W-517

SSN, SSGN, SSBN with MK-48 Exercise Torpedo

Basic Phase (Unit Level Training) Scenario

A single submerged submarine uses its sensors to localize and track the threat submarine and develop a firing solution. The submarine then proceeds to a position where the torpedo can be launched up to a maximum range of 35,000 yards from the threat submarine. Torpedoes are only released during the day and are recovered before sunset.

This exercise typically lasts one to two hours. It follows the same initial procedures of an ASW TRACKEX-Sub but quickly advances into the neutralization stage with the actual launch of a MK-48 exercise torpedo. The target is typically a MK-30 Mobile ASW Target or an EMATT.

Training Considerations

This exercise is ideally conducted on an instrumented range, but it may be conducted in other operating areas depending on training requirements and available assets. The MK-48 exercise torpedo requires recovery support assets such as special helicopters or vessels equipped for their recovery.

Air Intercept Control (AIC)

Surface ships, fixed-winged aircraft, or air control facilities use their air search radar capability to direct strike fighter aircraft toward threat aircraft where the threat aircraft may be engaged and destroyed by the strike fighter's missiles or guns.

Ships, Airborne Early Warning (AEW) Aircraft, and Air Control Facilities with Air Search Radar

Unit Level Training Scenario

The goal of the AIC exercise is the training of both the controllers and the aircraft pilots to intercept and simulate destruction of an opposing aircraft with own force aircraft using either the aircraft's missile or gun systems.

Air intercept controllers embarked in ships, AEW aircraft, or in air control facilities use their air search radars to track both the friendly strike fighter interceptor and the threat aircraft at altitudes typically well above 15,000 ft. Friendly and threat aircraft may be 100 nm apart at the start of this exercise. When the threat aircraft is detected by the controller's air search radar, a course and speed is provided to the strike fighter to intercept and engage the threat aircraft. Speeds in excess of 450 kts may be used. No high explosive ordnance is used, but captive carry training missile (CATM) may be used when strike fighters participate, and thereby complete MISSILEX (A-A) or GUNEX (A-A) exercises. Several intercepts are usually conducted over one to two hours.

When fleet aircraft are not available for this training, commercial air services aircraft ***can be*** used to provide the level of training required by controllers.

Coordinated Event and Major Exercise Training Scenarios

Typically do not differ from the Unit Level Scenario, except that two to four interceptors may be directed toward larger numbers of threat aircraft.

Table D-25: Air Intercept Control (AIC)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AIR WARFARE (AW)						
Air Intercept Control	Fixed Wing Aircraft, *e.g.* FA-18; F-15; F-35	Search and Fire Control Radars	40 sorties (2-4 aircraft) 20 events	80 sorties (2-4 aircraft) 40 events	100 sorties (2-4 aircraft) 50 events	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs

Air Combat Maneuver (ACM)

Strike fighter aircraft perform intricate flight maneuvers to achieve a gun or missile firing position from which an attack can be made on a threat aircraft with the goal of destroying the adversary aircraft.

ACM is the general term used to describe an air-to-air (A-A) event involving two or more aircraft. These aircraft may be similar or dissimilar. Aircraft are considered similar if they are of the same aircraft type and model. For example, an F/A-18C is similar to an F/A-18E, whereas an F/A-18 and an F-15 are dissimilar.

Unit Level ACM training consists of three levels: Basic Fighter Maneuvering (BFM), intermediate level Offensive Counter Air (OCA), and Defensive Counter Air (DCA) training. No live-weapons are fired during ACM operations.

BFM: during BFM, two aircraft (one vs. one) will engage in offensive and defensive maneuvering against each other.

OCA and DC: during OCA or DCA training, three or more aircraft (one vs. two, two vs. two, or three vs. one) will engage in offensive and defensive maneuvering. Participating aircraft will be separated at the start by distances up to 50 nm. During OCA training, a force of two or more aircraft will attempt to establish and maintain air superiority over a defined battle space by defeating a force of defending aircraft. During DCA training, a force of two or more aircraft will attempt to retain air superiority over a defined battle space by defeating a force of aggressor aircraft. Unit level OCA and DCA training, which is a precursor to joint and combined integrated range operations, involves high airspeeds (from high subsonic to supersonic) and rapidly changing aircraft altitudes and attitudes.

Table D-26: Air Combat Maneuver (ACM)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AIR WARFARE (AW)						
AIR COMBAT MANUEVERS (ACM)	Fixed Wing Aircraft, e.g. FA-18; F-35; AV-8B; F-15; F16	Captive Air Training Missile (CATM) or Telemetry Pod	360 sorties of 2-4 aircraft per sortie	720 sorties of 2-4 aircraft per sortie	840 sorties 2-4 aircraft per sortie	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs

Fighter Aircraft with Captive Carry Training Missiles (CATM-9)

Basic Phase (Unit Level Training) Scenario

Typically two aircraft, operating from 5,000 to 30,000 ft, begin their maneuvers from a separation distance of 2 to 3 nm and, throughout an “engagement,” will normally not separate beyond visual range (6 to 8 nm). Aircraft airspeeds will range from very low (less than 100 kts) to high subsonic (less than 600 kts). Their maneuvers will be continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed to gain advantage over the adversary aircraft, resulting in its simulated destruction from guns or missiles. Maneuvers will last for about one hour.

The training scenario builds through several separate basic levels as the pilot becomes more experienced and will include:

- Defensive fighter maneuvers - one vs. one adversary is described above
- High aspect fighter maneuvers - one vs. one adversary that starts from a offensive, defensive or neutral position

- Dissimilar fighter maneuvers - one vs. one adversary of a different type of adversary aircraft
- Section fighter maneuvers - two vs. one adversary or more.

Integrated and Sustainment Phase Training Scenarios

Typically not conducted during these phases; these scenarios do not normally have adversary aircraft operating within visual range of friendly aircraft.

Training Considerations

The preferred ACM training location is on a Tactical Aircrew Training System (TACTS) Range located within a Warning Area or Restricted Airspace; TACTS is not available in the MIRC. TACTS equipped range airspaces are designed to keep other aircraft clear of the area where military aircraft are conducting operations and thereby allow safe operations. The TACTS range has the capability to precisely track and record the location of aircraft conducting maneuvers on the range. This capability provides excellent data for feedback that is used to debrief the aircraft crews after their training. The TACTS system is being replaced by a new system called Tactical Combat Training System (TCTS); Carrier Air Wing Five, stationed in Japan, is scheduled to receive TCTS. It essentially provides the same service, but it can more precisely locate each aircraft on the range, is portable and organic to the air wing, and has a longer range capability than TACTS. The training aircraft must still conduct their training within a Warning or Restricted Area, but more of the area is now available because of the new technology available in TCTS.

Missile Exercise (Air-to-Air) (MISSILEX [A-A])

Strike fighter aircraft attack a simulated threat target aircraft with its air-to-air missile with the goal of destroying the other aircraft.

Table D-27: Missile Exercise (Air-to-Air) (MISSILEX [A-A])

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AIR WARFARE						
MISSILEX / GUNEX Air-to-Air	Fixed Wing Aircraft, e.g. FA-18; F-35; EA-18; AV-8B. TALD tgt.	AIM-7 Sparrow (Non Explosive). 20mm or 25 mm cannon.	4 sorties (2-4 aircraft) (4 missiles; 1,000 rounds)	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	8 sorties (2-4 aircraft) (8 missiles; 2,000 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
		AIM-9 Sidewinder (HE)/AIM-120 (HE or Inert). 20mm or 25 mm cannon.	4 sorties (2-4 aircraft) (4 missiles; 1,000 rounds)	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	8 sorties (2-4 aircraft) (8 missiles; 2,000 rounds)	

F/A-18 with AIM-7 Sparrow; AIM-9 Sidewinder; or AIM-120 AMRAAM (Live or Inert)

EA-18G with AIM-120 AMRAAM (Live or Inert)

Basic Phase (Unit Level Training) Scenario

A flight of two aircraft operating between 15,000 to 25,000 ft and at a speed of about 450 kts will approach a target from several miles away and, when within missile range, will launch their missile against the target. Approximately half of the missiles have live warheads and about half have an inert telemetry head package. The missiles fired are not recovered.

The target is an unmanned aerial target drone (BQM-34; BQM-74) or Tactical Air-Launched Decoy (TALD). BQM targets deploy parachutes, float on the surface of the water, and are recovered by boat. TALDs are expended. The exercise lasts about one hour, is conducted in a warning Area at sea outside of 12 nm and well above 3,000 ft

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

Range operations conducted with "captive carry" missiles (missiles that are not released from the aircraft) are documented under Air Combat Maneuver. Only live or inert missiles that are actually fired from the aircraft are documented under this range operation heading.

Local Training Considerations

In the MIRC this event refers to training operations in which air-to-air missiles are fired from aircraft against unmanned aerial target drones, gliders, or flares. The missiles fired are not recovered.

Electronic Combat Operations (EC OPS); Chaff and Flare Exercises

Aircraft, surface ships, and submarines attempt to control critical portions of the electromagnetic spectrum used by threat radars, communications equipment, and electronic detection equipment to degrade or deny the enemy's ability to defend its forces from attack and/or recognize an emerging threat early enough to take the necessary defensive actions.

EC OPS can be active or passive, offensive or defensive.

Active EC OPS use radio frequency (RF) transmissions in the 2-12 gigahertz frequency spectrum to conduct jamming and deception.

- Jamming bombards a radio or radar receiver with sufficient RF energy to cause the internal automatic gain setting of the receiving equipment to adjust the signal-to-noise threshold setting downward to a point where the desired RF return (for example, a radio voice, datalink transmission, or a target's radar return) is "lost" in the background noise of the RF spectrum.
- Electronic deception may generate false targets that appear to be real, thereby causing the recipient of the false targets to commit forces or weapons to attack those targets, and, in the process, not attack the real target. Another type of deception allows the defender to deny the attacker's weapon system from successfully acquiring and engaging a valid target.

Passive EC OPS use the enemy's electromagnetic transmissions to obtain intelligence about enemy operations and to recognize and categorize an enemy threat and take steps to defend against it.

Offensive EC OPS use active or passive installed EC systems against enemy search, EC, and weapons systems. Electronically, this process is active (overpowering enemy receiver systems) or passive (chaff) jamming.

Defensive EC OPS use active or passive installed EC systems in reaction to enemy threat systems. These installed EC systems are programmed to recognize an enemy threat signal and will automatically send a false return signal to the enemy threat system or dispense chaff and/or flares in immediate reaction to receiving an enemy threat signal. Missile, gun or search radar signals are common threat signals that can initiate an automatic response.

Navy units can conduct EC OPS training as stand alone events, but they are often embedded in other training events, such as fighting through enemy jamming to deliver ordnance on targets or ejecting chaff and flares in response to enemy missile threat radars.

Training ranges need an EC OPS training capability that can generate threat signals that will exercise the full range of every platform's EC capability and also be able to evaluate the effectiveness of both the equipment and operator's tactical responses to those signals.

EC OPS may also be categorized in several other areas where they may be combined with primary exercise being conducted. These other exercises include:

- HARMEX, destruction of enemy threat radars; non-firing exercises are included in this EC OPS category.
- Chaff Exercise, disruption of enemy threat search or guidance radars.
- Flare Exercise, seduction of enemy threat missile guidance systems or infrared systems.

Ships, fixed-winged aircraft, and helicopters deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack.

The chaff exercise trains aircraft in the use and value of chaff to counter an enemy threat. Chaff is a radar reflector material made of thin, narrow, metallic strips cut in various lengths to elicit frequency responses, which deceive enemy radars. Chaff is employed for a number of different tactical reasons, but the end goal is to create a target from the chaff that will lure enemy radar and weapons system away from the actual friendly platform.

Chaff may be employed offensively, such as before a major strike to "hide" inbound striking aircraft or ships, or defensively in reaction to being detected by an enemy targeting radar. Defensive chaff training is the most common exercise used for training both ships and aircraft. In most cases, the chaff exercise is training for the ship or aircraft that actually deploys the chaff, but it is also a very important event to "see" the effect of the chaff from the "enemy" perspective so that radar system operators may practice corrective procedures to "see through" the chaff jamming, so exercises are often designed to take advantage of both perspectives.

Chaff exercises are often conducted with flare exercises, as well as other exercises, rather than as a stand alone exercise.

Table D-28: Electronic Combat Operations (EC OPS); Chaff and Flare Exercises

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ELECTRONIC COMBAT						
CHAFF Exercise	SH-60; MH-60; HH-60; MH-53	RR-144A/AL	12 sorties (360 rounds)	14 sorties (420 rounds)	14 sorties (420 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
	FA-18; EA-18; AV-8B; MPA; EA-6	RR-144A/AL	16 sorties (160 rounds)	32 sorties (320 rounds)	48 sorties (500 rounds)	
	USAF Fixed Wing Aircraft *e.g.* F-15; F-16; F-35; C-130	RR-188	150 sorties (1,500 rounds)	500 sorties (5,000 rounds)	550 sorties (5,500 rounds)	
	CG, DDG, FFG, LHA, LHD, LPD, LSD	MK 214 (seduction); MK 216 (distraction)	12 (72 canisters)	16 (90 canisters)	20 (108 canisters)	

Table D-28: Electronic Combat Operations (EC OPS); Chaff and Flare Exercises (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ELECTRONIC COMBAT (Continued)						
FLARE Exercise	SH-60; MH-60; HH-60; MH-53	MK 46 MOD 1C; MJU-8A/B; MJU-27A/B; MJU-32B; MJU-53B; SM-875/ALE	12 sorties (360 flares)	14 sorties (420 rounds)	14 sorties (420 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
	FA-18; EA-18; AV-8B; MPA; EA-6		16 sorties (160 rounds)	32 sorties (320 rounds)	48 sorties (500 rounds)	
	USAF Fixed Wing Aircraft *e.g.* F-15; F-16; F-35; C-130	MJU-7; MJU-10; MJU-206	4 sorties (1,500 rounds)	500 sorties (5,000 rounds)	550 sorties (5,500 rounds)	

<u>F/A-18C/E/F; EA-18G; E-2C; MPA; SH-60B/F; MH-60R/S; HH-60H; MH-53E with Defensive Chaff</u>

There are various types of chaff; the type used varies based on the anticipated threat frequencies to be countered. Typical chaff includes:

- AN/ALQ-190(V)1 - used by SH-60B/F and MPA. This canister is the size of a sonobuoy and can also be employed in the offensive role to create chaff corridors as well as decoy missiles and radars in the defensive role.
- RR-129A/AL - used by all naval airframes.
- RR-144A/AL - designed specifically for training and used by all naval airframes.
- RR-181/AL - used by SH-60B/F and MPA. This chaff can also be employed in the offensive role to create chaff corridors as well as decoy missiles and radars in the defensive role.

Basic Phase (Unit Level Training) Scenario

Aircraft detect electronic targeting signals from threat radars or missiles, dispense chaff, and immediately maneuver to defeat the threat. The chaff cloud deceives the inbound missile, and the aircraft clears away from the threat.

The chaff disperses with the winds over a wide area and will eventually settle in limited concentrations over the surrounding land or sea areas where it was dispensed.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

CG, DDG, FFG, LCC, LHA, LHD, LPD, LSD with MK-214 or MK-216 Super Rapid Bloom Off-board Chaff (SRBOC) Defensive Chaff

Defensive chaff deployed from ships is typically MK-214 (Seduction Chaff) or MK-216 (Distraction Chaff) from the MK-36 SRBOC launcher. The specific type and amount of chaff deployed will depend on the specific tactical situation.

Basic Phase (Unit Level Training) Scenario

A surface ship detects an electronic targeting signal or the ship's search radar detects an inbound threat missile. Chaff rounds are fired automatically or manually, depending on the setting selected for the tactical situation, from the MK-36 Super Rapid Bloom Off-board Countermeasures (SRBOC) Chaff and Decoy Launching System, or other similar systems. The chaff forms a cloud that presents a ship size “target,” forcing the inbound missile to make a choice between the chaff and the real ship. With the employment of additional countermeasure tactics, the ship may maneuver away from the cloud and cause the missile to choose the chaff “target.”

The chaff disperses with the winds over a wide area and will eventually settle in limited concentrations over the surrounding sea areas where it was dispensed.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

The chaff exercise trains shipboard personnel in the use and value of chaff to counter an enemy threat. Chaff is a radar reflector material made of thin, narrow, metallic strips cut in various lengths to elicit frequency responses, which will deceive enemy radars. Chaff is employed for a number of different tactical reasons, but the end goal is to create a target from the chaff that will lure enemy radar and weapons system away from the actual friendly ship.

Local Training Considerations

Chaff Exercises train aircraft and/or shipboard personnel in the use of chaff to counter anti-ship and antiaircraft missile threats. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, which are used to reflect echoes to deceive radars. During a Chaff Exercise, the chaff layer combines maneuvering with deployment of multiple rounds of chaff to confuse incoming missile threats. In an integrated Chaff Exercise scenario, ships/helicopters/fixed wing craft will deploy ship and air launched rapid bloom offboard chaff in pre-established patterns designed to enhance missile defense. In FY03 Air Force C-130 aircraft conducted Chaff Exercises in W-517.

CG, DDG, FFG, LHA, LHD, LPD, LSD, CVN with SLQ-32

The SLQ-32 provides early warning, identification, and direction of threat targeting radars and weapon emitters to its own ship systems that will engage hard kill weapons (e.g. CIWS), automatically disperse chaff and flare decoys, and use active electronic emissions to counter inbound missiles.

Basic Phase (Unit Level Training) Scenario

Surface ships detect and evaluate threat electronic signals from threat aircraft or missile radars, evaluate courses of action concerning the use of passive or active countermeasures, then use ship maneuvers and either chaff, flares, active electronic countermeasures or a combination of them to defeat the threat.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

Threat signals are commonly provided by a commercial air service Lear Jet with a threat signal simulator pod that flies an appropriate threat missile profile; this service is not available in the MIRC.

F/A-18C/D with ALQ-165 and F/A-18E/F with ALQ-214 Jamming System

The AN/ALQ-165 is an automated active deception jammer designed to contribute to the electronic self-protection of the host aircraft from a variety of air-to-air and surface-to-air radar threats.

The AN/ALQ-214 is an Integrated Defensive Electronic Countermeasures (IDECM) Radar Frequency Countermeasures system that uses autonomous active techniques that deny, disrupt, delay, and degrade missile launch and firing solutions from a variety of air-to-air and surface-to-air radar and infrared threats. This system includes an onboard radio frequency countermeasures system as well as the ALE-55 Fiber Optics Towed Decoy, which is trailed behind the aircraft at varying lengths.

Basic Phase (Unit Level Training) Scenario

The F/A-18 will typically fly well above 3,000 ft at about 400 kts toward the threat signal generators used by the training range. When a threat signal is received, the pilot reacts to the enemy missile threats by maneuvering and employing autonomous active jamming against the threat search radars or missiles.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except that it is employed during a major range event, at sea, and in conjunction with other friendly forces.

EA-18G with Active Jamming Systems

- AN/ALQ-218 Airborne Electronic Attack (AEA) Suite - capable of selective reactive and pre-emptive electronic jamming of enemy communications. It is designed to replace the AN/ALQ-99.
- AN/ALQ-99 Tactical Jamming System - provides jamming in support of strike or assault forces. It automatically detects and classifies an enemy's radar then automatically electronically jams the radar.
- AN/USQ-113 Communications Jamming System - used to jam enemy communications

Basic Phase (Unit Level Training) Scenario

The EA-18G supports strike aircraft by employing active jamming against threat search radars to mask the friendly inbound strike aircraft mission against threat antiaircraft weapons or command and control communication radios. Aircraft will typically fly at about 18,000 ft at about 400 kts in a racetrack pattern that will best support jamming the threat receivers.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except that it is typically employed during a major range event where jamming could be employed during strike or assault missions planned against opposing shore targets.

Training Considerations

Areas where active jamming may be employed are limited in order not to interfere with commercial RF signals or reveal current jamming capabilities.

SSN/SSGN/SSBN with Passive Electronic Detection Systems

Basic Phase (Unit Level Training) Scenario

Submarines use passive electronic detection equipment to search for, identify, and locate threat radars and communication systems in an effort to identify the threat that faces friendly forces and provide threat location to strike forces that can destroy the threat systems.

This is a completely passive training scenario, but realistic target threat signals in a realistic threat environment improve the quality of training for submarine crews.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except that it is conducted during major range events where the submarine could interact with Strike Forces.

Bombing Exercise (Air-to-Ground) (BOMBEX [A-G])

Fixed-winged strike aircraft deliver bombs and rockets against land targets, day or night, with the goal of destroying or disabling enemy vehicles, infrastructure, and personnel.

Table D-29: Bombing Exercise (Air-to-Ground) (BOMBEX [A-G])

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
STRIKE WARFARE (STW)						
BOMBEX (LAND)	Fixed Wing Aircraft, e.g. FA-18; AV-8B; B-1; B-2; B-52; F-15; F-16; F-22; F-35; A-10	High Explosive Bombs ≤ 500 lbs	400 annually	500 annually	600 annually	FDM (R-7201)
		High Explosive Bombs: 750 / 1,000 lbs / 2,000 lbs	1,600 annually	1,650 annually	1,700 annually	
		Inert Bomb Training Rounds ≤ 2,000 lbs	1,800 annually	2,800 annually	3,000 annually	
		Total Sorties (1 aircraft per sortie):	1,000 sorties	1,300 sorties	1,400 sorties	

Unguided or Precision-guided Bombs

Unguided munitions: MK-76 and BDU-45 (inert training bombs); MK-80 series bomb (inert or live); MK-20 Cluster Bomb (inert or live).

Precision-guided munitions: Laser-guided bombs (LGB) (live or inert); Laser-guided Training Rounds (LGTR) (inert, but does contain an impact initiated spotting charge); Joint Direct Attack Munition (JDAM) (inert or live). JDAM is simply a GPS guidance kit that is attached to an unguided munition, typically a MK-80 series bomb, in the 500 to 2000 lb range.

Basic Phase (Unit Level Training) Scenario

A flight of two aircraft will approach the target from an altitude of between 15,000 ft to less than 3,000 ft and, when on an established range, will usually establish a racetrack pattern around the target. The pattern is established in a predetermined horizontal and vertical position relative to the target to ensure that all participating aircraft follow the same flight path during their target ingress, ordnance delivery, target egress, and "downwind" profiles. This type of pattern is designed to ensure that only one aircraft will be releasing ordnance at any given time. The typical bomb release altitude is below 3,000 ft and within a range of 1,000 yards for unguided munitions; above 15,000 ft and may be in excess of 10 nm for precision-guided munitions. Laser designators from the aircraft dropping the bomb, a support aircraft, or ground support personnel are used to illuminate certified targets for use with lasers when using laser guided weapons. The average time for this exercise is about one hour.

Integrated and Sustainment Phase Training Scenarios

Typically involve a simulated strike scenario with a flight of four or more aircraft, with or without a designated opposition force (OPFOR). Participating aircraft attack the target using real-world tactics, which may require that several aircraft approach the target and deliver their ordnance, simultaneously, from several different altitudes and/or directions. An E-2 aircraft is typically involved in this exercise from a command and control perspective, and an EA-18G aircraft may provide electronic combat support in larger events.

Training Considerations

Strike fighter pilots can fulfill this training requirement against either a land or water target, but the land target is most common.

Unguided munitions: Usually conducted at land ranges with inert or live ordnance, or water ranges with grounded ship hulks available for targets. MK-76 and BDU-48 inert bombs are the most common weapon allocation.

Precision-guided munitions: The very large safety footprints of these bombs limit their employment to land ranges with sufficiently large controlled air space and safety zones, or at-sea during a Sinking Exercise (SINKEX) or BOMBEX. Each squadron's training allowance is very small (only one or two per year), severely limiting the total fleet-wide annual expenditure of these weapons.

The major difference between a BOMBEX (A-S) and BOMBEX (A-G) is related to targets. Ground targets may include any combination of fixed and mobile targets. Fixed targets may include a bull's eye of concentric rings and real or simulated wheeled vehicles, convoys, trains, aircraft, buildings, petroleum and oil storage areas, personnel silhouettes, and artillery and missile sites. Mobile targets include remote-controlled wheeled vehicles. Any ashore BOMBEX target may be actively or passively augmented to provide radar, infrared, or electronic signals, or support laser designation.

Feedback to participants is very important for this exercise and can include any combination of real-time and post-mission feedback from a Weapon Impact Scoring System (WISS) or instrumented range, real-time visual sighting by range observers or participating aircrews, and post-mission telephonic or facsimile debrief.

Local Training Considerations

BOMBEX (A-G) allows aircrews to train in the delivery of bombs and munitions against ground targets. The weapons commonly used in this training on FDM are inert training munitions (e.g., MK-76, BDU-45, BDU-48, BDU-56 and MK-80-series bombs), and live MK-80-series bombs and precision guided munitions (Laser Guided Bombs [LGBs] or Laser Guided Training Round [LGTRs]). Cluster bombs, fuel-air explosives, and incendiary devices are not authorized on FDM. Depleted uranium rounds are not authorized on FDM.

BOMBEX (A-G) exercises can involve a single aircraft, a flight of two, four, or multiple aircraft. The types of aircraft that frequent FDM are FA-18, AV-8B, B-1B, B-2, B-52, F-15, F-16, F-22, F-35, and A-10.

FDM is an uncontrolled and un-instrumented, laser certified range with fixed targets, which includes CONEX boxes (metal shipping containers) in various configurations within the live-fire zones, and high fidelity anti aircraft missile, and gun shape targets within the inert only zone. COMNAVMAR is the scheduling authority. All aircraft without aid of an air controller must make a clearance pass prior to engaging targets as instructed in the FDM Range Users Manual (COMNAVMARINST 3502.1).

Missile Exercise (Air-to-Ground) MISSILEX [A-G] and MISSILEX [A-S] (Air-to-Surface) and CATMEX

Fixed-winged aircraft and helicopter crews launch missiles at ground targets and ships, day and night, with the goal of destroying or disabling vehicles, infrastructure, and personnel.

SH-60B, HH-60H, & MH-60R/S Helicopters with Hellfire Missiles

AGM-114 - Hellfire uses a laser guidance system.

Basic Phase (Unit Level Training) Scenario

One or two helicopters approach and acquire an assigned target, which is then designated with a laser to guide the Hellfire to the target. The laser designator is either own aircraft, wingman, or another source. The helicopter launches one live missile per exercise from an altitude of about 300 ft while in forward flight or in a hover, against a specially prepared target. The target could be a stationary or small hull target, or a remote controlled vehicle whose infrared signature has been augmented with a heat source (charcoal or propane) to better represent a typical threat vehicle. In any case, the targets are not usually expended.

Table D-30: MISSILEX [A-G] and MISSILEX [A-S] and CATMEX

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
STRIKE WARFARE (STW)						
MISSILEX [A-G]	Fixed Wing and Rotary, e.g. FA-18; AV-8B; F-15; F-16; F-22; F-35; A-10; MH-60R/S; SH-60B; HH-60H; AH-1	TOW; MAVERICK; HELLFIRE (Live Rounds)	30 annually	60 annually	70 annually	FDM (R-7201)
SURFACE WARFARE (SUW)						
MISSILEX [A-S] (Air to Surface)	Rotary and Fixed Wing Aircraft (MK 58 Smoke tgt. or towed sled or small hull target)	HELLFIRE (Live Rounds)	0	2 rounds	2 rounds	PRI: W-517, >50 nm from land SEC: MI Maritime, >50 nm from land; ATCAAs
MISSILEX (Air to Surface CATMEX) Inert Only	Rotary and Fixed Wing Aircraft (MK 58 Smoke tgt. or towed sled or small hull target)	Laser Designation and Tracking with Captive Air Training Missile	40	60	60	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario.

Training Considerations

This exercise is more commonly done in a Warning Area at sea, which can better accommodate the Hellfire's large safety footprint. MISSILEX [A-S] is frequently completed using the Captive Air Training Missile (CATM), which is a missile shape with electronics simulating a live missile. The CATM is fixed to the aircraft hardpoints and in electronic communication with the aircraft fire control system. Training is conducted as though the CATM were a "live" missile and the event is called a CATMEX.

F/A-18C/E/F Aircraft with Maverick, SLAM-ER or JSOW

- AGM-65 - Maverick uses infrared guidance.
- AGM-84 - Stand-off Land Attack Missile - Extended Range (SLAM-ER) uses GPS-aided Inertial Navigation System, IR, and datalink guidance.
- AGM-154 - Joint Stand-Off Weapon (JSOW) uses GPS guidance.

Basic Phase (Unit Level Training) Scenario

A flight of two aircraft approach a land target from an altitude between 40,000 ft and 25,000 ft for SLAM-ER or JSOW (high) and 25,000 ft and 5,000 ft for Maverick or JSOW (low), complete the internal targeting process, and launch the weapon at the target beyond 150 nm for SLAM-ER, 60 nm for JSOW (high), 15 nm for JSOW (low), and 12 nm for Maverick. Unit level training is usually highly structured to achieve desired training results. The majority of unit level exercises involve the use of captive carry (inert, no release) training missiles, where the aircraft can perform all detection, tracking, and targeting requirements without actually releasing a missile.

Targets used may include bulls-eyes of concentric rings, real or simulated wheeled vehicles, convoys, trains, aircraft, buildings, petroleum and oil storage areas, personnel silhouettes, and artillery and missile sites. Mobile targets include remotely controlled wheeled vehicles.

Feedback to land based participants can include any combination of real-time and post-mission feedback from an impact scoring system or instrumented range, real-time visual sighting by range observers or participating aircrews, and post-mission telephonic or facsimile debrief. With some A-G missiles, feedback may also include other indications from the target such as the loss or absence of a RF emission following the attack.

Integrated and Sustainment Phase Training Scenarios

Typically do not differ from the Basic Phase Scenario, except that an E-2 aircraft may participate in the integrated or sustainment phase exercise to assist with targeting procedures and command and control of several sections (four or more) of F/A-18.

Training Considerations

Because of the expense and large safety footprint, the Navy launches very few live missiles per year, land or sea. The typical live annual allocation is one SLAM-ER and one Maverick per squadron. Live Maverick can be launched at sea or at the Fallon Range Training Complex, while live SLAM-ER is typically fired only at sea. The missiles will typically be fired at a decommissioned ship during a SINKEX.

Local Training Considerations

Air-to-ground Missile Exercise trains aircraft crews in the use of air-to-ground missiles. On FDM it is conducted mainly by H-60 Aircraft using Hellfire missiles and occasionally by fixed wing aircraft using Maverick missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire the target, and launch the missile. The missile is launched in forward flight or at hover at an altitude of 300 feet Above Ground Level (AGL).

Missile Exercise (Surface-to-Air) (MISSILEX (S-A))

Surface ships engage threat missiles and aircraft with missiles with the goal of disabling or destroying the threat.

There is a training restriction on firing surface-to-air missiles from all surface ships, except aircraft carriers (CVN). Only CVNs fire surface-to-air missiles for training. Other surface-to-air missiles are typically fired for a RDT&E purpose.

Table D-31: Missile Exercise (Surface-to-Air) (MISSILEX [S-A])

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AIR WARFARE						
MISSILEX Ship-to-Air	CVN, LHD, CG, DDG; BQM-74E.	RIM-7 Sea Sparrow RIM-116 RAM RIM-67 SM-II ER	1 (1 missile)	2 (2 missile)	2 (2 missile)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs

CVN, CG, DDG, FFG, LHA, LHD, LSD, LPD, AOE with Point Defense Missiles

Point defense missiles are designed to defend the ships on which they are installed. These missiles are installed on various surface ships and are not inclusive in every class (the specific ship, by name, must be identified to determine what, if any, point defense missile system is installed):

- NATO Sea Sparrow - may be installed on AOE, LHD, CVN
- Evolved NATO Sea Sparrow, scheduled to replace NATO Sea Sparrow - may be installed on CG, LHA, AOE
- Rolling Airframe Missile - may be installed on CVN, FFG, LHA, LHD, LSD, LPD.
- Standard Missile – installed on CG, DDG

Basic Phase (Unit Level Training) Scenario

The scenario for this exercise is the same as for the main battery gun exercise above, but the simulated threat missile is engaged with the point defense missile system. One live or telemetered-inert-missile is expended against a target towed by a commercial air services Lear jet after two or three tracking runs. The exercise lasts about two hours.

The BQM-74 target, sometimes augmented with a TDU, is used as an alternate target for this exercise. The BQM target is a subscale, subsonic, remote controlled ground or air launched target. A parachute deploys at the end of target flight to enable recovery at sea.

Training Considerations

The CVN is currently the only ship to have a periodic training requirement with an actual live missile shot. Other surface ships routinely conduct the "detect to engage exercise" without a live missile firing, using a missile training round simulator. The training requirement for other ships to fire live or inert telemetry missiles on a periodic or test basis is continually subject to review or exemption.

CG, DDG with Standard Missile (SM-2)

CGs and DDGs use the Standard Missile (SM-2) to defend the force against threat missiles and aircraft. These ships are tactically stationed to defend the aircraft carrier, amphibious ships, or logistic ships of the force, as well as themselves, from the air threat.

Basic Phase (Unit Level Training) Scenario

One live or telemetered-inert-missile is fired against a missile target or jet/towed target after conducting a tracking run. The exercise lasts about two hours.

The BQM-74 target, sometimes augmented with a TDU, is used an alternate target for this exercise. The BQM target is a subscale, subsonic, remote controlled ground or air launched target. A parachute deploys at the end of target flight to enable recovery at sea.

Training Considerations

The "detect to engage exercise" is used to conduct this training where there is no longer a training requirement for these ships to fire live or inert missiles.

Naval Surface Fire Support (NSFS) Exercise (FIREX)

Surface ships use main battery guns to support forces ashore in their battle against threat forces.

NSFS normally consists of the bombardment of a target within an impact area, by one or more ships. The ship is often supported by Navy, Marine, or NSW spotters ashore, or by spotters embarked in fixed-wing aircraft or helicopters in the air, to call for the fire support from the ship, and to adjust the fall of shot onto the target.

The locations and opportunities for live-fire from a ship at sea to targets ashore are very limited, and often the training range area is not adequate to establish and maintain surface fire support proficiency.

Table D-32: Naval Surface Fire Support (NSFS) Exercise (FIREX)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AMPHIBIOUS WARFARE (AMW)						
FIREX (Land)	CG, DDG	5" Guns and (HE) shells	4 (400 rounds)	8 (800 rounds)	10 (1,000 rounds)	FDM (R-7201)

CG and DDG with 5-inch Guns

FIREX (Land Target) (FIREX (Land))

This exercise uses a land area where live and inert ordnance is authorized to impact and is often supported by target shapes such as tanks, truck, trains, or aircraft on the ground. These targets add to the realism for both the spotters and the ships involved in the exercise.

Basic Phase (Unit Level Training) Scenario

The ship positions itself about four to six nm from the target area to receive information concerning the target and the type and exact location of the target from the assigned spotter. One or more rounds are fired at the target. The fall of the round is observed by the spotter, who then tells the ship if the target was hit or if the ship needs to adjust where the next round should fall. More shots are fired, and once the rounds are falling on the target, then the spotter will request a larger number of rounds to be fired to effectively destroy the target. Typically five rounds are fired in rapid succession (about one round every five to seven seconds). Ten or more minutes will pass, and then similar missions will be conducted until the allocated number of rounds for the exercise has been expended.

About 70 rounds of 5-inch inert or high explosive ordnance (typically 53% live and 47% inert), in addition to about 5 rounds of illumination are expended by the CG or DDG during a typical exercise. Portions of the exercise are conducted during both the day and the night to achieve full qualification. A ship will normally conduct three FIREXs at different levels of complexity over several months to become fully qualified.

A Shore Fire Control Party (SFCP) may consist of about 10 personnel who supply target information to the ship. From positions on the ground, the Navy, Marine, or NSW personnel who make up the SFCP provide the target coordinates at which the ship's crew directs its fire. As the rounds fall, the SFCP records where the rounds falls and provides adjustments to the fall of shot, as necessary, to ensure the target is "destroyed."

Integrated and Sustainment Phase Training Scenarios

Typically does not differ significantly from the Basic Phase Scenario with respect to the NSFS procedures and ordnance used.

If NSFS training is conducted as part of an ESGEX, in could be part of several independent or coordinated missions being conducted simultaneously, including CAS, Marine Corps artillery fires, and troop movements, that are being coordinated by the Expeditionary Strike Group Commander embarked in the LHA. In a training environment, it is expected that NSFS is only combined with Marine Corps artillery fires as a live or inert ordnance exercise in the same area.

Local Training Considerations

FIREX (Land) on FDM consists of the shore bombardment of an Impact Area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or in the air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed. On FDM, spotting may be conducted from the special use "no fire" zone or provided from a helicopter platform. No one may land on the island without the express permission of COMNAVMAR (COMNAVMARINST 3502.1).

Marksmanship

Navy personnel use small arms and small unit tactics to defend unit positions or attack simulated enemy positions with the goal of defending the unit position or clearing an area of a threat.

Marksmanship exercises are used to train personnel, beyond basic introductory skills, in the use of all small arms weapons for the purpose of ship self defense and security as well as NSW personnel in many of their training tasks.

Special Warfare, NECC, Shipboard and Other personnel with Small Arms

Marksmanship exercises may include but are not limited to 9 mm pistols, 12-gauge shotguns, .50 cal, 7.62 mm, 5.56 mm rifles and machine guns, and 40 mm grenades.

Basic Phase (Unit Level Training) Scenario

A squad, or other size unit, of personnel uses small unit tactics and small arms to approach a simulated hostile target area manned by an opposing force. The opposing force in this case may be popup targets and other targets designed to improve the marksmanship of the individual squad members.

Training Considerations

Basic marksmanship operations are strictly controlled and regulated by specific individual weapon qualification standards and typically occur on specific small arms ranges. While marksmanship exercises can occur on designated small arms ranges ashore, they are also scheduled on live fire or maneuver ranges ashore, MOUT areas ashore, or aboard surface ships at sea firing into the sea.

Local Training Considerations

Marksmanship exercises are used to train personnel in the use of all small arms weapons for the purpose of ship self defense and security. Basic marksmanship operations are strictly controlled and regulated by specific individual weapon qualification standards. Small arms include but are not limited to 9mm pistol, 12-gauge shotgun, and 7.62mm rifles.

Special Warfare Mission Area Training

Mission area training will typically be unique training for a particular unit's mission that can be completed at specific range areas that best support the required training.

Naval Special Warfare and EOD units most commonly have training requirements that fall into this category. This training usually requires a training range or training range support, but may have little or no environmental or community impact.

Table D-33: Special Warfare Mission Area Training

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL WARFARE						
HYDROGRAPHIC SURVEYS	SEAL Platoon/Squad; EOD Platoon/Squad; USMC Platoon/Squad; Small Craft; RHIB; CRRC; H-60	SCUBA	3	6	6	PRI: FDM; Tinian; Tipalao Cove SEC: Haputo Beach; Gab Gab Beach; Dadi Beach

Mission Area Training at a typical range complex may include the following operations:

- Hydrographic Reconnaissance. A survey of underwater terrain conditions near shore and a report of findings to provide precise analysis for amphibious landings. Personnel perform methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and determine the feasibility of landing an amphibious force on a particular beach.
- Closed Circuit Breathing Diving. Swimming and diving in underwater ocean and bay areas with the Lambert Air Rebreather (LAR) V. The LAR V is a 100% oxygen rebreather system that makes use of a small oxygen bottle and a “scrubber” canister that filters the CO2 from exhaled air and allows the diver to re-breathe 100% oxygen.
- Open Circuit Breathing Diving. Swimming and diving underwater ocean and bay areas using the typical Self-Contained Underwater Breathing Apparatus (SCUBA) equipment, including compressed air and MK-16 mixed gas SCUBA equipment.
- Surf Observations. Recording information about ocean surf conditions using standard documentation methods for amphibious operations.
- Inflatable Small Boat Surf Passage. Various methods are learned for bringing inflatable small boats through the surf from sea to shore or shore to sea.
- Rock Portage. Various methods are learned to move small boats and equipment through rocky areas that would typically be found at the sea/shore beach interface.
- Land Patrolling. Various methods for patrolling and moving through various land terrain areas are learned by squads of about seven to 15 personnel.
- NSW Scout Training. Special tactical techniques are learned for observing threat areas and areas that may later be used by friendly forces to gain the most information from all available sources in the field.
- Advanced Close Quarters Defense Training. Hand-to-hand combat techniques within special training facilities to teach special tactical techniques with and without weapons.
- NSW Photo Image Capture. Tactical patrolling techniques to move in and out of a threat area without leaving any trace that anyone was there, while capturing detailed photography of the assigned threat.

Local Training Considerations

Hydrographic Reconnaissance is conducted to survey underwater terrain conditions and report findings to provide precise analysis typically in support of amphibious landings and precise ship and small craft movement through cleared routes (Q-Routes). Exercises involve the methodical reconnoitering of beach and surf conditions during the day and night to find and clear underwater obstacles and to determine the feasibility of landing an amphibious force on a particular beach. Explosive Ordnance Disposal (EOD) units periodically survey FDM to determine the condition of coral around the island and to detect the presence of Unexploded Ordnance (UXO).

Combat Search and Rescue (CSAR)

Fixed-winged aircraft, helicopters and submarines use tactical procedures to rescue military personnel within a hostile area of operation.

Table D-34: Combat Search and Rescue (CSAR)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
STRIKE WARFARE (STW)						
COMBAT SEARCH AND RESCUE (CSAR)	SH-60; MH-60; HH-60; MH-53; CH-53; C-17; C-130; V-22	NIGHT VISION	30 sorties	60 sorties	75 sorties	PRI: Tinian North Field: Guam Northwest Field SEC: Orote Point Airfield; Rota Airport

<u>**HH-60H, SH-60F, MH-60S with Machine Guns**</u>

Basic Phase (Unit Level Training) Scenario

Helicopters fly below 3,000 ft at the best altitudes and speeds between 50 kts and 100 kts to approach the area where the suspected personnel to be rescued are located. Machine guns (7.62 mm or 5.56 mm) will be mounted in the side door, but blank ammunition is normally used in this exercise. Chaff and flares may be expended if a surface-to-air or air-to-air threat or opposing force is available and an additional level of complexity is desired for the scenario. NSW personnel may be embarked during this exercise to act as the rescue party. This NSW squad would debark from the helicopter, “rescue” the personnel to be recovered, and return to the helicopter to be removed from the area. This basic exercise would last about one and a half hours.

Integrated and Sustainment Phase Training Scenarios

The basic procedures completed by the helicopter and embarked personnel are typically the same. The added complexity is the required coordination between rescue units and support from additional participants. See the E-2C and F/A-18C/E/F scenario below.

Training Considerations

See the E-2C and F/A-18C/E/F scenario below.

E-2C and F/A-18C/E/F with Cannon or Bombs

Basic Phase (Unit Level Training) Scenario

CSAR is typically conducted by these units in the integrated or sustainment phase training scenario.

Integrated and Sustainment Phase Training Scenarios

The E-2 will serve as a command and control element for the evolution while flying at an altitude of about 20,000 ft at a cruising speed of about 260 kts. Remaining within an assigned station, the E-2 will maintain communications and a tactical picture of the area containing the personnel to be rescued and other forces involved in the evolution. Two F/A-18s will serve as a Rescue Combat Air Patrol or Rescue Escort. In this role they will approach the rescue area at altitudes below 3,000 ft, down to about 300 ft where they can observe the area and provide protection as required with cannon (GUNEX (A-G)) or bombs (BOMBEX (A-G)) for both the personnel to be rescued as well as helicopters (HH-60H, SH-60F, MH-60S) and ground forces (NSW or Marine Corps) conducting the rescue. The principal focus of this exercise is the integration and coordination of actions between the various platforms involved. A CSAR exercise will last between two and three hours.

Training Considerations

This exercise will be supported by an opposition force and in conjunction with other exercises.

SSN, SSGN, SSBN

Basic Phase (Unit Level Training) Scenario

The submarine will proceed to a specified location at sea in a hostile area near land where the rescue is to be made, come to a depth of about 60 ft and visually search for the person to be rescued. Once the person is located, the submarine will surface just long enough to embark the persons to be rescued, and then leave the area.

Integrated and Sustainment Phase Training Scenarios

Not typically conducted in these phases.

Training Considerations

May be combined with insertion and extraction training.

Local Training Considerations

CSAR operations train rescue forces personnel the tasks needed to be performed to recover distressed personnel during war or military operations other than war. These operations could include aircraft, surface ships, submarines, ground forces (Marine Corps and NSW), and their associated personnel in the execution of training events.

In FY03 North Field supported NVG familiarization training for CSAR operators from the USS KITTY HAWK.

Embassy Reinforcement

Marine Corps, Army, or Special Warfare units reinforce embassy security in an area where the lives or property are endangered by war, civil unrest, or natural disaster.

Marine Corps units routinely train to conduct embassy reinforcement operations, usually operating in conjunction with expeditionary strike group ships and aircraft to provide a secure embassy or safe haven for embassy noncombatants in foreign countries when their lives are endangered by war, civil unrest, or natural disaster. Normally there is no opposition from the host country in response; however, Marine Corps Marine Expeditionary Unit (Special Operations Capable) [MEU(SOC)] normally train under circumstances that require the use of force in a hostile environment. Much like a raid, Embassy Reinforcement involves the rapid introduction of forces, and preparation for evacuation of non-combatants, and a planned withdrawal. A MEU(SOC), short take-off or landing fixed wing aircraft (e.g. C-130), helicopters or tilt-rotor aircraft (e.g. H-60, H-46, H-53, V-22), LCACs or other landing craft could be expected to participate in this operation during day or night.

Table D-35: Embassy Reinforcement

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
FORCE PROTECTION / ANTI-TERRORISM						
Embassy Reinforcement	SEAL Platoon ARMY Platoon USMC Company/ Platoon Trucks; HMMWV; helicopters, tilt-rotor, STOL fixed wing aircraft; LCAC or other landing craft	5.56 mm blanks/Simulations	42 events, 1-2 days per event	50 events, 2-3 days per event	50 events, 2-3 days per event	PRI: Orote. Pt. Airfield Inner Apra Harbor; Northern and Southern Land Navigation Area SEC: Orote Pt. Triple Spot; Orote Pt. CQC; Kilo Wharf; Rota Municipality.

Local Training Considerations

Primary training sites include Orote Pt. Airfield, Inner Apra Harbor, and Northern and Southern Land Navigation Areas. Secondary sites include Orote Pt. Triple Spot, Orote Pt. CQC, Kilo Wharf, and Rota Municipality.

Force Protection

Force protection operations increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures.

Table D-36: Force Protection

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
FORCE PROTECTION / ANTI-TERRORISM						
FORCE PROTECTION	USAF Squadron/ Platoon NECC SEABEE Company/ Platoon USAR Engineer Company/ Platoon Tents; Trucks; HMMWV; Generators	5.56 mm blanks/Simulations	60 events, 1-2 days per event	75 events, 1-2 days per event	75 events, 1-2 days per event	PRI: Guam, Northwest Field; Northern Land Navigation Area; Barrigada Annex SEC: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field; Rota Municipality.

Local Training Considerations

Base Naval Security Forces and MSS-7 frequently conduct force protection training throughout the Waterfront Annex, but all forces will participate in force protection training to some degree in multiple locations throughout the MIRC.

Anti-Terrorism

Anti-Terrorism (AT) operations concentrate on the deterrence of terrorism through active and passive measures, including the collection and dissemination of timely threat information, conducting information awareness programs, coordinated security plans, and personal training. The goal is to develop protective plans and procedures based upon likely threats and strike a reasonable balance between physical protection, mission requirements, critical assets and facilities, and available resources to include manpower.

Anti-Terrorism operations may involve units of Marines dedicated to defending both U.S. Navy and Marine Corps assets from terrorist attack. The units are designated as the Fleet Anti-Terrorism Security Team (FAST). FAST Company Marines augment, assist and train installation security when a threat condition is elevated beyond the ability of resident and auxiliary security forces. They are not designed to provide a permanent security force for the installation. They also ensure nuclear material on submarines is not compromised when vessels are docked. FAST Companies deploy only upon approval of the Chief of Naval Operations.

Table D-37: Anti-Terrorism

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
FORCE PROTECTION / ANTI-TERRORISM						
ANTI-TERRORISM	Navy Base Security USAF Security Squadron USMC FAST Platoon Trucks; HMMWV; MH-60	5.56 mm blanks/Simulations	80 events, 1 day/event	80 events, 1 day/event	80 events, 1 day/event	PRI: Tarague Beach Shoot House and CATM Range; Polaris Pt.; Northwest Field. SEC: Kilo Wharf; Finegayan Comm. Annex; Navy Munitions Site; AAFB Munitions Site; Rota Municipality.

Local Training Considerations

The USMC Security Force FAST Platoon stationed in Yokosuka, Japan conducts Anti-Terrorism training with Base Naval Security, NSWU-1, and EODMU-5 support and in multiple locations within the MIRC in Guam.

Field Training Exercise (FTX)

FTX is an exercise where the battalion and its combat and combat service support units deploy to field locations to conduct tactical operations under simulated combat conditions.

Table D-38: Field Training Exercise (FTX)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
FIELD TRAINING EXERCISE (FTX)	ARMY Company/ Platoon NECC SEABEE Company/ Platoon	Tents; Trucks; HMMWV; Generators	100 events, 2-3 days per event	100 events, 2-3 days per event	100 events, 2-3 days per event	PRI: Guam, Northwest Field; Northern Land Navigation Area SEC: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field.

Local Training Considerations

A company or smaller-sized element of the Army Reserve, Guam Army National Guard, or Guam Air National Guard will typically accomplish FTX within the MIRC, due to the constrained environment for land forces. The headquarters and staff elements may simultaneously participate in a CPX mode.

Surveillance and Reconnaissance (S&R)

Surveillance and reconnaissance is conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, "red cell" or "OPFOR" units may be positioned ahead of the assault force and permitted a period of time to conduct S&R and prepare defenses to the assaulting force.

Table D-39: Surveillance and Reconnaissance (S&R)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
Intelligence, Surveillance, Reconnaissance (ISR)	SEAL Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad; USAF Platoon/Squad	Night Vision; Combat Camera; 5.56 mm blanks/Simunition	12 Events; 8 – 24 hours	16 Events; 8 – 24 hours	16 Events; 8 – 24 hours	PRI: Guam; Northwest Field; Barrigada Housing; Finegayan Comm. Annex; Orote Pt. Airfield. SEC: Tinian, Rota, Saipan

Local Training Considerations

None documented.

USAF Airlift—Air Expeditionary—Force Protection

- Provide airlift support to combat forces.
- Provide air expeditionary operations support to forward deployed forces
- Provide Force Protection

Table D-40: USAF Airlift--Air Expeditionary—Force Protection

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
AIRFIELD EXPEDITIONARY	USAF RED HORSE Squadron. NECC SEABEE Company. USMC Combat Engineer Company USAR Engineer Dozer, Truck, Crane, Forklift, Earth Mover, HMMWV. C-130; H-53.	Expeditionary Airfield Repair and Operation (includes temporary FARP construction and operation)	1 exercise	12 exercises	12 exercises	PRI: Northwest Field SEC: Orote Pt. Airfield; Tinian North Airfield

Local Training Considerations

Northwest Field is used in support of expeditionary training and is available as an alternate landing and lay down site for short field capable aircraft.

Miscellaneous Range Events

Sinking Exercise (SINKEX)

A SINKEX is typically conducted by aircraft, surface ships, and submarines in order to take advantage of a full size ship target and an opportunity to train with live weapons fire.

The target is typically a decommissioned combatant or merchant ship that has been made environmentally safe for sinking. It is placed in a specific location so that when it sinks it will serve another purpose, such as a reef, or be in deep water where it will not be a navigation hazard to other shipping.

Ship, aircraft, and submarine crews typically are scheduled to attack the target with coordinated tactics and deliver live ordnance to sink the target. Inert ordnance is often used during the first stages of the event so that the target may be available for a longer time. The duration of a SINKEX is unpredictable because it ends when the target sinks, but the goal is to give all forces involved in the exercise an opportunity to deliver their live ordnance. Sometimes the target will begin to sink immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons. Typically, the exercise lasts for 4 to 8 hours and possibly over 1 to 2 days, especially if inert ordnance, such as 5-inch gun projectiles or MK-76 dummy bombs, is used during the first hours.

A SINKEX is conducted under the auspices of a permit from the U.S. Environmental Protection Agency (EPA).

Table D-41: Sinking Exercise (SINKEX)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SURFACE WARFARE (SUW)						
SINKEX	Ship hulk or barge	HARM [2] SLAM-ER [4] HARPOON [5] 5” Rounds [400] HELLFIRE [2] MAVERICK [8] GBU-12 [10] GBU-10 [4] MK-48 [1] Underwater Demolitions [2 -100lb]	1	2	2	PRI: W-517 SEC: MI Maritime, >50 nm from land; ATCAAs

The participants and assets could include:

- One full-size target ship hulk
- One to five CG, DDG, or FFG firing ships
- One to 10 F/A-18, or MPA firing aircraft
- One or two HH-60H, MH-60R/S, or SH-60B helicopters
- One E-2 aircraft for Command and Control
- One firing submarine
- One to three range clearance aircraft.

Some or all of the following weapons could be employed:

- Two to four Harpoon surface-to-surface or air-to-surface missiles
- Two to eight air-to-surface Maverick missiles
- Two to 16 MK-82 / MK-84 General Purpose Bombs
- Two to four Hellfire air-to-surface missiles
- One or two SLAM-ER air-to-surface missiles
- Fifty to 500 rounds 5-inch and 76 mm gun
- One MK-48 heavyweight submarine-launched torpedo
- Two to Ten Thousand rounds .50 cal and 7.62 mm.

Major Range Events

Table D-42: Annual Major Exercise Activities in the Mariana Islands Range Complex

MIRC EIS/OEIS		Major Exercises							
Exercise		Joint Expeditionary Exercise (CSG + ESG)	Joint Multi-strike Group Exercise (3 CSG + USAF)	Fleet Strike Group Exercise (CSG)	Integrated ASW Exercise (CSG)	Ship Squadron ASW Exercise (CRU DES)	MAGTF Exercise (STOM/ NEO)	SPMAGTF Exercise (HADR/ NEO)	Urban Warfare Exercise
Exercise Sponsor		US PACOM	US PACOM	C7F	C7F	C7F	III MEF	III MEF; MEU/UDP	III MEF; MEU/ UDP
Alternative: No Action		1 of the above		0	0	0	1	0	2
Alternative 1		1	1	0	0	0	4	2	5
Alternative 2		1	1	1	1	1	4	2	5
Primary Training Site		Tinian	MI Maritime >12 nm	MI Maritime >12 nm	MI Maritime >3 nm	MI Maritime >3 nm	Tinian	Guam	Guam
Secondary Training Sites		Nearshore to OTH: Guam: Rota; Saipan; FDM	FDM	FDM	FDM	N/A	Nearshore to OTH: Guam: Rota; Saipan; FDM	Tinian, Rota, Saipan	Tinian, Rota, Saipan
Activity Days per Exercise		10	10	7	5	5	10	10	7-21
Exercise Footprint									
NAVY SHIPS	CVN	1	3	1	1	0	0	0	0
	CG	1	3	1	1	1	0	0	0
	FFG	2	3	1	1	1	1	0	0
	DDG	5	12	3	3	3	2	0	0
	LHD/ LHA	1	0	1	0	0	1	1	1
	LSD	2	0	0	0	0	2	1	1
	LPD	1	0	0	0	0	1	1	1
	TAOE	1	3	1	0	0	0	0	N/A
	SSN	1	5	1	1	1	0	0	N/A
	SSGN	1	0	0	0	0	1	0	0
	T-AGO (LFA)	2	2	N/A	N/A	N/A	N/A	N/A	N/A
Partner National Ships	CG	1	0	0	0	0	0	0	N/A
	DDG	2	0	0	0	0	0	0	N/A
	SS	1	1	0	0	0	0	0	N/A
FIXED WING	F/A-18	4 Squadrons	12 Squadrons	4 Squadrons	4 Squadrons	N/A	N/A	N/A	N/A
	EA-6B/ EA-18G	1 Squadron	3 Squadrons	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A
	E-2	1 Squadron	3 Squadrons	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A
	MPA (P-3/8A)	3	5	3	3	3	N/A	N/A	N/A
	AV-8B/F-35	1 Squadron	N/A	1 Squadron	N/A	N/A	N/A	N/A	N/A
	C-130	2	N/A	N/A	N/A	N/A	1	1	1

Table D-42: Annual Major Exercise Activities in the Mariana Islands Range Complex (Continued)

MIRC EIS/OEIS		Major Exercises							
Exercise		Joint Expeditionary Exercise (CSG + ESG)	Joint Multi-strike Group Exercise (3 CSG + USAF)	Fleet Strike Group Exercise (CSG)	Integrated ASW Exercise (CSG)	Ship Squadron ASW Exercise (CRU DES)	MAGTF Exercise (STOM/ NEO)	SPMAGTF Exercise (HADR/ NEO)	Urban Warfare Exercise
Exercise Footprint									
FIXED WING	USAF Bomber	N/A	1 Squadron	N/A	N/A	N/A	N/A	N/A	N/A
	F-15/16/22/35	N/A	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A	N/A
	A-10	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	E-3	1	1	1	N/A	N/A	N/A	N/A	N/A
	KC-10/135/130	1	2	1	N/A	N/A	N/A	N/A	N/A
ROTARY	MH-60R/S	4	12	4	4	4	2	N/A	N/A
	SH-60H	4	12	4	4	4	N/A	N/A	N/A
	HH-60H	4	12	4	4	N/A	N/A	N/A	N/A
	SH-60F	3	9	3	3	N/A	N/A	N/A	N/A
	CH-53	4	N/A	4	N/A	N/A	4	4	4
	CH-46	12	N/A	12	N/A	N/A	12	12	12
	AH-1	4	N/A	4	N/A	N/A	4	4	4
	UH-1	2	N/A	2	N/A	N/A	2	2	2
	MV-22 FY10 (replace CH-46)	10	N/A	10	N/A	N/A	10	10	10
UAS	Ship Based	2	3	1	1	0	1	0	0
	Ground Based	2	1	0	0	0	2	1	1
Landing Craft	LCAC	3-5	N/A	N/A	N/A	N/A	3-5	3	N/A
	LCU	1-2	N/A	N/A	N/A	N/A	1-2	1	N/A
	CRRC	18	N/A	N/A	N/A	N/A	18	18	0
GCE	AAV	14	N/A	N/A	N/A	N/A	14	3	3
	LAV	13	N/A	N/A	N/A	N/A	5	5	5
	HMMWV	78	N/A	N/A	N/A	N/A	78	16	16
	Ground Personnel	1200	N/A	N/A	N/A	N/A	1200	250	250
LCE	Trucks	36	N/A	N/A	N/A	N/A	36	8	8
	Dozer	2	N/A	N/A	N/A	N/A	2	1	1
	Forklift	6	N/A	N/A	N/A	N/A	6	2	2
	ROWPU	2	N/A	N/A	N/A	N/A	2	1	1
	RHIB	2	N/A	N/A	N/A	N/A	2	2	2
	Ground Personnel	300	N/A	N/A	N/A	N/A	300	60	60

Joint Expeditionary Exercise

The Joint Expeditionary Exercise brings different branches of the U.S. military together in a joint environment that includes planning and execution efforts as well as military operations at sea, in the air, and ashore. The purpose of the exercise is to train a U.S. Joint Task Force staff in crisis action planning for execution of contingency operations. It provides U.S. forces an opportunity to practice training together in a joint environment as well as a combined environment with partner nation forces, where more than 8,000 personnel may participate.

The participants and assets could include:

- Fleet and Battle Group Staffs
- Aircraft carrier
- Cruisers
- Guided missile destroyers
- Amphibious command and assault ships
- Submarines
- Mobile logistic ships
- Naval and Air Force aircraft
- Marine Expeditionary Units (MEU)
- Army Infantry Units.

Military operations would be conducted at sea and in the air near, and ashore on Tinian, FDM, Guam, and Saipan.

Training in Urban Environment Exercise (TRUEX)

TRUEX is a MEU integration level exercise conducted over a period of weeks. MEU personnel enhance the skills needed for military operations in an urban environment. Events typically take place on Guam and utilize Finegayan Housing, Andersen South, Barrigada Housing, and Northwest Field. TRUEX has been conducted in Saipan as part of the Joint Expeditionary Exercise. TRUEX on Tinian and Rota is possible however due to distance and lack of infrastructure support they are secondary sites.

Joint Multi-Strike Group Exercise

The Joint Multi-Strike Group Exercise demonstrates the Navy’s ability to operate a large naval force of up to three Carrier Strike Groups in coordination with other Services. In addition to this joint warfare demonstration, it also fulfills the Navy’s requirement to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The Joint Multi-Strike Group conducts training involving Navy assets engaging in a schedule of events battle scenario, with U.S. forces pitted against a notional opposition force. Participants use and build upon previously gained training skill sets to maintain and improve the proficiency needed for a mission-capable, deployment-ready unit. The exercise includes the at sea activities described below:

Command and Control (C2): A command organization exercises operational control of the assets involved in the exercise. This control includes monitoring for safety and compliance with protective measures.

Air Warfare (AW): AW includes missile exercises which involve firing live missiles at air targets. Ships and aircraft fire missiles against air targets. AW also includes non-firing events such as Defensive Counter Air (DCA). DCA exercises ship and aircrew capabilities at detecting and reacting to incoming airborne threats.

Anti-Surface Warfare (ASUW): Naval forces control sea lanes by countering hostile surface combatant ships. Two methods will be utilized for neutralizing opposition force ships: Maritime Interdiction (MI) and Air Interdiction of Maritime Targets (AIMT). MI is the use of Navy ships to counter the surface threat, while AIMT involves the use of U.S. aircraft. Two SINKEX may be conducted. These are live-fire events in which ship hulks are fired upon and sunk. The firing platforms can include aircraft, surface ships, and submarines.

Anti-Submarine Warfare (ASW): During ASW activities, air, surface and submarine units would be used to locate and track opposition force submarines. Methods used to locate and track submarines include acoustic (active and passive sonar), visual, and electronic. ASW may include the use of Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA).

Fleet Strike Group Exercise

The Fleet Strike Group Exercise is a one week event focused on sustainment training for the forward deployed Carrier Strike Group and may integrate joint operations with the U.S. Air Force and U.S. Marine Corps in the Western Pacific. The exercise focuses on integrated joint training among U.S. military forces in the maritime environment with an ASW threat; enabling real-world proficiency in detecting, locating, tracking and engaging units at sea, in the air, and on land, in response to a range of mission areas.

Integrated ASW Exercise

This is a five day Anti-Submarine Warfare (ASW) exercise conducted by the forward deployed Navy Strike Groups to sustain and assess their ASW proficiency while located in the Seventh Fleet area of operations. The exercise is designed to assess the Strike Groups' ability to conduct ASW in the most realistic environment, against the level of threat expected, in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of U.S. Navy Strike Groups. The Strike Group receives significant sustainment training value in ASW and other warfare areas, as training is inherent in all at-sea exercises.

The Strike Group must demonstrate strike warfare capabilities of the strike group while establishing and maintaining control over any threats posed by submarines. CSGs must demonstrate the ability to enter a theater, transit through littoral or simulated littoral waterspace that restricts the maneuverability of the strike group, establish an operating area, and conduct air strikes against land and sea based targets. The ESG must demonstrate the ability to enter a theater, transit through littoral or simulated littoral waterspace that restricts the maneuverability of the strike group, establish an operating area, and conduct amphibious warfare operations in a shallow littoral or simulated littoral environment.

Ship Squadron ASW Exercise

The Ship Squadron ASW Exercise overall objective is to sustain and assess surface ship ASW readiness and effectiveness. The exercise typically involves multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less. Maximizing opportunities to collect high-quality data to support quantitative analysis and assessment of operations is an additional goal of this training.

Marine Air Ground Task Force (Amphibious) Exercise

Ship to Objective Maneuver / Noncombatant Evacuation Operation (STOM / NEO)

This exercise may last up to ten days and conducts over the horizon, ship to objective maneuver of the elements of the ESG and the Amphibious MAGTF. The exercise utilizes all elements of the MAGTF to secure the battlespace (air, land, and sea), maneuver to and seize the objective, and conduct self-sustaining operations ashore with continual logistic support of the ESG. Tinian is the primary MIRC training area for this exercise; however elements of the exercise may be rehearsed nearshore and on Guam.

Table D-43: Ship to Objective Maneuver/Noncombatant Evacuation Operation (STOM/NEO)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
AMPHIBIOUS WARFARE (AMW)						
Amphibious Assault Marine Air Ground Task Force (MAGTF)	1 LHA or LHD, 1 LPD, 1 LSD, 1 CG or DDG, and 2 FFG.	4-14 AAV/EFV or LAV/LAR; 3-5 LCAC; 1-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8; Includes temporary FARP construction.	1 event (assault, offload, backload)	4 events (assault, offload, backload)	4 events (assault, offload, backload)	PRI: Tinian Military Leased Area; Unai Chulu, Dankulo and Babui (beach) and Tinian Harbor; North Field. SEC: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Sumay Cove and MWR Ramp; Tipalao Cove and Dadi Beach

Special Purpose Marine Air Ground Task Force Exercise:

Humanitarian Assistance / Disaster Relief / Noncombatant Evacuation Operations [NEO]

Marine Corps units bring relief to or evacuate noncombatants from an area where the lives of the people are endangered by war, civil unrest, or natural disaster.

Training Scenario

Special Purpose MAGTF, operating in conjunction with Navy ships and aircraft, typically conduct humanitarian and disaster relief, or evacuation of noncombatants from foreign countries to safe havens or back to the United States when their lives are endangered by war, civil unrest, or natural disaster. Normally, there is no opposition from the host country; however Marine Corps Special Purpose MAGTF or MEU(SOC)s normally train for evacuation under a circumstance that requires the use of force in a hostile environment. Much like a raid, a NEO involves the rapid introduction of forces, the evacuation of non-combatants, and a planned withdrawal. A MEU(SOC), H-53, H-46, or H-60 helicopters, LCACs or other landing craft could be expected to participate in this operation during day or night. Guam is the primary training are for this exercise.

Table D-44: Special Purpose Marine Air Ground Task Force Exercise

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
SPECIAL/EXPEDITIONARY WARFARE						
Humanitarian Assistance/ Disaster Relief Operation (HADR)	Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 or MV-22	1 event, 3-10 days	2 events	2 events,	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field; Rota Airfield/West Harbor.
Non-Combatant Evacuation Operation (NEO)	Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 or MV-22	1 event, 3-10 days	2 events,	2 events,	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu, Dankulo, and Babui (beach) and Tinian Harbor; North Field. Rota Airfield/West Harbor

Ordnance use by training area

Table D-45: Summary of Ordnance Use by Training Area in the MIRC Study Area[1]

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
FDM (R-7201)	**BOMBEX [A-G]; MISSILEX [A-G]; GUNEX [A-G]; NSFS**		
Inert Bomb Training Rounds ≤ 2000 lb (nominal weight)	1,800	2,800	3,000
Bombs (HE) ≤ 500 lb (nominal weight)	400	500	600
Bombs (HE) 750 / 1000 / 2000 lb (nominal weight)	1,600	1,650	1,700
Missiles [Maverick; Hellfire; TOW]	30	60	70
Cannon Shells (20 or 25 mm)	16,500	20,000	22,000
Cannon Shells (30 mm)	0	1,500	1,500
AC-130 Cannon Shells (40mm or 105mm)	100	200	200
5-inch Gun Shells	400	800	1,000
Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]	2,000	3,000	3,000
PRIMARY: Guam Maritime > 3 nm from land SECONDARY: W-517	**TORPEX**		
MK-48/MK-46/MK-50/MK-54 EXTORP	20	40	48
MK-46/ MK-50/MK-54 REXTORP	0	7	14
MK-84 SUS (Signal Under Surface Device, Electro-Acoustic)	20	40	48

Table D-45: Summary of Ordnance Use by Training Area in the MIRC Study Area[1] (Continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
PRIMARY: W-517 **SECONDARY: Marianas Maritime > 12 nm; ATCAAs**	**MINEX; BOMBEX [A-S]; MISSILEX [A-S; S-A; A-A; S-S]; GUNEX [S-S; A-S]; CHAFFEX; FLAREX**		
Air Deployed Mines [MK-62; MK-56] (inert)	320	480	480
Inert Bomb Training Rounds [MK-82 I; BDU-45; MK-76]	48	72	90
MK-82/83/84 / JDAM	1	4	4
5-inch Gun Shells	160	320	400
HELLFIRE	0	2	2
76 mm Gun Shells	60	120	150
.50 cal MG	4,400	16,000	16,000
25 mm MG	1,600	8,000	8,000
7.62 mm MG	30,000	40,000	40,000
20 mm; 25 mm; 30 mm Cannon Shells	8,000	18,500	19,500
RR-144A/AL Chaff Canisters	520	740	920
RR-188 Chaff Canisters	1,500	5,000	5,500
MK-214; MK-216 Chaff Canisters	72	90	108
MK-46 MOD 1C; MJU-8A/B; MJU-27A/B; MJU-32B; MJU-53B; SM-875/ALE Flares	520	740	920
MJU-7; MJU-10; MJU-206 Flares	1,500	5,000	5,500
AIM-7 Sparrow	4	6	8
AIM-9 Sidewinder	4	6	8
AIM-120 AMRAAM	4	6	8
RIM-7 Sea Sparrow/ RIM-116 RAM / **RIM-67 SM II ER**	2	4	6

Table D-45: Summary of Ordnance Use by Training Area in the MIRC Study Area[1] (Continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
PRIMARY: Marianas Maritime > 3 nm **SECONDARY: W-517**	**TRACKEX; GUNEX [S-S]**		
EER/IEER/AEER	103	106	115
5.56 mm; 7.62 mm; .50 cal; 40 mm	12,000	16,000	20,000
PRIMARY: W-517 **SECONDARY: Marianas Maritime > 50 nm; ATCAAs**	**SINKEX**		
HARM	2	4	4
SLAM-ER	4	8	8
HARPOON	5	10	10
5-inch Gun Shells	400	800	800
HELLFIRE	2	4	4
MAVERICK	8	16	16
GBU-12	10	20	20
GBU-10	4	8	8
MK-48	1	2	2
Underwater Demolitions [100 lb NEW]	2	4	4
PRIMARY: Agat Bay (10 lb NEW max) **SECONDARY: Apra Harbor (10 lb NEW max)**	**Underwater Demolition**		
5 – 10 lb NEW	22	30	30
PRIMARY: Agat Bay (10 lb NEW max) **SECONDARY: Piti (10 lb NEW max)**	**Floating Mine Neutralization**		
5 – 10 lb NEW	8	20	20

[1.] Baseline ordnance expenditure estimates were made from review of FY03-07 service records, databases, schedules, and estimates

Sonar Activity

Table D-46: Summary of Sonar Activity by Exercise Type in the MIRC Study Area

Exercise Type	No Action	Alternative 1	Alternative 2
Multi-Strike Group: One; [3] CSG; April – September; [10] Days	**Activity Guidelines Per CSG: [4] SQS-53; [1] SQS-56 ; [2] Dips per hour; [1] EER/IEER/AEER per hour until 100; [16] DICASS per hour; Reset Time -12 hours**		
Events Per Year	0 or 1 (One Multi-Strike Group Exercise or One Joint Expeditionary Exercise)	1	1
SQS-53	1705 hours	1705 hours	1705 hours
SQS-56	77 hours	77 hours	77 hours
AQS-22	288 dips	288 dips	288 dips
DICASS	1282	1282	1282
Sub BQQ	0	0	0
LFA	LFA support activity conducted in accordance with LFA FEIS		
SINKEX : Two [2] Day Event	**Activity Guidelines: Sonar Hours in TRACKEX/TORPEX below**		
Events Per Year	1	2	2
DICASS	100	200	200
MK-48 (HE)	1	2	2
Joint Expeditionary: One [1] CSG + ESG; [10] Days	**Activity Guidelines: [3] SQS-53; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0 or 1 (One Multi-Strike Group Exercise or One Joint Expeditionary Exercise)	1	1
Fleet Strike Group: One [1] CSG; [7] Days	**Activity Guidelines: [4] SQS-53; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0	0	1
Integrated ASW: One [1] CSG; [5] Days	**Activity Guidelines: [4] SQS-53; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0	0	1

Table D-46: Summary of Sonar Activity by Exercise Type in the MIRC Study Area (Continued)

Exercise Type	No Action	Alternative 1	Alternative 2
Ship Squadron ASW: One [1] DESRON; [5] Days	**Activity Guidelines: [4] SQS-53; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0	0	1
MAGTF Exercise (STOM/NEO)	**Activity Guidelines: [2] SQS-53; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	1	4	4
ASW TRACKEX (SHIP) : One [1] Reset, One [1] Day Event	**Activity Guidelines: [2] SQS-53, [1] SQS-56; Reset Time - 8 hours (sub target), 4 hours (non-sub target); [3] 53C/D, ½ Time Active, [1] 56, ¼ Time Active**		
Events Per Year	10	30	60
SQS-53 C/D	120 hours	360 hours	720 hours
SQS-56	20 hours	60 hours	120 hours
ASW TRACKEX (HELO) : One [1] Reset, One [1] Day Event	**Activity Guidelines: [2] HELO; [1] Dipping HELO 2 dips per hour; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events Per Year	9	18	62
AQS-22	144 dips	288 dips	576 dips
DICASS	36	72	144
ASW TRACKEX (MPA) : One [1] Reset, [1] Day Per Event	**Activity Guidelines: [1] MPA; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events Per Year	5	8	17
DICASS	50	80	170
EER/IEER/AEER	5	8	17
ASW TORPEX (SUB) : One [1] Reset, [1] Day Per Event; [1] EXTORP Per Event	**Activity Guidelines: [1] SSN or SSGN; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events Per Year	5	10	12
Sub BQQ	6 hours	12 hours	15 hours
MK-48 EXTORP	20	40	48

Table D-46: Summary of Sonar Activity by Exercise Type in the MIRC Study Area (Continued)

Exercise Type	No Action	Alternative 1	Alternative 2
ASW TORPEX (SHIP): One [1] Reset, [1] Day per Event; [1] REXTORP	**Activity Guidelines: [2] SQS-53, [1] SQS-56; Reset Time - 8 hours (sub target), 4 hours (non-sub target); ½ Time Active**		
Events per Year	0	3	6
SQS-53 C/D	0	8 hours	16 hours
SQS-56	0	4 hours	8 hours
REXTORP	0	3	6
ASW TORPEX (MPA/HELO): One [1] Reset, One [1] Day Event; [1] REXTORP	**Activity Guidelines: [2] HELO; [1] Dipping HELO; [1] MPA; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events per Year	0	4	8
AQS-22	0	16 dips	32 dips
DICASS	0	20	40
REXTORP	0	4	8
Portable Underwater Tracking Range	**Activity Guidelines: [4] MK-84 Range Pinger; [7] Transponders; Exercise Time – 8 hours; Reset Time – 24 hours.**		
PUTR Range Days	0	35	35

This page intentionally left blank.

APPENDIX E

WEAPON AND RANGE SYSTEMS

Descriptions of weapon and range systems used in the MIRC.

This Page Intentionally Left Blank.

TABLE OF CONTENTS

LIST OF FIGURES

There are no figures in this section.

LIST OF TABLES

LIST OF ATTACHED WEAPON and RANGE SYSTEM REFERENCES

a. Fact sheets for Common Targets and Weapons used in the Mariana Islands Range Complex

b. Naval Surface Warfare Center, Corona: Laser Range Safety Report for Commander United States Naval Forces, Mariana Islands, Guam. September 2009.

c. NAVSEA Warfare Center Newport, Portable Underwater Training Range Concept of Operations, pages 8 – 16 (summary), Doc. No. PUTR-PM-002 Version 1, 10 OCT 2006

This page intentionally left blank.

Table E-1: Missile Exercise Weapons Used in the MIRC

TYPE	CHARACTERISTICS				
	Weight	**Length**	**Diameter**	**Range**	**Propulsion**
Air-to-Air Missiles					
			Short Range		
Sidewinder (AIM-9)	84.4 kg (186 lb)	2.9 m (9 ft 6 in)	127 mm (5 in)	18.5 km (10 nm)	Solid fuel
			Medium Range		
Sparrow (AIM-7)	231 kg (510 lb)	3.6 m (11 ft 10 in)	203.2 mm (8 in)	55.6 km (30 nm)	Solid fuel
Slammer (AIM-120)	151 kg (335 lb)	3.7 m (12 ft)	18 cm (7 in)	33km (18 nm)	Solid fuel
			Air-to-Surface Missiles		
			Medium Range		
TOW (BGM-71)*	18.9 kg (41.67 lb)	1.16 m (3.81 ft)	0.152 m (0.50 ft)	3,750 m (2.02 nm)	Solid fuel
Hellfire (AGM-114)	45.77 kg (100.9 lb)	1.63 m (64 in)	17.78 cm (7 in)	8000 m (4.3 nm)	Solid fuel
Maverick (AGM-65)	136 kg (300 lb)	2.49 m (98 in)	30.48 cm (12 in)	27 km (12 nm)	Solid fuel
HARM (AGM-88)	366.1 kg (807 lb)	4.2 m (13 ft 9 in)	254 mm (10 in)	18.5 km (10 nm)	Solid fuel
			Extended Range		
Harpoon (AGM 84)	515.25 kg (1,145 lb}	3.84 m (12 ft 7 in)	24.29 cm (13.5 in)	111+ km (60+ nm)	Turbojet
SLAM-ER	635.04 kg (1,400 lb)	4.36 m (14 ft 4 in)	24.29 cm (13.5 in)	278+ km (150+ nm)	Turbojet
			Surface-to-Air Missiles		
Sea Sparrow (RIM-7)	225 kg (500 lb)	3.64 m (12 ft)	20.3 cm (8 in)	19+ km (10+ nm)	Solid fuel
RAM (RIM-116) Block 1	73.5 kg (162 lb)	278 cm (109.4 in)	12.7 cm (5 in)	7.5 km (4.5 nm)	Solid fuel
SM-2 ER (RIM-67)	1341 kg (2,980 lb)	7.9 m (26.2 ft)	1.6 m (5 ft 2 in)	185 km (100 nm)	Solid fuel

Source: U.S. Department of the Navy 1998a

Notes:

* Describes the Variant BGM-71B.

Table E-2: Aviation Range Systems Used in the MIRC

TYPE	CHARACTERISTICS			
	Length	Speed (Maximum)	Operational Altitude (Maximum)	Time on Station (Maximum)
Subsonic				
TALD/ITALD	2.34 m (7ft 8in)	Mach 0.84	12,200 m (40,000 ft)	23.2 minutes
BQM-74E	4 m (13 ft)	525 knots	12,308 m (40,000 ft)	68 minutes

Source: U.S. Department of the Navy 1998a

Notes: N/A: Not Applicable; TALD: Tactical Air Launched Decoy; ITALD: Improved TALD.

Table E-3: Surface and Subsurface Range and Target Systems Used in the MIRC

Type	Category	Name	Fuel Type
Balloon			
	Aerial	Balloon	N/A
Surface			
	Floating	MK-58 (Smoke Float)	N/A
		Ship Hulk	N/A
		Stationary Barge	N/A
		Radar Reflective Surface Balloon (Killer Tomato)	N/A
		Barrel on a Pallet	N/A
		Torpedo Retriever Boat	DFM
		High Speed Maneuvering Surface Target (Proposed)	MOGAS
		QST-35 Tow Boat (Proposed)	DFM
		Low Cost Modular Target (Proposed)	Towed
		Improved Surface Towed Target (Proposed)	Towed
	Land	Hi-fidelity shapes (SAM Launcher)	N/A
		Paper Silhouette	N/A
Sub Surface			
	Self-propelled	EMATT	Battery
		MK-30	Battery
		MK 84 Range Pingers	Battery
		Portable Underwater Tracking Range Transponders (Proposed)	Battery
		Portable Underwater Tracking Range Support Boat	DFM

Source: U.S. Department of the Navy 1988a; Notes: N/A Not Applicable

Table E-4: Weapons Used in the Mariana Islands Range Complex

Type	Category	Name	Propellant Type (Liquid/Solid)
Air Deployed Mines			
	Air	MK-62; MK-56 (non-explosive/inert)	N/A
Underwater Charges			
	NSW and EOD Divers	10 lb / 5lb NEW (C-4) charges for Underwater Detonation or Mine Neutralization. 100 lb NEW for SINKEX.	N/A
Missiles			
	Air	Captive Air Training Missile (CATM)-9	N/A
	Air	Hellfire (AGM-114)	Solid
	Air	TOW (BGM-71)	Solid
	Air	Sparrow (AIM-7)	Solid
	Air	Sidewinder (AIM-9)	Solid
	Air	Slammer (AIM 120)	Solid
	Air	HARM (AGM-88)	Solid
	Air	SLAM ER	Turbojet
	Air/Ship/Undersea	Harpoon (A/R/UGM-84)	Turbojet
	Ship	Sea Sparrow (RIM-7)	Solid
	Ship	RAM (RIM-116)	Solid
	Ship	SM-2 ER (RIM-67)	Solid
Guns			
	Ship	Large Caliber Naval Guns (5” and 76mm)	N/A
	Ship	Mk-38 25 mm Machine Gun	N/A
	Ship	Phalanx/Vulcan (20mm)	N/A
	Ship	9 mm pistol	N/A
	Ship	5.56/7.62 mm/.50 caliber guns	N/A
	Ship	Small Caliber (M-16, M-4, M-249 squad automatic weapon, M-240G machine gun)	N/A
	Ship	M-40 sniper rifle (.308 cal)	N/A
	Air	Small Caliber (.50 cal, 7.62 mm, 9 mm, 5.56 mm, .308 cal)	N/A
	Air	20 mm cannon and 25 mm cannon	N/A
	Air	40mm Bofors and 105mm cannon (AC-130)	N/A
Bombs			
	Air	Mk-82 or GBU-30/38 JDAM (HE and NEPM)	N/A
	Air	Mk-83 or GBU-32 JDAM (HE and NEPM)	N/A
	Air	MK-84 or GBU-31 JDAM (HE)	N/A
	Air	GBU-10	N/A
	Air	GBU-12	N/A
	Air	GBU-16	N/A

Type	Category	Name	Propellant Type (Liquid/Solid)
	Air	M-117	N/A
	Air	BDU-33	N/A
	Air	BDU-50	N/A
	Air	BDU-56	N/A
	Air	BLU-111	N/A
	Air	LGTR (NEPM)	N/A
	Air	BDU-45 (NEPM)	N/A
	Air	MK-76 (NEPM)	N/A
Torpedoes			
	Sub	MK-48 and MK-48 EXTORP	Liquid
	Ship/Helo/MPA	MK-46; MK-50; MK-54 EXTORP	Liquid

Source: Adapted from U.S. Department of the Navy 1998a; Note: N/A Not Applicable.

Table E-5: Electronic Warfare Assets Used in the Mariana Islands Range Complex

TYPE	CHARACTERISTICS	
	Frequency Bands	Power Output (Maximum)
Threat Simulators (Airborne)		
AN/AST6DPT-1(V)	Version V10 7.8-8.5 GHZ	15 MW
	Version V20 8.5-9.6 GHZ	20 MW
	Version V30 14-15.2 GHZ	25 MW
	Version V42 15.5-17.5 GHZ	30 MW
AN/AST 9	Version India (M) 8.5-9.6 GHZ	20 MW
	Version India (T) 8.5-9.6 GHZ	115 KW
	Version Juliet (M) 14-15.2 GHZ	25 MW
	Version Juliet (T) 14-15.2 GHZ	115 KW
Radar Jamming Systems (Airborne)		
AN/ALQ 167	Version V38 425 to 445 MHZ	800 W
	Version V39 902-928 MHZ	800 W
	Version V46 2.9-3.5 GHZ	800 W
	Version V15a/6X 9-10.2 GHZ	800 W
Communications Jamming System (Airborne)		
AN/USQ-113	Version V1 20-500 MHZ	400 W
Chaff (Passive system)		
RR-144A/AL	N/A	N/A
RR-188	N/A	N/A
MK-214	N/A	N/A
MK-216	N/A	N/A
Flares (Infrared Countermeasures)		
Mk-46 MOD 1C	N/A	N/A
MJU-8A/B	N/A	N/A
MJU-27A/B	N/A	N/A
MJU-32B	N/A	N/A
MJU-53B	N/A	N/A
MJU-7	N/A	N/A
MJU-10	N/A	N/A
MJU-24	N/A	N/A
MJU-206	N/A	N/A
SM-875/ALE	N/A	N/A

Source: Adapted from U.S. Department of the Navy 1998a.

This page intentionally left blank.

APPENDIX E

Reference

A. Fact sheets for Common Targets and Weapons used in the Mariana Islands Range Complex

This page intentionally left blank.

TYPICAL EXISTING TARGET SYSTEMS IN USE

This page intentionally left blank

AIR TARGETS

This page intentionally left blank

NORTHROP GRUMMAN

DEFINING THE FUTURE™

The Navy's Premier Aerial Target
The linchpin in RDT & E and training operations since 1978.

BQM-74E

Delivering High Performance at Low-Cost and Supporting More Than 80 Percent of the U.S. Navy's Target Missions

The BQM-74E is a turbojet-powered aerial target with high performance capabilities. While emulation of enemy anti-ship cruise missiles is the primary mission; others include simulation of aircraft for training naval aviators in air-to-air combat and support of the test and evaluation of new weapon systems. The BQM-74E and its ground support system are highly portable. This attribute enables shipboard operations in support of deployed naval combatants where maximum flexibility and rapid turnaround are required.

The BQM-74E can carry a variety of internal and wing tip-mounted payloads in support of mission requirements. Payloads include passive and active radar augmentation, infrared (IR) flares, electronic countermeasures (ECM), seeker simulators, scoring, IFF, and dual wing tip-mounted tow bodies. The Integrated Avionics Unit, with its integral Inertial Measurement Unit (IMU), Air Data Computer, and Global Position System (GPS), provides a highly accurate navigation solution. Recently incorporated Low Altitude Control Enhancement (LACE II) software allows the vehicle to perform complex, programmable, 3-dimensional maneuvers and operate down to altitudes of 7 feet.

The BQM-74E can be used with multiple command and control systems, including the Integrated Target Control System (ITCS), Multiple Aircraft GPS Integrated Command Control (MAGIC2), Vega, and System for Naval Target Control (SNTC). It can be employed in either a manual mode or a pre-programmed (hands off) mode.

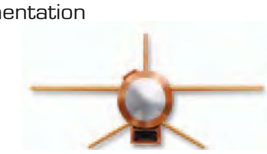
Since 1968, the MQM/BQM-74 series of aerial targets has been the workhorse of the Navy's subsonic aerial target inventory. Due to its exceptional performance and mission reliability, the BQM-74E has provided over 80 percent of all U.S. Navy target presentations.

Specifications

Length	12.95 ft (4.0 m)
Wingspan	5.78 ft (1.8 m)
Range	>350 nm (648.6 km)
Altitude	
Low	7 ft (2.1 m)
High	40,000 ft (12.2 km)
Speed	>515 Knots at Sea Level
Weight	455 lbs (206.4 kg)
Endurance	78 Minutes
Navigation	GPS/IMU
Fuel	Jet Fuel (JP-5, JP-8, or Jet A-1)

Payloads

- Passive or Active Radar Augmentation
- Seeker Simulators
- Infrared Augmentation
- Tow Systems
- Scoring Systems
- IFF
- Electronic Countermeasures



Northrop Grumman Corporation • Unmanned Systems
P.O. Box 509066 • San Diego • California 92150-9066 • www.northropgrumman.com
Contact: Cynthia Curiel • 858.618.4355 • E-Mail: cynthia.curiel@ngc.com
452-AS-3990_06.05 • Approved for Public Release • Distribution Unlimited
USN 209/04, 01/05/05 • TDEA 05504

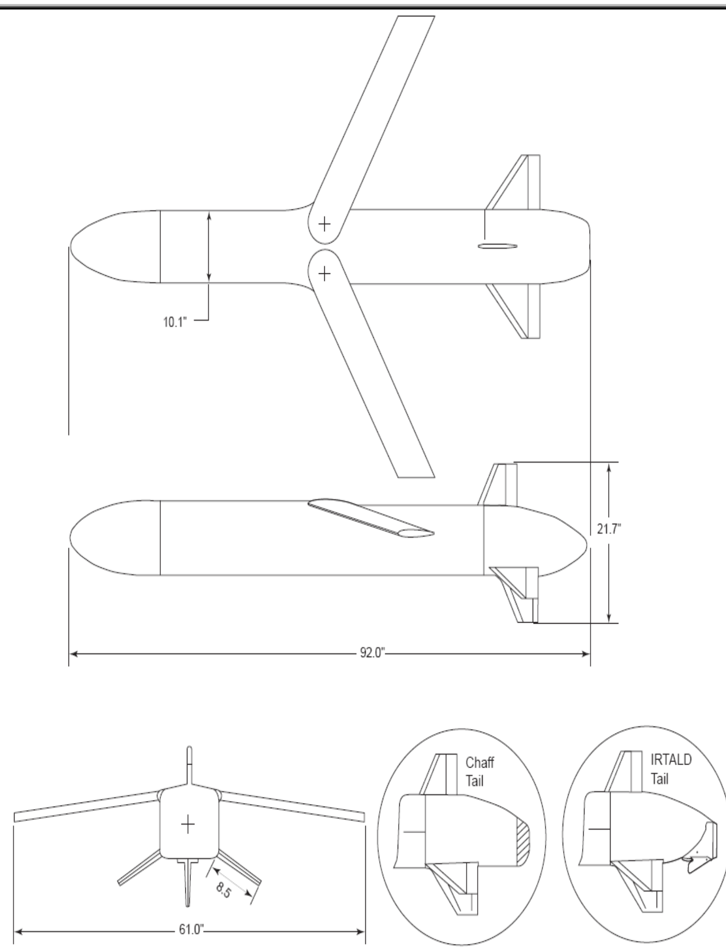
AN-ADM-141A/B Tactical Air-Launched Decoy (TALD)

Description

The TALD (AN-ADM-141A/B) is an expendable glide vehicle with a square fuselage, flip-out wings, and three tail control surfaces. The wings, which are folded during carriage, open 3 seconds after launch. The necessary command sequences are pre-programmed on the ground. The AN-ADM-141A has passive and active radar enhancers.

The TALD is cleared for launch from S-3, A-4, F-4, A-6, A-7, F-14, F/A-18, AV-8 & UK GR7 platforms.

Physical Characteristics



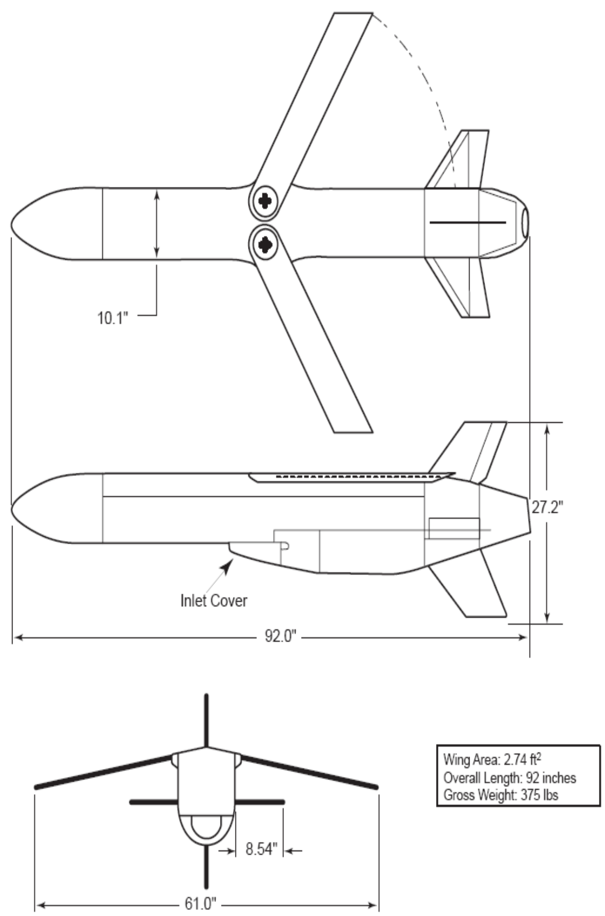
AN-ADM-141C Improved Tactical Air-Launched Decoy (ITALD)

Description

The ITALD (AN-ADM-141C) is a modified propelled version of the TALD which incorporates a turbojet engine, the Teledyne CAE J700-CA-400. The engine starts after launch produces 170 lbs, has a 5.7 gallon fuel bladder and uses JP-10. This engine provides three constant airspeed settings. The necessary command sequences are pre-programmed on the ground. The ITALD is capable of climbs and descents, left or right turns, or an offset maneuver.

The ITALD is only carried on the F/A18C&D. It carries a max loadout of 6 ITALDs.

Physical Characteristics



This page intentionally left blank

SURFACE TARGETS

This page intentionally left blank

Ship Deployable Surface Target (SDST)

Description

The Ship Deployable Seaborne Target (SDST) is a high-speed commercial personnel watercraft. It is designed to provide a remotely controlled target, which can be augmented to present various threat scenarios.

SDST is unique in that it can be launched from Navy ships as well as any standard boat launch ramp. It can operate in at approximately 40 knots in sea state 1 and in a sea state 2 at approximately 20 knots.

Physical Characteristics

Length:	10.8 ft.
Beam:	4 ft.
Freeboard:	N/A
Draft (when static):	1.7 ft.
Hull Construction:	Fiberglass Reinforced Plastic

Performance Data

Maximum Speed:	40 kts. Sea State 1
	20 kts. Sea State 2

Williams Sled

Description

The Williams Sled Tow Target is a surface gunnery target consisting of a tubular framework mounted on two pontoons. The target is towed by approximately 5,000 feet of double-braided nylon line by a seagoing tug at approximately 10 knots or utilized as a freely drifting target. Wire fabric screens are mounted on both sides of the upper quarter of the framework to provide radar augmentation.

Physical Characteristics

Length:	27.8 ft.
Beam:	14 ft.
Freeboard:	10 in. to top of pontoon
Draft:	1.0 ft.
Hull Construction:	Steel

Performance Data

Maximum Tow Speed:	10 kts. Sea State 2

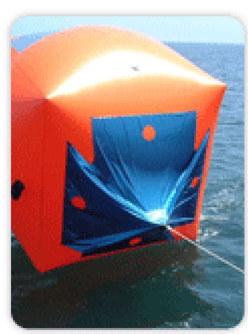
Radar Reflective Surface Balloon (Killer Tomato™)

Description

Killer Tomato™ Naval Gunnery Target balloon is an adrift target designed to stand upright on the wave surface without tumbling over in moderate sea states. Yields a radar signature to ship borne radar equipment from corner reflectors mounted in top corners of target. Can be detected 10+ miles away depending on radar equipment and sea state.

Physical Characteristics

This target has a self filling integrated drogue chute / skirt secure bottom of target to sea surface. It is air inflated, bright orange, 3 m^3 (10 x 10 x 10 feet) in size. Made with 12 mil PVC. Stainless steel metal "D-rings" for tie down, handling, minor towing, or floating trip line for recovery purposes. Integrated, self-deploying, drogue chute (no external sea anchor to buy and rig) reduces target wind drift and keeps target useful in more demanding sea state situations. Can be towed once chute is disabled or water ballast is tipped out using tie line. Radar reflective.



Mk 42 Floating At-Sea-Target (FAST)

Description	Physical Characteristics	
The Floating At-Sea-Target (FAST) MK42 Mod 0 is a polygon (isodecahedron) shape of 20 sides approximately 6 feet in diameter. It consists of 20 equilateral triangular panels, which are reflector panels. Each reflector panel has nine integral corner reflectors which are coated with conductive paint that provides a radar reflective characteristic simulating the size of a destroyer or frigate-type vessel. FAST is a reusable shipboard assembled target, deployable and recoverable from any Navy ship in weather conditions up to Sea State 3. FAST uses a Sea anchor to maintain stability. Once deployed, FAST can be used as a target in weather conditions of Sea State 4 or 5. In calm seas, the FAST has a visible range of up to 3.5 miles and can be used for surface to surface gunnery training.	Height: Width: Hull Construction:	5.4 ft. 5.4 ft. Aluminum/Plastic

Performance Data

N/A

TYPICAL EXISTING WEAPONS IN USE IN THE MIRC

This page intentionally left blank

Backgrounder

Integrated Defense Systems
P.O. Box 516
St. Louis, MO 63166
www.boeing.com

Harpoon Block II

Description & Purpose:
Harpoon Block II expands the capabilities of the Harpoon anti-ship weapon. Harpoon, the world's most successful anti-ship missile, features autonomous, all-weather, over-the-horizon capability.

Customer(s):
Twenty-eight countries are Harpoon customers.

General Characteristics:

Length:	182.2 in. ship launch, 151.5 in. air launch
Diameter:	13.5 in.
Weight:	1,160 lb. Air configuration 1,459 lb. ASROC configuration 1,520 lb. TARTAR configuration 1,523 lb. Capsule/canister configuration
Range:	In excess of 67 NM
Propulsion:	Air-breathing turbojet engine (cruise), solid-propellant booster
Guidance:	Terminal: Active Radar Midcourse: GPS-aided inertial navigation
Warhead:	Penetration, high-explosive blast
System Elements:	Missile - Common for all launch platforms Booster - For surface, sub and land based applications Launch Support Structure and Canisters Command and Launch System - Provides engagement planning and launch control
Platforms:	Air, land, surface and sub-surface applications

Harpoon Block II provides accurate long-range guidance for land and ship targets by incorporating the low-cost inertial measuring unit from the Boeing Joint Direct Attack Munition (JDAM) program; and the software, mission computer, integrated Global Positioning System/Inertial Navigation System, GPS antenna and receiver from the Standoff Land Attack Missile Expanded Response (SLAM-ER).

The multi-mission Block II is deployable from all current Harpoon missile system platforms with either existing command and launch equipment or the commercially available Advanced Harpoon Weapon Control System (AHWCS).

Background:
Harpoon Block II is capable of executing both anti-ship and land-strike missions. To strike targets on land and ships in port, the missile uses GPS-aided inertial navigation to hit a designated target aimpoint. The 500-pound blast warhead delivers lethal firepower against a wide variety of land-based targets, including coastal defense sites, surface-to-air missile sites, exposed aircraft, port/industrial facilities and ships in port. For conventional anti-ship missions, such as open-ocean and near-land, the GPS/INS eliminates midcourse guidance errors enroute to the target area. The accurate navigation solution coupled with launch system improvements combine to offer better discrimination of target ships from islands, nearby land masses or other ships. These Block II improvements maintain Harpoon's high hit probability against ships very close to land or traveling in congested sea lanes.

Miscellaneous:
More than 7,000 Harpoons have been produced.

Contact: Tim Deaton
Global Strike Systems
The Boeing Company
(314) 232-5886
timothy.r.deaton@boeing.com

August 2008

Backgrounder

Integrated Defense Systems
P.O. Box 516
St. Louis, MO 63166
www.boeing.com

Harpoon Block III

Description & Purpose:
Harpoon Block III takes the world's most successful anti-ship missile to a whole new level. With the addition of a robust data link system, Harpoon Block III provides in-flight target updates, positive terminal control and connectivity with future network architecture, resulting in more control after the weapon is released. The data link is the perfect addition to a missile that already provides autonomous, all-weather, over-the-horizon capability.

Customer(s):
The Harpoon Block III Weapon System will provide the U.S. Navy and its allies with Surface Warfare (SuW) capabilities from ships and aircraft. Harpoon Block III creates a highly-capable weapon for the open water and littoral warfare environment, adding Global Positioning System capability, littoral performance improvement and a precision moving target solution.

General Characteristics:

Length:	182.2 in. ship launch, 151.5 in. air launch
Diameter:	13.5 in.
Weight:	1,160 lb. air configuration 1,523 lb. surface launch capsule/canister configuration
Range:	In excess of 67 NM
Propulsion:	Air-breathing turbojet engine (cruise), solid-propellant booster
Guidance:	Terminal: Active Radar Midcourse: GPS-aided inertial navigation and In-Flight Target Updates (IFTU) via secure data link.
Warhead:	Penetration, high-explosive blast
System Elements:	Missile - Common for all launch platforms Booster - Added for surface applications Launchers - Uses existing equipment or the Harpoon Canister Launcher Command and Launch System - Provides engagement planning and launch control

Launch Platforms:	Air, surface applications
Ships	Guided Missile Destroyers (DDG) Conventional/Nuclear Guided Missile Cruisers (CG)
Aircraft	F/A-18E/F Super Hornet Multi-Mission Maritime Aircraft (MMA)

The 500-pound blast warhead delivers lethal firepower for conventional anti-ship missions, such as open-ocean, near-land or ships in port. The datalink updated Global Positioning System/Inertial Navigation System improves midcourse guidance to the target area. The accurate navigation solution allows users to discriminate target ships from islands, other nearby land masses, obstructions or ships.

Harpoon Block III will be deployable from Harpoon missile system platforms with existing command and launch equipment, the F/A-18E/F Super Hornet and the Multi-Mission Maritime Aircraft (MMA). Block III is ready to meet the over-the-horizon threat and provide our customers with the right weapon for today's environment.

Contact: Tim Deaton
Global Strike Systems
The Boeing Company
(314) 232-5886
timothy.r.deaton@boeing.com

August 2008

Raytheon

AIM/RIM-7 Sparrow

Cost-Effective Medium-Range Missile System

The AIM/RIM-7 Sparrow medium-range, radar-guided missile provides a versatile and cost-effective solution for the world's air-defense needs.

Benefits

- Multimission capability
- Combat-proven air defense and air superiority
- Proven reliability
- Committed full-service support program

The AIM/RIM-7 Sparrow missile is a medium-range, all-weather, all-aspect, semiactive guided missile used in multiple roles by the United States and more than 25 international customers.

The AIM/RIM-7M model was developed around a digital monopulse seeker, which greatly improved seeker capability under heavy electronic countermeasures (ECM) and adverse weather conditions. The latest version of Sparrow, the AIM/RIM-7P, has a new higher capacity computer and uplink capability for command midcourse guidance. The AIM/RIM-7P computer incorporates a reprogrammable digital processor with software that may be modified to optimize effectiveness against enemy countermeasures. AIM/RIM-7P software continues to be upgraded for new scenarios and can be loaded via external means.

The RIM-7 Sparrow is the surface-launched (sea or land) version of Sparrow used for ship, airfield and facility self-defense. It can be launched in trainable or vertical launcher configurations. In the vertical launch variant, the RIM-7M/P uses a jet vane control to provide initial missile flight control.

Sparrow continues to be a central element in the air-defense process for the U.S. Navy and many international armies, navies and air forces. Because of its capability and flexibility, Sparrow will remain in service for many years in the future. Raytheon is committed to providing product support for the Sparrow family through 2025.

AIM/RIM-7 Sparrow

Upgradeable

Legacy AIM/RIM-7M configurations can be upgraded to AIM/RIM-7M/P configurations:

AIM-7M F1	**Baseline:** Increased memory More prelaunch messages — improve kill probability Trajectory shaping Better multiple target performance
AIM/RIM-7P Computer Kit	**All factory H-build improvements plus:** Reprogrammable circuit cards More memory and throughput increase Improved trajectory shaping performance Improved ground clutter performance Improved ECM
Full AIM/RIM-7P	**All above plus:** Improved low-altitude guidance Will accept 7P++ software

Maintenance Support

Intermediate Level	In-country test capability using the AN/DSM-162B or AN/DSM-156D test set • AN/DSM-162B test set for AIM-7 (Air Force) operations • AN/DSM-156D test set for RIM-7 (Navy/remote test) operations
Depot Level	Raytheon Missile Systems — Tucson, Arizona Sole existing full-service Sparrow depot Proven, experienced, rapid turnaround, low cost

AIM/RIM-7 Specifications

Length:	AIM/RIM without JVC	12 ft	3.66 m
	RIM with JVC	12 ft 7 in	3.85 m
Diameter:	8 in	0.2 m	
Weight:	AIM/RIM without JVC	502 lb	228 kg
	RIM with JVC	650 lb	295 kg
Wing Span:	3 ft 4 in	1 m	
Guidance System:	Semiactive compatible with continuous wave or pulsed Doppler radar illumination		
Warhead:	Annular blast fragmentation expanding continuous rod		
Fuzing:	Proximity and impact fuzing		
Power Plant:	MK-58 boost-sustain solid propellant rocket motor with manual or remote safe and arm		

Sparrow provides customers with:

- Intercepts against high- and low-altitude threats
- Intercepts of aircraft, missiles and surface targets
- Engagements of maneuvering targets in both forward and rear hemispheres
- Engagements of targets in clutter and ECM environments
- Intercepts in snap-up and shoot-down conditions
- Intercepts against multiple closely-spaced threats
- Superior operational ready rate and reliability

Raytheon is fully committed to Sparrow full-service support, including depot repair of AIM/RIM-7M/P Sparrow missiles, through 2025.

Raytheon Company
Missile Systems
Naval Weapon Systems
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.794.5318 phone
520.794.3134 fax

www.raytheon.com

Raytheon

Customer Success Is Our Mission

Printed in the U.S.A. MS 10/08 4K 80840R

Raytheon

Standard Missile-2

International Fleet Defense

SM-2

The world's premier fleet/air defense weapon.

Benefits

- Rail or vertical launch
- Inertial or command midcourse guidance
- Semiactive terminal homing
- Blast fragmentation warhead

The Standard Missile-2 (SM-2) is the latest in a long history of highly capable antiair warfare weapons. The lineage of SM-2 can be directly traced back over 50 years to the original Talos, Tartar and Terrier air defense missiles.

The current generation of SM-2, Blocks IIIA and IIIB, capitalizes on communication techniques, advanced signal processing and propulsion improvements to substantially increase the intercept range and provide high- and low-altitude intercept capability and performance against the advanced antiship missile threat.

SM-2 also employs an ECM resistant monopulse receiver for semiactive radar terminal guidance, while long-range intercepts are accomplished through the use of Inertial Midcourse Guidance (Tartar) and Command Midcourse Guidance (Aegis). The Tartar and Aegis flight profiles allow the missile to approach the target without the need for a shipboard illuminator until the terminal engagement phase. Target updates are provided through a weapon fire control system for Tartar missiles, while Command Guidance is accomplished via a link for Aegis missiles. A significant advantage of midcourse guidance is the resultant increase in firepower.

The SM-2 Block IIIB configuration incorporates a side-mounted imaging infrared seeker into the proven Standard Missile guidance system. This adjunct sensor provides a significant improvement to the missiles terminal engagement performance against stressing antiship missile threats.

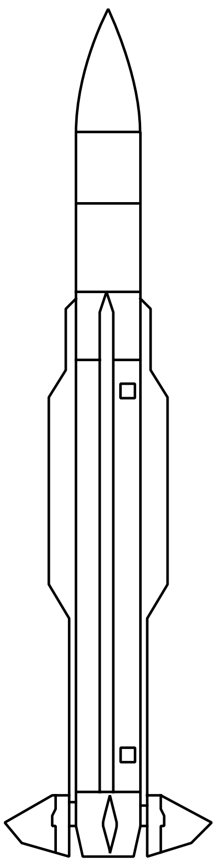
SM-2 is compatible with the MK13 and MK26 rail launchers as well as the MK41 Vertical Launching System.

The SM-2 family continues to grow, as Canada, Japan, Germany, Korea, The Netherlands and Spain are deploying compatible surface combatants, and several other navies are in the process of defining requirements and ship configurations to support SM-2 applications.

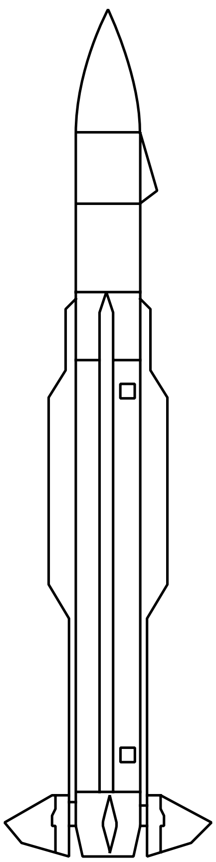
System/Subsystem	Characteristics
Overall System	All-weather, ship-launched, medium-to-long range, fleet air defense missile system
Airframe	Cylindrical body with ogive nosecone, cruciform trapezoidal tail control fins with inlne long chord, fixed dorsal fins immediately forward
Propulsion	Dual-thurst, solid-propellant rocket motor (MK104)
Guidance/Control	Monopulse, solid-state, semi-active radar terminal guidance with digital computer. Inertial or command midcourse guidance. Control effected through electrically activated tail fins
Fuzing	MK45 direct action and proximity fuze
Warhead	Common high-explosive fragmentation warhead (MK125)

Standard Missile-2 Specifications

Length:	15.5 ft	4.72 m
Diameter:	1.1 ft	34.3 m
Span:	3.0 ft	91.5 cm
Weight:	1,558 lb	708 kg
Range, Max:	> 50 mi	> 80.45 km
Altitude:	> 65,000 ft	> 20,000 m
Speed:	Mach 3+	
Other:	MK125 high-velocity fragmentation warhead	



SM-2 Block IIIA



SM-2 Block IIIB

Final video frame from target cockpit camera.

Raytheon Company
Missile Systems
Naval Weapon Systems
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.794.9344 phone
520.794.0148 fax

www.raytheon.com

Raytheon
Customer Success Is Our Mission

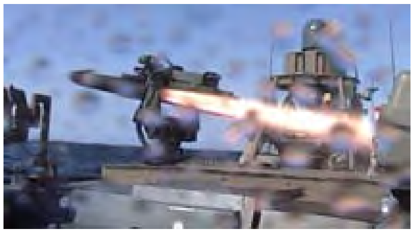
HELLFIRE II®

The HELLFIRE II modular missile system defeats advanced armor and urban point targets in the presence of severe electro-optical countermeasures. It can be launched from multiple air, sea and ground platforms, autonomously or with remote designation.

Apache, Kiowa Warrior, Cobra, Seahawk and Tiger helicopters are all equipped with the HELLFIRE system. HELLFIRE has also been successfully fired from several wheeled and armored vehicles and from various small boats and ships, as well as ground-mounted tripods. The tripod-mounted system is currently in service with the Swedish and Norwegian defense forces.

HELLFIRE II is a combat-proven weapon system for precision kill of high-value armor, air defense, ships, waterborne and fixed targets, with minimal collateral damage. The missile may be employed by lock-on before or lock-on after launch for increased platform survivability. Its multi-mission, multi-target capability with precision-strike lethality and fire-and-forget survivability provides field commanders maximum operational flexibility.

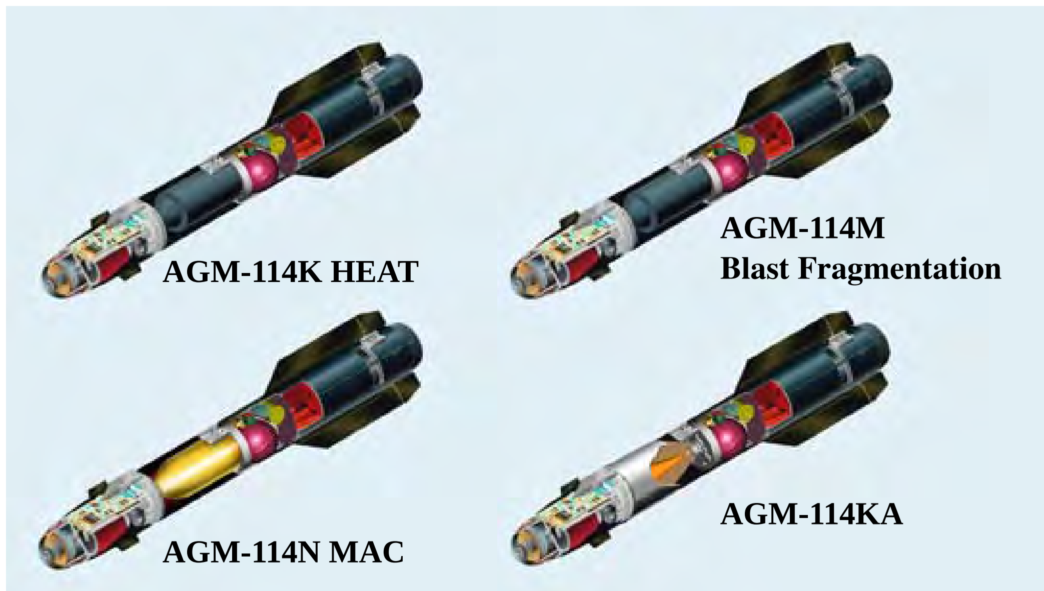
TS0074-30-02.8



PD077-099

TS0539-30-03.4

PD079-029



PD079-107; PD079-109
PD079-108; PD079-110

Specifications

Range	0.5 to 8+ km
Guidance	Semi-active laser seeker
Warheads	HEAT, augmented HEAT, blast fragmentation, and MAC
Platforms	Helicopters, tripods, boats, vehicles (from pedestal-mounted to full integration)

AGM-114K (HEAT)

Weight	45.4 kg (100 lb)
Length	163 cm (64 in)
Diameter	17.8 cm (7 in)

AGM-114KA (Augmented HEAT)

Weight	47.3 kg (104 lb)
Length	163 cm (64 in)
Diameter	17.8 cm (7 in)

AGM-114M (Blast Frag)

Weight	48.2 kg (106 lb)
Length	163 cm (64 in)
Diameter	17.8 cm (7 in)

AGM-114N (MAC)

Weight	48.2 kg (106 lb)
Length	163 cm (64 in)
Diameter	17.8 cm (7 in)

Features

- Modular HELLFIRE offers four variants: AGM-114K high-explosive anti-tank (HEAT) warhead neutralizes even the most advanced armored threats; AGM-114KA augmented HEAT warhead defeats lightly armored threats, as well as soft targets in the open; AGM-114M blast fragmentation warhead defeats ships, light armor and urban targets; AGM-114N metal augmented charge (MAC) warhead is highly effective against enclosed structures (caves and bunkers)
- Software driven – digital electronics for seeker growth applications
- Electro-optical countermeasures immunity proven by test; reprogrammable
- Effective target tracking in presence of backscatter, dust, water vapor, smoke and sea spray
- Trajectory shaping for performance in degraded weather
- Automatic target reacquisition after loss of track in low clouds
- Combat proven against a wide array of targets

Lockheed Martin Corporation
Missiles and Fire Control
Business Development
Phone: (407) 356-4464
Fax: (407) 356-7199
www.lockheedmartin.com/mfc

Front top: PD079-189

Raytheon

AGM-65 Maverick

Man-in-the-Loop Precision, Low Collateral Damage, Anti-tank, Anti-ship, Close Air Support Weapon

AGM-65 Maverick is the precision strike missile-of-choice for the U.S. Air Force, Navy, Marine Corps and 33 international customers.

Benefits

- Launch-and-leave capability with combat-proven high single-pass probability of kill
- Low collateral damage
- Proven capability against high-speed moving and maneuvering targets
- Modular design provides various combinations of seekers and warheads

Today's Maverick provides aircrews with launch-and-leave capability across a wide span of employment ranges and speeds. With its one-meter precision accuracy and lethal warhead, Maverick gives a high single-pass probability of success, with low collateral damage — attributes of the modern battlefield. Its modular design provides nine configurations with choices of three different seeker/guidance options, two different warheads and fuzing options, plus a rocket motor safe-arm option for naval flight deck operations.

Maverick is certified on more than 25 types of aircraft and is effective against nearly all air-to-ground target sets in battlefield, urban and maritime, including field fortifications, bunkers, tanks, armored personnel carriers, parked or taxiing aircraft, radar or missile sites, port facilities, ships, high-speed vehicles, swarming boats and other time sensitive threats. Maverick continues to evolve, providing cost effective solutions to meet current and future capability needs for network centric warfare.

TV Maverick

The first Maverick produced was the television (TV) guided AGM-65A, delivered in 1972, followed in 1975 by the AGM-65B, with scene magnification optics. AGM-65A and B versions are now being upgraded to the newer H, J, JX and K configurations for U.S. and international customers. The newer configurations incorporate modern charge-coupled-device (CCD) TV technology, circuitry and associated software to more than triple the lock-on and launch range of the original versions. The CCD seeker's sharper image gives the aircrew longer acquisition and launch ranges, allowing greater use of the aerodynamic envelope of the missile. The tracking software and cockpit display symbology are the same as those used successfully in infrared (IR) guided missiles. The superior service life of Maverick's center-aft section makes upgrading AGM-65B to AGM-65H missiles a viable and highly affordable option.

Infrared Maverick

The U.S. Air Force's AGM-65D, G and G2 and the Navy's AGM-65F are equipped with IR seekers that work in both day and night situations. The IR seeker presents a TV-like image on the cockpit display as it senses small differences in heat energy between target objects and the surrounding background. The tracking software for the IR missile has evolved to effectively accommodate a wide spectrum of land and maritime targets.

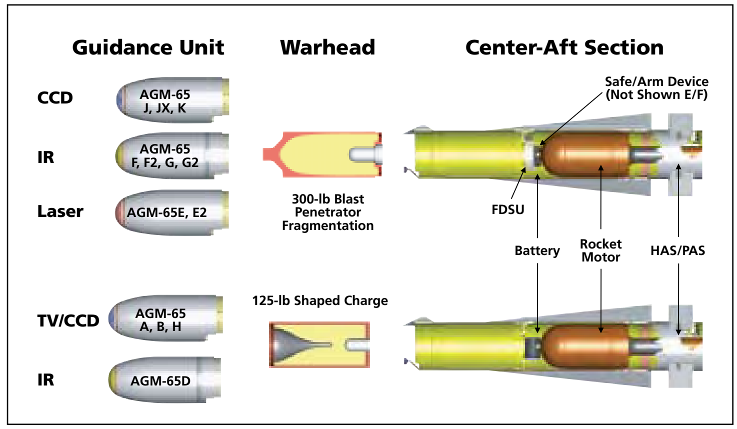
Laser Maverick

The current Laser Maverick (AGM-65E) uses a semi-active laser (SAL) seeker that

AGM-65 Maverick

Before

After



Maverick Guidance Warhead Family Chart

AGM-65 Maverick Specifications

Fuze:	Contact (Shaped-charge warhead)	Selectable Delays (Penetrator warhead)
Length:	98.0 in	249 cm
Wing Span:	28.5 in	72 cm
Diameter:	12.0 in	30.5 cm
Weights:		
125-lb Shaped Charge Warhead		
D (IR)	485 lb	220 kg
H (TV)	466 lb	211 kg
300-lb Blast Fragmentation Penetrator Warhead		
E (Laser)	645 lb	293 kg
F, F2, G, G2 (IR)	670 lb	304 kg
J, JX, K (TV)	654 lb	297 kg
Single-Rail Launcher		
LAU-117	135 lb	61 kg

Precision Against High-Speed Moving Targets

tracks laser energy reflected from a target being illuminated by a laser designator device, either airborne or ground-based. It was designed in the 1980s for defeating armored targets and providing close air support beyond the line of battle. Its analog SAL seeker provides long-range, lock-on, fire-and-forget capability that incorporates safety features for collateral damage avoidance by flying long and deactivating the warhead upon loss of laser designation. It remains extremely effective in dynamic combat operations requiring high reliability and surgical lethality.

Warheads

Two warheads are available for the Maverick. The A, B, D and H versions use a 125-pound warhead with a forward-firing, conical-shaped charge for armor penetrations. The E, E2, F, F2, G, G2, J, JX and K versions employ a 300-pound blast fragmentation/penetrator warhead that was developed for maximum effectiveness against larger, reinforced targets. Selectable fuzing gives the aircrew the option of detonating the warhead on impact or after penetration.

The Future of Laser Maverick

Raytheon is designing a new laser guidance and control section (GCS) to allow production of Laser Maverick (AGM-65E2) missiles. This next-generation Laser Maverick uses digital Semi-Active Laser (dSAL™) seeker technology that allows tighter tracking against high-speed moving targets and greater precision in tough urban environments, while minimizing collateral damage. The new Laser Maverick GCS uses key components from existing Mavericks, to include: circuit card assemblies, autopilot, and electrical interfaces. The new GCS can mate to existing Maverick center-aft sections and retains Maverick shape and mass properties to reduce cost and schedule time. The missile uses built-in-test to limit test equipment requirements. Laser Maverick requires no aircraft operational flight program changes and no change in launch aircraft. Incorporating GPS/INS features is under consideration to improve end-game accuracy, permit adverse weather employment, and offer an expanded engagement envelope.

Surgical Precision

Assured Destruction

Raytheon Company
Missile Systems
Air Warfare Systems
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.663.6540 phone
520.663.6402 fax

www.raytheon.com

LASER MAVERICK

Raytheon
Customer Success Is Our Mission

Printed in the U.S.A. MS 5/08 4K 70873R

AIM-132 Advanced Short-Range Air-to-Air Missile (ASRAAM)

Description

ASRAAM (Advanced Short Range Air-to-Air Missile) is the most agile, modern air-to-air missile designed to dominate the combat mission from Within Visual Range to near Beyond Visual Range. The combat concept behind **ASRAAM** is designed to give the pilot the ability to engage the enemy, fire and get away without risking himself or his aircraft in a dogfight. **ASRAAM** unique capabilities enable it to defeat all short-range missiles, existing or planned, in close-in combat.

The missile system performance is attributed to a revolutionary design concept and state-of-the-art technology providing fast reaction time from button press to end game performance and giving **ASRAAM** the highest speed of any short-range missile.

ASRAAM high speed is achieved by means of a combination of low drag and rocket motor size. By using a 166mm (6.5ins) diameter motor, compared with other missiles which use a 127mm (5ins) motor, **ASRAAM** has approximately 70% more thrust and can maintain a high speed throughout its flight time.

Designed to outmaneuver target aircraft in short-range aerial engagements and to allow launch at high off-bore sight angles during such engagements, **ASRAAM** is a highly agile missile. The exceptional maneuverability is provided by a sophisticated control system using innovative body lift technology coupled with tail control.

Physical Characteristics

• **Length**	**2.90 m (9 ft 6 in)**
• **Finspan**	**45 cm (17.7 in)**
• **Diameter**	**16.6 cm (6.5 in)**
• **Weight**	**87 kg (192 lb)**
• **Speed**	**Mach 3+**
• **Range**	**15 km (8 nm)**
• **Propulsion**	**Dual-thrust (boost/sustain) solid-fueled rocket**
• **Warhead**	**10 kg (22 lb) blast-fragmentation**

- **Length** 2.90 m (9 ft 6 in)
- **Finspan** 45 cm (17.7 in)
- **Diameter** 16.6 cm (6.5 in)
- **Weight** 87 kg (192 lb)
- **Speed** Mach 3+
- **Range** 15 km (8 nm)
- **Propulsion** Dual-thrust (boost/sustain) solid-fueled rocket
- **Warhead** 10 kg (22 lb) blast-fragmentation

Reference: http://www.mbda.co.uk/

Raytheon

AIM-9M Sidewinder

A Proven History of Success in Air-to-Air Combat

AIM-9M Sidewinder
Combat-proven, advanced infrared-tracking, short-range air-to-air missile

Benefits

- Advanced countermeasure features
- Improved identification of targets against background clutter
- Improved tracking against low-signal level targets
- Reduced-smoke rocket motor

For more than 40 years, the Sidewinder missile's effectiveness and all-aspect capabilities have been combat proven in several theaters and conflicts around the world.

Manufactured Since 1964

Raytheon has manufactured Sidewinder guidance control sections continuously since 1964 and has provided coalition nations with equipment for in-country missile repair. Since 1971, Raytheon has been the U.S. Navy's Development Industrial Support Contractor. Raytheon has delivered more than 45,000 Sidewinder guidance sections.

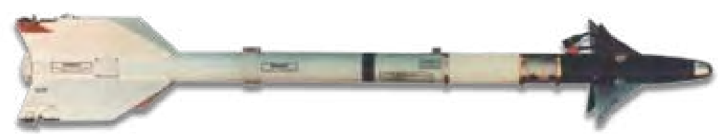
Enhanced Performance

The AIM-9M provides significant performance improvements over its predecessor, the AIM-9L. These include advanced countermeasure features, improved identification of targets against background clutter, improved tracking against low-signal level targets and a reduced-smoke rocket motor.

The AIM-9M is configured for easy installation on a wide range of modern tactical aircraft, including the F-4 Phantom II, F-5 Tiger, F-14 Tomcat, F-15 Eagle, F-16 Fighting Falcon, and F/A-18 Hornet fighters; the A-4 Skyhawk, A-6 Intruder, A-7 Corsair II, AV-8B Harrier II, and A-10 Thunderbolt II attack aircraft; and the AH-1 Cobra helicopter. Sidewinder is also integrated on the JAS-39 Gripen, JA-37 Viggen, FA2 Sea Harrier, Tornado GR4, and Jaguar GR3.

Raytheon's Sidewinder reliability has been thoroughly demonstrated, consistently achieving 400 percent above contractual mean time between failure requirements.

AIM-9M Sidewinder



AIM-9M Features

- Combat-proven
- Demonstrated high-kill probability
- High reliability
- Multiple applications
- Minimal size, low drag and weight
- Low per-round cost
- Simplicity
- Adaptability

AIM-9M Specifications

Length:	113 in	2.9 m
Diameter:	5.0 in	12.7 cm
Wing Span:	25 in	63.5 cm
Canard:	22.3 in	56.6 cm
Weight:	190 lb	86 kg
Warhead:	25 lb	11.3 kg
Guidance:	Passive infrared	
Fuzing:	Proximity and content	
Launcher:	Rail	

Raytheon Company
Missile Systems
Air-to-Air
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.794.9978 phone
520.794.8978 fax

www.raytheon.com

Raytheon

Customer Success Is Our Mission

Printed in the U.S.A. MS 01/08 80064A

Raytheon

AIM-9X Sidewinder

Fifth Generation High Off-boresight, Thrust-Vectored Air-to-Air Missile

AIM-9X Sidewinder provides first-shot/first-kill capability to ensure air combat victory.

Benefits

- Low cost of development and ownership
- Superior performance exceeds tactical requirement
- In production and in the fleet now
- Selected by numerous coalition air forces

SIDEWINDER AIM-9X

AIM-9X Sidewinder

The AIM-9X is the newest member of the AIM-9 Sidewinder short-range missile family in use by more than 40 nations around the world. This next-generation Sidewinder missile passed operational evaluation in November 2003 and was approved for full-rate production in May 2004.

Enhanced Capability

The AIM-9X acquisition plan addresses the urgent warfighting requirement for the development and deployment of a next-generation Sidewinder to replace the AIM-9M. AIM-9X is a launch-and-leave air combat missile that uses passive infrared (IR) energy for acquisition and tracking. The AIM-9X can be employed in both near beyond visual range and within visual range arenas. Complemented by the Advanced Medium-Range Air-to-Air Missile (AMRAAM), the AIM-9X equipped warfighter has offensive firepower that is unmatched by any other weapon systems in the world. The AIM-9X program addresses the requirement for evolutionary improvements to the AIM-9 series missile through revolutionary advancements. This extends the operational effectiveness of existing inventories at an affordable cost while continuing the evolution of the AIM-9 series.

AIM-9X provides the warfighter with the following capabilities: full day/night employment, resistance to countermeasures, extremely high off-boresight acquisition and launch envelopes, greatly enhanced maneuverability and improved target acquisition ranges. The AIM-9X airframe coupled with other advanced features gives fighter pilots a significant tactical advantage in the dogfight arena. The AIM-9X uses an extremely agile thrust vector controlled airframe. Configured with a mature and high-performance staring focal plane array (FPA) sensor and existing AIM-9M components (rocket motor, warhead and fuze), AIM-9X evolutionary design is a low-cost, low-risk, all-up-round evolutionary design with robust performance. The digital design architecture of the AIM-9X provides growth capability to ensure air superiority in the future.

AIM-9X Development AIM-9X is a joint U.S. Navy and U.S. Air Force program with the Navy designated as the Executive Service. Several nations have already selected AIM-9X as their next short-range missile, and potential exists for procurement by numerous other coalition nations. The first AIM-9X air launch was accomplished in March 1999. This milestone was the first in a series of separation and control test vehicle and guided launches. From 1999 to 2001, the AIM-9X program launched 19 separation and control test vehicles and 18 guided launches from U.S. Navy F/A-18 and U.S. Air Force F-15 aircraft. Of the 18 guided firings, 14 resulted in direct hits against QF-4 unmanned drones. The AIM-9X engineering and manufacturing development (E&MD) phase completed the development of the missile

AIM-9X

Unprecedented . . . Fifth Generation . . . Smarter

tactical system design and established the weapons system interface with the F-15C and F/A-18C/D aircraft and the joint helmet-mounted cueing system. U.S. government development and operational testing plans include extensive captive carry reliability testing and free-flight guided launches. In addition to the F/A-18C/D and the F-15C, AIM-9X will be integrated on the Navy F/A-18E/F and the Air Force F-15E, F-16, the Joint Strike Fighter, and the F-22 during Follow-on Test and Evaluation. AIM-9X is fully compatible with the LAU-12X series and the LAU-7 launchers.

The Threat

For more than 40 years, U.S. and coalition fighter pilots have enjoyed air superiority in short-range engagements. Now, however, current threat missiles, aircraft and environments may eclipse this advantage ... demanding a new fifth generation Sidewinder Missile — the AIM-9X.

AIM-9X – The Answer

In modern short-range air-to-air combat, first-shot/first-kill capability is necessary to ensure victory in today's high technology battlefield. Coalition fighter pilots will enter the fight with AIM-9X, a missile that retains the essence of Sidewinder heritage, while employing a fifth-generation seeker and thrust vectoring control for unprecedented performance. The Raytheon team's experience in advanced IR technologies, weapons systems integration and affordable missile production provides an AIM-9X that ensures air superiority for the 21st century.

Unprecedented

Superior Performance Exceeds Tactical Requirement

- Greatly enhanced acquisition ranges in blue sky and clutter
- IR countermeasures resistance to meet the threats of today and tomorrow
- Extremely high off-boresight capability gives the pilot the first-shot first-kill opportunity
- Highly agile airframe
- Inherent growth potential

Fifth Generation

Leadership in Advanced IR Missiles and Weapon Systems Integration Brings the Warfighter Unprecedented Technology Today — AIM-9X

Raytheon's commitment and acknowledged leadership in advanced IR missile design enabled a low-risk, low-cost development phase that ensures air superiority for the U.S. and coalition warfighter. Mature

AIM-9X Sidewinder Specifications

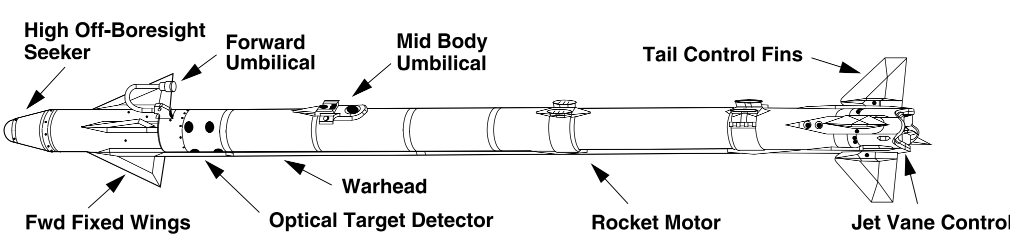
Weight:	118 lb	85 kg
Length:	119 in	3 m
Diameter:	5 in	12.7 cm
Fin Span:	17.5 in	44.45 cm
Wing Span:	13.9 in	35.31 cm

enabling technologies that include staring FPAs, adaptive compensation techniques, and advanced IR signal processing permit a low risk E&MD phase. The Raytheon AIM-9X team is a world leader in advanced digital aircraft weapons integration. This weapon system design experience includes the AMRAAM; the AMRAAM/AIM-9X compatible digital launcher; the F-14D, F/A-18E/F and F-15 advanced radars; and the F-22 weapon system. Raytheon understands the digital combat environment and the critical weapon system parameters necessary to fight and win in the pre- and post-merge arena.

Smarter

Revolutionary Ideas Through Evolutionary Development

The critical path of any missile development is through the seeker. The payoff from leveraging an in-production seeker and Raytheon's extensive commitment to advanced fifth-generation IR technologies is a low-cost, low-risk AIM-9X development. Raytheon's advanced, mature IR FPA sensor and innovative guidance and control design combined with reuse of existing components presents an AIM-9X that is affordable and lethal. Features such as a cryoengine and an extended warranty significantly reduce the cost of ownership while increasing the AIM-9X tactical utility and availability. Raytheon's integrated product team culture and lean manufacturing techniques are combined with acquisition reform initiatives to produce an affordable, low-risk, and highly reliable AIM-9X design.



Raytheon Company
Missile Systems
Air Warfare Systems
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.794.1572 phone
520.794.8978 fax

www.raytheon.com

Raytheon

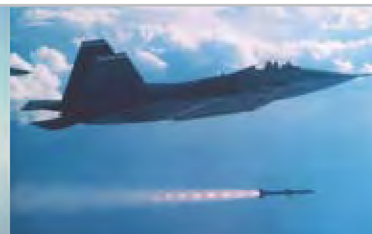
Customer Success Is Our Mission

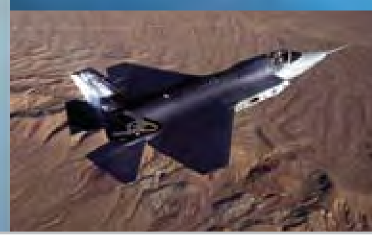
Printed in the U.S.A. MS 10/08 4K 80838R

Raytheon

AMRAAM

Advanced Medium-Range Air-to-Air Missile





Advanced Medium-Range Air-to-Air Missile

Combat-proven performance and reliability.

Benefits

- Highest dependability at lowest cost of ownership
- Maximizes operational flexibility
- Multi-shot capability
- State-of-the-art active radar guidance
- Dual use from the same missile (air and surface launch)
- Cost effective life cycle support for both ATA and SL missiles
- Planned performance software upgrades to combat emerging technologies

The Advanced Medium-Range Air-to-Air Missile (AMRAAM) is combat proven, scoring victories over the skies of Iraq, Bosnia, and Kosovo. AMRAAM operational reliability is measured in thousands of hours — an order of magnitude improvement beyond other systems — with mean-time-between-failure rates in excess of 1500 hours of operation. AMRAAMs are currently flown by the majority of coalition air forces. Attesting to AMRAAM reliability, the U.S. Air Force has recently exceeded one million captive carry hours while maintaining field availability well above requirements.

With state-of-the-art active radar guidance, AMRAAM packs unprecedented performance into a lightweight package. AMRAAM's incorporation of the latest digital technology and microminiaturized solid-state electronics makes this remarkable weapon more reliable and maintainable, resulting in the highest dependability at the lowest cost of ownership throughout the intended service life of the missile.

AMRAAM's unprecedented air combat flexibility, including its multi-shot capability, provides pilots the ability to launch at an enemy aircraft day or night, in all weather. In beyond visual range (BVR) engagements, AMRAAM is guided initially by its inertial reference unit and microcomputer. During this midcourse phase of flight, AMRAAM receives target position updates directly from the launch radar system. In the terminal phase of flight, without further reliance on the launching aircraft, the internal active radar seeker acquires the target and independently guides the missile to intercept.

AMRAAM's autonomous guidance capability provides the pilot with critical range preserving launch and leave capability. This substantially improves a pilot's overall survivability by allowing immediate maneuver following missile launch. Immediate post-launch maneuver allows the pilot faster engagement of follow-on targets, as well as the option to maximize his separation from the original engaged threat.

AMRAAM's multi-shot capability is also designed to improve pilot survivability by allowing multiple simultaneous threat engagements. AMRAAM operational capabilities include quick flyout, robust immunity to countermeasures, and improved capability attacking low-altitude targets. The low-smoke, high-impulse rocket motor effectively reduces the visual signature of the missile and thus reduces the overall probability of an enemy pilot's sighting either the launch or the incoming missile.

AMRAAM is operational on the F-22, Eurofighter, F-15, F-16, F/A-18, the German F4F, the United Kingdom's Sea

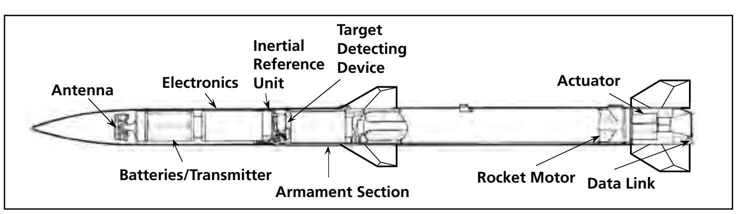
Harrier, Tornado, Harrier II Plus, the JAS-39 Gripen, JA-37 Viggen, and the Norwegian Advanced Surface-to-Air Missile System (NASAMS). Raytheon is currently integrating AMRAAM on the Joint Strike Fighter.

AMRAAM sets the global, beyond visual range standard. With more than 33 countries procuring the missile, AMRAAM has attained a level of international procurement that enriches interoperability, ensures commonality, and improves overall logistic support which ensures effective coalition operations.

AMRAAM has demonstrated equally outstanding surface-to-air performance. Surface-launch operators find AMRAAM performance extremely effective through increased long-range firepower, multiple target capability, and resilient ECCM features. The NASAMS was the first surface-launch system to take advantage of these unique air defense capabilities and has been operational with the Royal Norwegian Air Force since 1994. The Spanish army has also procured NASAMS. In 1998, NASAMs became the NATO Response Force standard for mobile/deployable netted air-defense systems to counter modern threats.

Recently, the U.S. Army approved an Operational Requirements Document (ORD) for a similar Surface-Launch AMRAAM (SLAMRAAM) capability. The Army expects to field its system in the near future. Internationally, Raytheon promotes SL-AMRAAM capability for HAWK/SHORAD upgrades and air defense systems employing the Mobility and Canister launcher on a variety of alternative vehicles.

The AMRAAM program is a model defense acquisition reform process managed by the Air-To-Air Missile Systems Wing at Eglin Air Force Base, Florida. AMRAAM is in full-rate production at Raytheon's Tucson, Arizona, facility. Raytheon's innovative evolutionary spiral development began early in the AMRAAM program. This remarkably successful spiral development process continues to extend AMRAAM's world-renowned capability well into the future. Performance, reliability, and affordability with state-of-the-art technology are Raytheon's commitments as the producer of the world's preeminent air-to-air missiles.



AMRAAM AIM-120C-7 Specifications

Length:	12 ft	3.65 m
Diameter:	7 in	17.8 cm
Wing Span:	17.5 in	44.5 cm
Fin Span:	17.6 in	44.7 cm
Weight:	356 lb	161.5 kg
Warhead:	45 lb	20.5 kg
Guidance:	Active radar	
Fuzing:	Proximity and contact	
Launcher:	Rail and eject	

Raytheon Company
Missile Systems
Air Warfare Systems
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.794.0198 phone
520.794.8978 fax

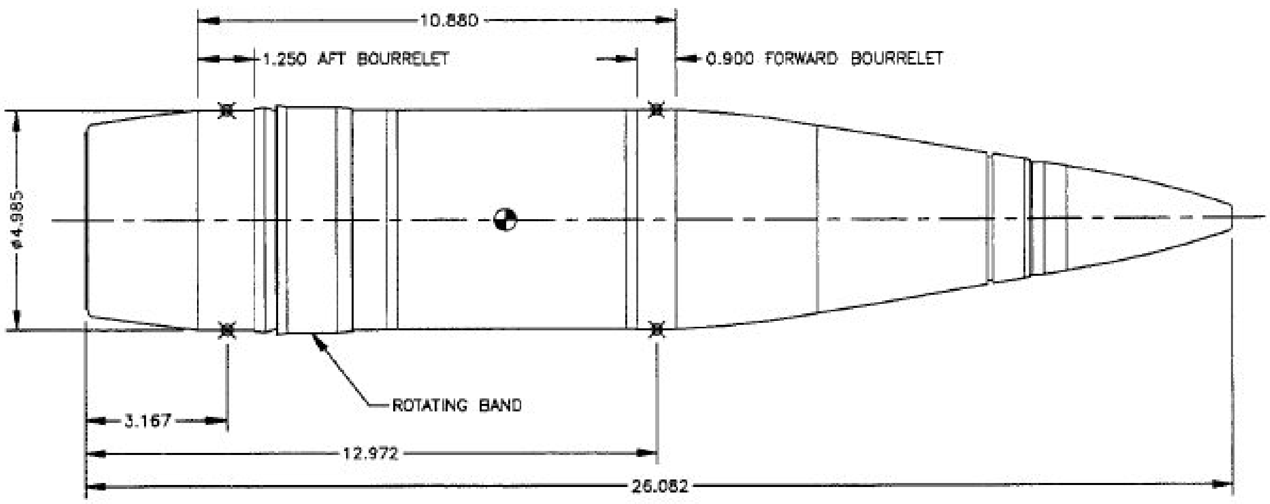
www.raytheon.com

Customer Success Is Our Mission

This page intentionally left blank

GUNS

Mk-64 5” / 54 Caliber Blind, Loaded, & Plugged Naval Projectile



Description	Physical Characteristics
The MK64 5 inch 54 caliber naval projectile is the basic round of ammunition for the U.S. Navy's main armament systems. The forged steel projectiles have a long and streamlined outline, especially the ogive, together with a distinctive boat tail and flat base. The single, wide rotating band is made of copper. The 5"/54 MK64-2 Projectile Body (MPTS) is a component of the 5"/54 Caliber Blind, Loaded and Plugged (BL&P) MK92-1 Projectile which is a training round that lacks a fuse and is filled with sand.	

Reference: www.navweaps.com, www.globalsecurity.com

76mm

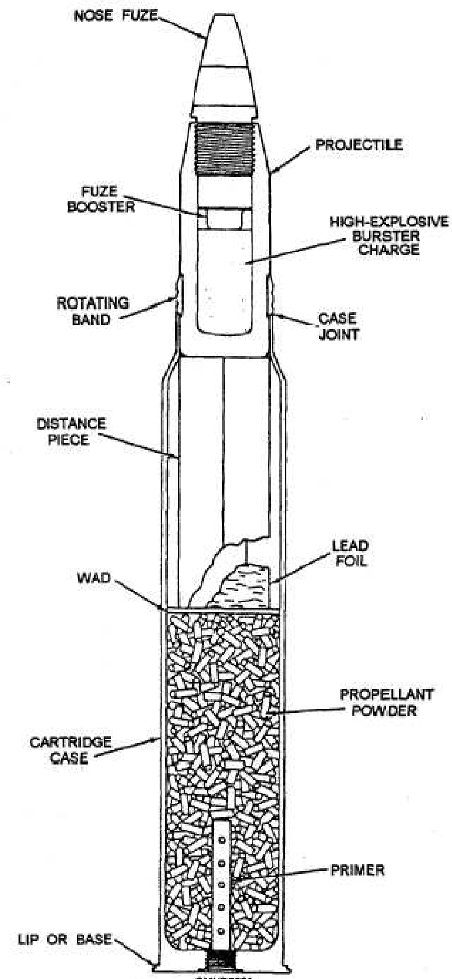
Description

All 76mm round are essentially the same in that they are made of approx. 10 lbs of iron casing with approx. 4 lbs of filler material. The current training allocation show that mostly BL-P (blind load and plug) rounds are used, MK201. As such, the 4 lbs of inert filler in the MK201 rounds is usually sand or cement. Some of the training rounds may contain spotting charges. These rounds are put together as a full up cartridge meaning they are all one piece (Projectile + Casing). The casing has approx. 4 lbs of nitrocellulose propellant.

*Note: the diagram at right shows a live round and not a BL&P round.

Reference: www.navweaps.com, www.globalsecurity.com, www.diehl-bgt-defence.de

Physical Characteristics



<u>Ordnance Technical Data Sheet</u>
U.S. PROJECTILE, 20 MM

Nomenclature: 20 MM Projectile
Ordnance Family: Small Arms
DODIC: A773
Propellant: Nitrocellulose/Nitroglycerin
Propellant weight: 585 grains
Item weight: 3,900 grains (case weight is 1,855 grains and the projectile weighs 1,580 grains)
Diameter: .79 in for projectile
Length: 6.62 in
Maximum Range: N/A

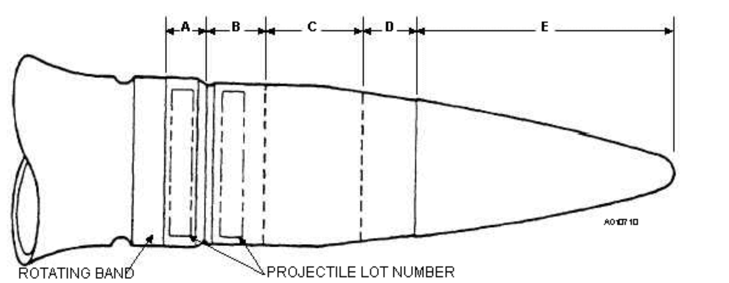
Usage: The PGU-28/B is the only projectile currently used by the Air Force and Navy for fixed wing air-to-air combat. This projectile is fired from the M61A1 gun system that is utilized by the F-14, F-15, F-16, and F/A-18 aircraft.

Description: The improved 20-mm (PGU) configuration ammunition for the M61A1/A2 aircraft guns is issued in the form of cartridges. All service cartridges have matched ballistics and are electrically primed. Initially procured ammunition is not graded, and all accepted lots are serviceable for issue and use in applicable weapons. The M103 brass cartridge cases are marked longitudinally or circumferentially with the caliber/case designation on the first line. The manufacturer symbol is on the second line. The interfix number, lot serial number, and year of manufacture are on the third line. All projectiles have essentially the same external configuration. The rotating band is copper alloy swaged into a circumferential groove near the aft end of the steel body. Ammunition type is identified by the color the projectile is painted and by the lettering on the body of the projectile.

PGU-27/B Target Practice (TP)
The PGU-27/B projectile consists of a steel body with a solid aluminum nosepiece swaged or crimped to the steel body. This cartridge has no explosive filler in the projectile. The cartridge is used in practice firing, for boresighting of weapons, and testing of new guns. The projectile shape and ballistic properties are similar to those of other PGU configuration ammunition.

PGU-28/B Semi-Armor Piercing High Explosive Incendiary (SAPHEI)
The PGU-28/B projectile consists of a steel body with an internal cavity filled with a sponge Zirconium pallet, composition A-4 and RS 40 incendiary mix. The aluminum nose contains RS 41 incendiary mix and is swaged to the steel body. This cartridge is for use against aircraft and light material targets, and functions with semi-armor piercing, high explosive, and incendiary effect.

PGU-30/B Target Practice-Tracer (TP-T)
The PGU-30/B consists of a steel body with an aft cavity containing the tracer pellet. The aluminum nose is swaged or crimped to the steel body. Tracer A tracer pellet is loaded into a cavity machined in the base of the TP-T projectile used in the assembling of the PGU-30/B cartridge. The heat and pressure of the propelling charge ignite the tracer pellet. The tracer is visible for approximately 3.2 seconds during projectile flight. This cartridge is virtually the same as the PGU-27/B projectile, except it incorporates a tracer in the base of the projectile.



Projectile Type	Color of Painting					Color of Marking
	Locations (See Figure 7-10)					
	A	B	C	D	E	
Target Practice (TP) PGU-27/B	No paint (copper)	Blue	Blue	Blue	Blue	White
Semi-Armor Piercing High Explosive Incendiary (SAPHEI) PGU-28/B	No paint (copper)	Black	Yellow	Red	No paint (chromate)	White
Target Practice Tracer (TP-T) PGU-30/B	No paint (copper)	Blue	Blue	Blue	Blue	White with Orange T's (location D)

References: The Aviation Ordnanceman; TRI-DDS website; MIDAS; Global Security.org.

20MM MK 149 (APDS)

PHALANX CIWS (CLOSE-IN WEAPON SYSTEM)

- General Dynamics Ordnance and Tactical Systems is the Sole Developer and Qualified Producer of the MK149 20mm Armor-Piercing, Discarding Sabot Cartridge
- General Dynamics Ordnance and Tactical Systems has Produced in Excess of 20 Million Rounds of Ammunition for the U.S. NAVY's PHALANX Anti-Ship Missile Defense System
- Compatible with all M61 And M197 Gun Systems
- Compatible with all MK15 PHALANX Systems and Block MOD Upgrades
- Increased Impact and Residual Energy at Target over the M50 Series
- Approved for Export

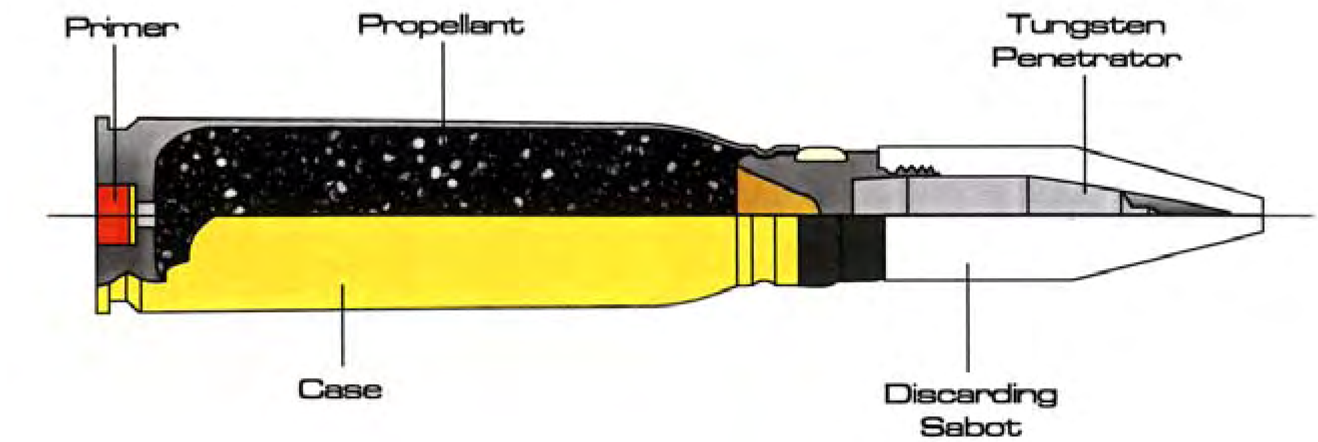
GENERAL DYNAMICS
Ordnance and Tactical Systems

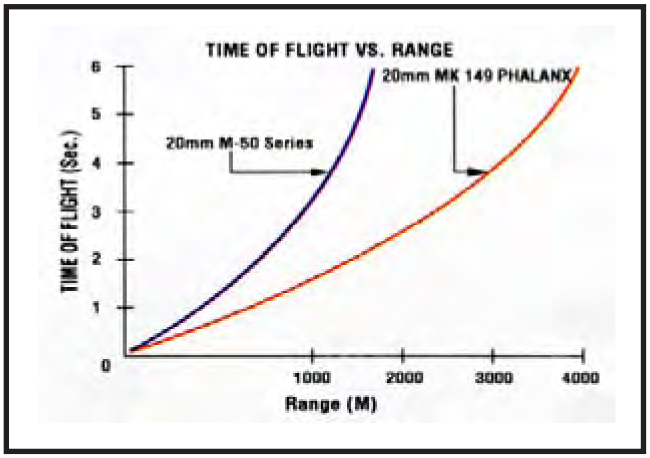
11399 16th Court North, Suite 200, St. Petersburg, FL 33716 Phone: (727) 578-8100

Approved for Public Release 09/30/05

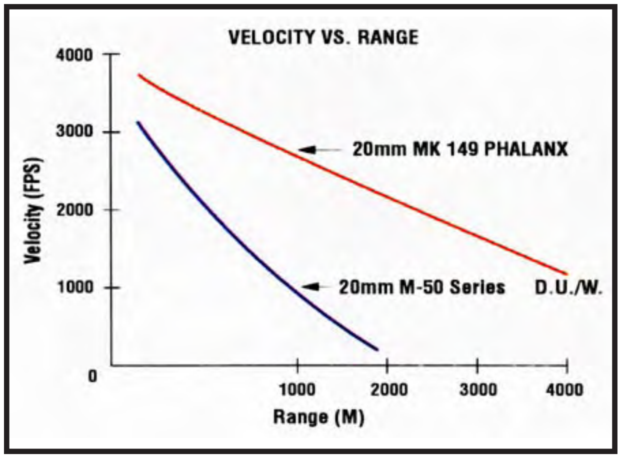
U.S. NAVY PHALANX AMMUNITION

20MM APDS-MK149

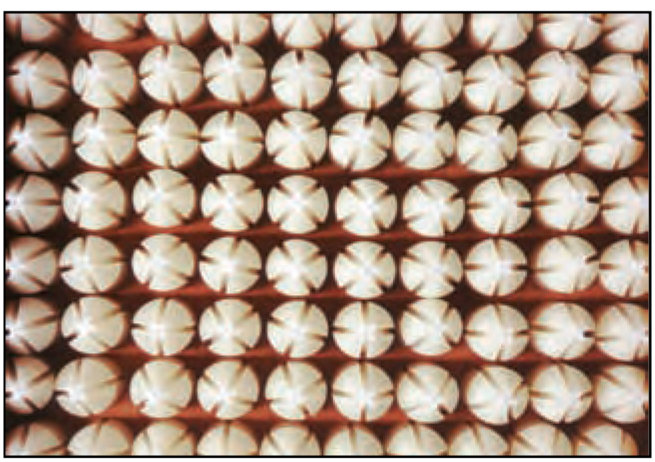




Short Time of Flight to Target



Optimized Exterior Ballistic Performance

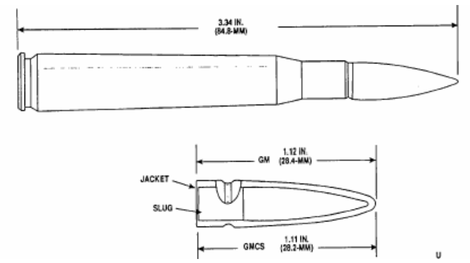


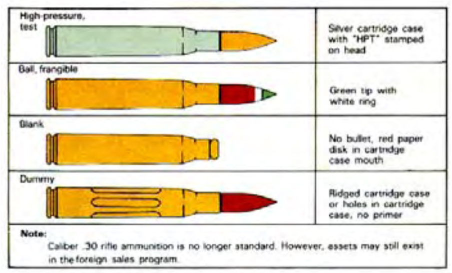
Over 20,000,000 Rounds Produced by
General Dynamcis Ordnance and Tactical Systems

GENERAL DYNAMICS
Ordnance and Tactical Systems

Ordnance Technical Data Sheet

U.S. Cartridge, .30 Caliber Ball, M2





Caliber .30 Cartridges. Colors and Shapes.

Nomenclature:	M2 Cartridge, .30 Caliber, Ball
Ordnance Family:	Small Arms
DODIC:	A212
Filler:	Single or Double Base Powder*
Filler weight:	Mission dependent
Item weight:	26.96 g (416 gr)
Diameter:	7.62 mm (.30 in)
Length:	84.80 mm (3.34 in)
Range:	3475 m (3800 yds)

Usage: Machine Guns, Caliber .30, M37, M1919A4 and M1919A6; and Rifle, Caliber .30, M1. The cartridge is intended for use against personnel or unarmored targets.

Description: Ball Cartridge. The bullet is copper clad and identified by a plain bullet tip.

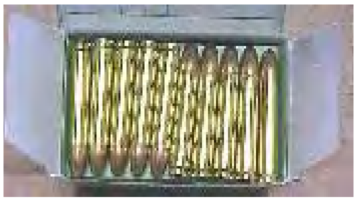
Reference: TM 43-0001-27

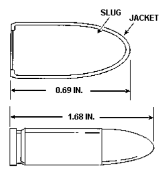
* **Single Base Propellant:** Single base propellants contain nitro cellulose as their chief ingredient. Single-base compositions are used as low-pressure propellants, such as those used in small arms ammunition. They may contain a stabilizer, inorganic nitrates, nitro-compounds, metallic salts, metals, carbohydrates and dyes.

Double Base Propellant: Double base propellants contain nitrocellulose and a liquid organic nitrate, such as nitroglycerine. As with single base, stabilizers and additives may be present. Double base propellants are used in cannon, small arms, mortars, rockets, and jet propulsion units.

Ordnance Technical Data Sheet
U.S. Cartridge .30 Caliber, Ball

CARTRIDGE, CALIBER .30, CARBINE, BALL, M1





Nomenclature:	Cartridge, .30 caliber, Ball
Ordnance Family:	Small Arms Ammunition
DODIC:	A182
Propellant:	Single or Double Base Powder**
Filler:	Lead or Copper Clad Lead
Filler weight:	Not Provided
Item Weight:	Not Provided
Diameter:	7.62 mm (.30 in)
Length:	42.67 mm (1.68 in)
Maximum Range:	2012.00 m (2,200 yds)
Fuze:	Percussion

Usage: Standard general purpose small arms ammunition for the M-1 and M1A1 .30 caliber Carbine.

Description: The cartridge case is brass comprised of 70 percent copper and 30 percent zinc. The bullet is copper clad lead. The propelling charge is either single or double base powder. Ball ammunition is unpainted; tracer ammunition has the tip painted either orange or red.

Reference: Army Technical Manuel TM 9-1300-200.

* Single-base propellant **-** Contains only one explosive ingredient, normally nitrocellulose.

* Double-base propellant **-** Contains two explosive ingredients, commonly nitrocellulose and nitroglycerin.

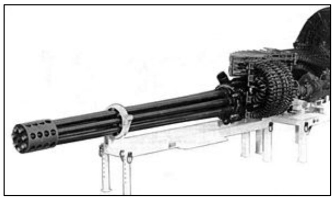
Ordnance Technical Data Sheet
U.S. PROJECTILE, 30 MM

Nomenclature: 30 MM Projectile
Ordnance Family: Small Arms
DODIC: B109
Propellant: Nitrocellulose
Propellant weight: .083lbs
Item weight: 360 grams
Diameter: 30 mm
Length: 113 mm or 173mm
Maximum Range: 4500 m

Usage: The 30mm lightweight family of ammunition was developed to optimize the air-to-ground mission of the U.S. Army AH-64 Apache helicopter. It is also used by the A-10. Tanks are the common real world target for 30 mm rounds.

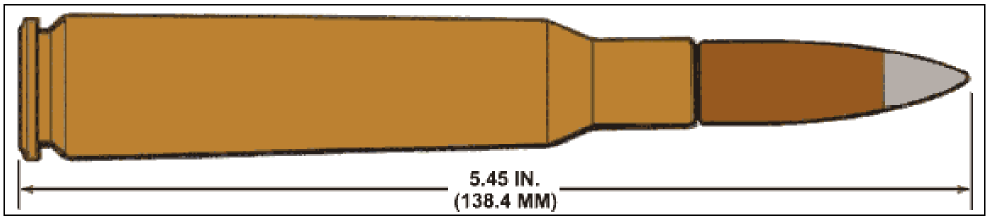
Description: Two airframes use a 30 mm round. The AH-64 Apache Helicopter which uses the M230 chain gun (see picture). The M788 is the practice 30mm round employed and is 30 x 113 mm with an effective range or 1,500 m and a max range of 4,500 m. Several ordnance variants are available, including: M788 Target Practice (TP); M789 High Explosive Dual Purpose (HEDP); and M799 High Explosive Incendiary (HEI).

The A-10 uses the GAU-8A Avenger, 30mm cannon (See picture). It uses PGU-15 30 x 173mm 30 mm ammo. The training round is the PGU-15B. The gun fires 3,900 rpm (rounds per minute).



References: TRI-DDS website; MIDAS; Global Security.org.

Ordnance Technical Data Sheet
U.S. Cartridge, .50 Caliber, Ball M8



Nomenclature: M8, Cartridge, .50 Caliber, Ball
Ordnance Family: Small Arms
DODIC: A576
Propellant: WC860 **-** Single or Double Base Powder*
Filler: Lead, Steel and/or Copper cladding
Filler weight: ± various
Cartridge weight: 1764 grams
Diameter: 12.70 mm (.50 in)
Length: 138.40 mm (5.45 in.)
Projectile Weight: 622.5 grams
Velocity: 2,910 fps (887 mps)

Usage: Machine Guns, Caliber .50, M2 and M85. The cartridge is intended for use against personnel or unarmored targets. Used by M2 and M85 machine guns, and the M107 Long Range Sniper Rifle. The cartridge combines the functions of the M2 armor piercing bullet and the incendiary bullet, and is used against flammable targets and light-armored or unarmored targets, concrete shelters, and similar bullet-resisting targets.

Description: Ball Cartridge. The cartridge is identified by an aluminum bullet tip.

Single Base Propellant: Single base propellants contain nitro cellulose as their chief ingredient. Single-base compositions are used as low-pressure propellants, such as those used in small arms ammunition. They may contain a stabilizer, inorganic nitrates, nitro compounds, metallic salts, metals, carbohydrates and dyes.
Double Base Propellant: Double base propellants contain nitrocellulose and a liquid organic nitrate, such as nitroglycerine. As with single base, stabilizers and additives may be present. Double base propellants are used in cannon, small arms, mortars, rockets, and jet propulsion units.

Reference: Army Technical Manual TM 43-0001-27; Midas; navy.mil

Ordnance Technical Data Sheet
U.S. Cartridge, 7.62 mm, Ball M80

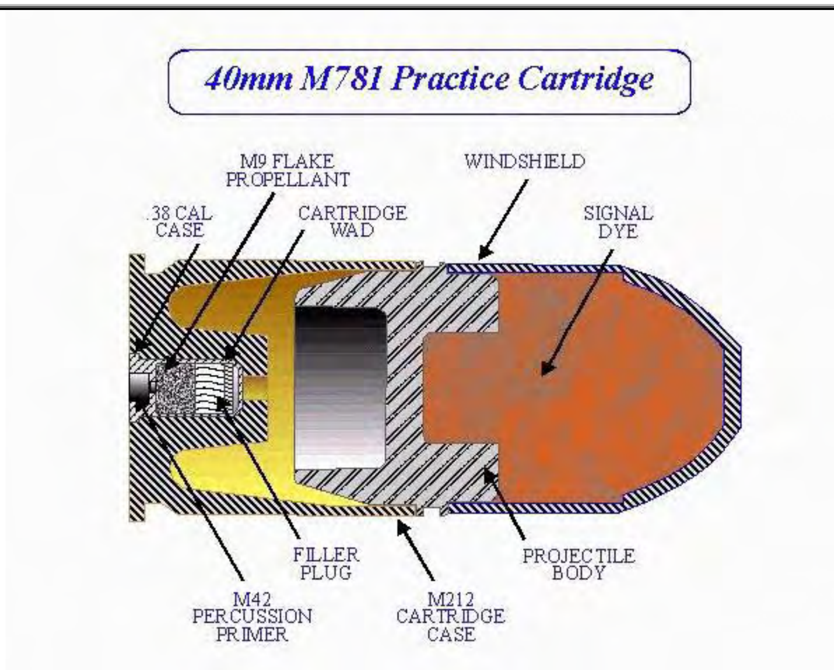
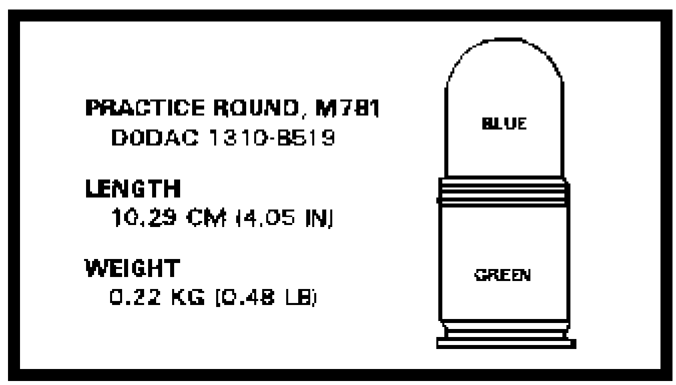
Nomenclature: U.S. Cartridge, 7.62 mm, Ball M80
Ordnance Family: Small Arms
DODIC: A130
Propellant: 46 grams **–** WC846 **-** Nitrocellulose/Nitroglycerin
Cartridge weight: 392 grams
Projectile weight: 146 grams
Diameter: 7.62 mm
Cartridge Length: 2.8 in (71.1 mm)
Velocity: 2,750 fps (838 mps)

Usage: This cartridge is intended for use against personnel and unarmored targets.

Description: Full metal jacketed bullet and brass cartridge case, center-fired NATO standard small arms.

Single Base Propellant: Single base propellants contain nitro cellulose as their chief ingredient. Single-base compositions are used as low-pressure propellants, such as those used in small arms ammunition. They may contain a stabilizer, inorganic nitrates, nitro-compounds, metallic salts, metals, carbohydrates and dyes.
Double Base Propellant: Double base propellants contain nitrocellulose and a liquid organic nitrate, such as nitroglycerine. As with single base, stabilizers and additives may be present. Double base propellants are used in cannon, small arms, mortars, rockets, and jet propulsion units.

References: ORDATA Online, MIDAS, Army Technical Manuel TM 9-1306-200, Navy.mil

M781 40mm Practice round	
	
Description	**Physical Characteristics**
This round is blue zinc or aluminum with white markings. It is used for practice and produces a yellow or orange signature on impact	 Figure 3-13. Practice round.

This page intentionally left blank

EOD DIVER DEPLOYED UNDERWATER CHARGES

This page intentionally left blank

M112 Composition C4 Block Demolition Charge

Description	Physical Characteristics
M112 composition C-4 block demolition charge is used primarily for cutting and breaching all types of demolition work. Because of its moldability and high brisance, the charge is ideally suited for cutting irregularly shaped targets such as steel. The adhesive backing allows the charge to be attached to any relatively flat, clean, dry surface that is above freezing point.	The M112 block demolition charge consists of 1.25-pounds of Composition C4 packed in a Mylar-film container with a pressure-sensitive adhesive tape on one surface. The tape is protected by a peelable paper cover. In blocks of recent manufacture, Composition C4 is white and packed in an olive-drab, Mylar-film container. Relative effectiveness factor is 1.34.

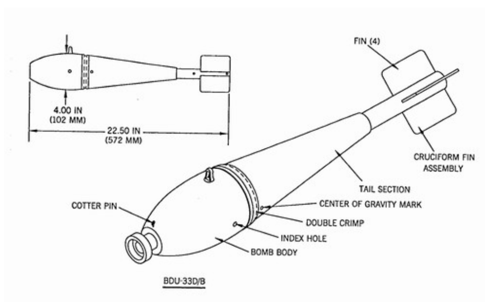
Reference: www.globalsecurity.com, www.omniexplosives.com

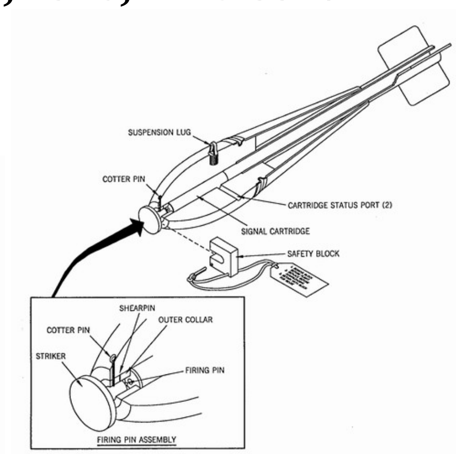
This page intentionally left blank

BOMBS

This page intentionally left blank

Ordnance Technical Data Sheet
U.S. Bomb, Practice, 25 lb, BDU 33D/B





Nomenclature:	BDU-33D/B Practice Bomb
Ordnance Family:	Bomb
DODIC:	Not Provided
Filler:	Signal Cartridge (see MK 4 Signal Cartridge)
Filler weight:	14.00 g (.49 oz)
Item weight:	11.00 kg (24.25 lbs)
Diameter:	102.00 mm (4.01 in)
Length:	527.00 mm (20.75 in)
Maximum Range:	Not Provided
Fuze:	Impact

Usage: These bombs are signal-generating; impact- or impact-inertia-fired practice/simulated bombs.

Description: The BDU-33D/B bombs are painted light blue; additionally, the BDU-33D/B has white stenciled markings only.

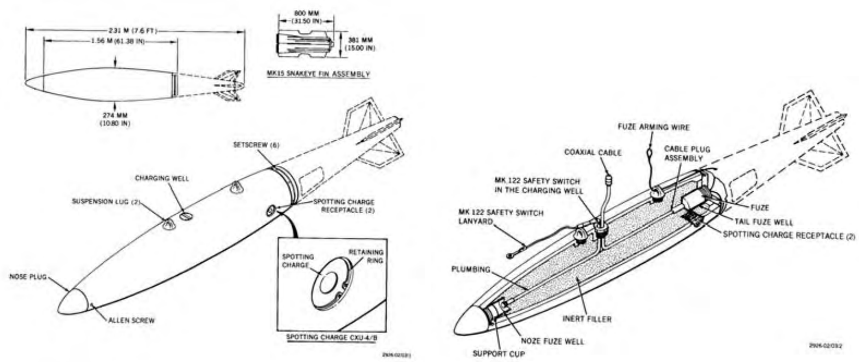
Reference: ORDATA Online.

***Titanium tetrachloride** is a colorless to pale yellow liquid that has fumes with a strong odor. If it comes in contact with water, it rapidly forms hydrochloric acid, as well as titanium compounds.

Titanium tetrachloride is not found naturally in the environment and is made from minerals that contain titanium. It is used to make titanium metal and other titanium-containing compounds, such as titanium dioxide, which is used as a white pigment in

<u>Ordnance Technical Data Sheet</u>

U.S. Bomb Unit, 500 lb, Simulated, BDU-45/B, Quiet Bomb



Nomenclature:	BDU-45/B, Bomb Unit, 500 lb, Simulated, Quite Bomb
Ordnance Family:	Bomb
DODIC:	Not Provided
Filler:	None
Filler weight:	Not Provided
Item Weight:	239.00 kg (500 lbs)
Diameter:	274.00 mm (10.79 in)
Length:	1.54 m (5.05 ft)
Maximum Range:	Not Provided
Fuze:	None

Usage: The bomb is a low drag type of the same size and shape as a Mk 82 bomb container. This is a signal generating simulated bomb used for pilot proficiency training with provisions for visual spotting of bombing accuracy. The bomb is loaded with an inert filler and contains no hazardous components. For the hazards of the fuze(s), TDD or sensing element, spotting charge adapter, and spotting charges refer to the appropriate reference.

Description: The bomb is painted blue with the designation BDU-45/B stenciled in white on the forward end of the bomb. Early models of the bomb are stamped with Mk 82 designations between the suspension lugs and with Mk 82 designation, ordnance drawing number, and loading data stenciled in white on the side of the bomb. The bomb fin assembly is painted olive drab.

Reference: ORDATA Online.

Ordnance Technical Data Sheet
U.S. BOMB, PRACTICE BDU-48/B

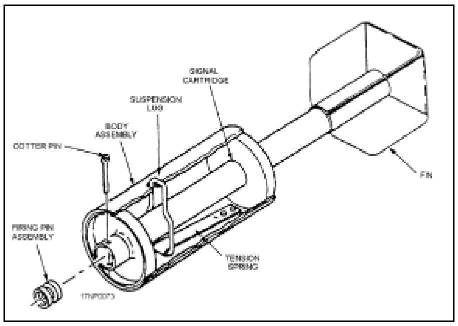
Photography by John Pitcher, 2007.

Nomenclature:	U.S. Bomb, Practice, BDU-48/B
Ordnance Family:	Bomb
DODIC:	E962
Filler:	Signal Cartridge, MK-4 MOD 3 or CXU-3A/B
Filler weight:	Not Provided
Item weight:	9.8 lbs
Diameter:	98.00 mm (3.86 in)
Length:	562.00 mm (22.13 in)
Maximum Range:	Not Provided
Fuze:	Impact or impact-inertia fired

Usage: These are air-dropped, impact or impact-inertia-fired signal-generating practice bombs used to train aircrews in the bombing of surface targets.

Description: The BDU-48/B is a 10-pound practice bomb. It is a thin-cased cylindrical bomb used to simulate retarded weapon delivery. The bomb is composed of the bomb body, a retractable suspension lug, a firing assembly, and box-type conical fins. The firing device consists of a firing pin assembly and a cotter pin. The BDU-48/B is painted blue. Identification nomenclature is stenciled in white letters on the bomb body. The bomb can use signal cartridge MK-4 Mod 3, or CXU-3A/B. While handling or transporting bombs, loaders should avoid placing their bodies in line with either end of the bomb.

*__Titanium tetrachloride__ is a colorless to pale yellow liquid that has fumes with a strong odor. If it comes in contact with water, it rapidly forms hydrochloric acid, as well as titanium compounds. Titanium tetrachloride is not found naturally in the environment and is made from minerals that contain titanium. It is used to make titanium metal and other titanium-containing compounds, such as titanium dioxide, which is used as a white pigment in paints and other products and to produce other chemicals. Military use it as a component of spotting charges. Titanium tetrachloride is very irritating to the eyes, skin, mucous membranes, and the lungs. Breathing in large amounts can cause serious injury to the lungs. Contact with the liquid can burn the eyes and skin.



HAZARDS:

- Explosive
- Red phosphorus or Titanium tetrachloride
- Smoke/incendiary

References: ATSDR; The Aviation Ordnanceman; TRI-DDS website; MIDAS; Global Security.org.

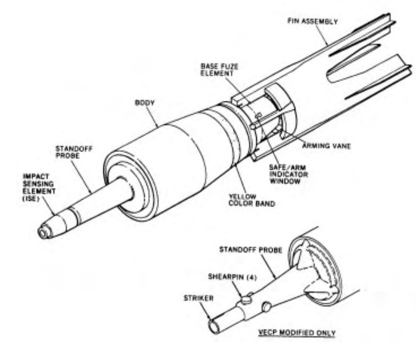
MK-20 Rockeye

Description

The MK-20 Rockeye is a free-fall, unguided cluster weapon designed to kill tanks and armored vehicles. The system consists of a clamshell dispenser, a mechanical MK-339 timed fuze, and 247 dual-purpose armor-piercing shaped-charge bomblets. The bomblet weighs 1.32 pounds and has a 0.4-pound shaped-charge warhead of high explosives, which produces up to 250,000 psi at the point of impact, allowing penetration of approximately 7.5 inches of armor. Rockeye is most efficiently used against area targets requiring penetration to kill. Fielded in 1968, the Rockeye dispenser is also used in the Gator air-delivered mine system. During Desert Storm US Marines used the weapon extensively, dropping 15,828 of the 27,987 total Rockeyes against armor, artillery, and antipersonnel targets. The remainder were dropped by Air Force (5,345) and Navy (6,814) aircraft.

Physical Characteristics

Length:	7.5 ft (2.3 m)
Diameter:	13.2 in (335 mm)
Tail Span	2.8 ft (0.85 m)
Weight:	485 lbs (220 kg)
Filling:	247 bomblets



Drawing: via *ORDATA Online Website*
Bomb MK 118 MOD 0

Data for MK 118 MOD 0:
Length: 34.3 cm (13.5 in)
Diameter: Body: 53 mm (2.1 in)
Fin assembly: 57 mm (2.25 in)
Weight: 590 g (1.3 lb)
Explosive: 170 g (0.37 lb) Oct

Reference: www.fas.org

Ordnance Technical Data Sheet
U.S. BOMB, 25-LB, PRACTICE, MK-76

Nomenclature:	U.S. Bomb, 25-lb, Practice, MK-76
Ordnance Family:	Bomb
DODIC:	E9AF, E9AE
Filler:	Signal Cartridge, typically MK-4 MOD 3 (red phosphorus), CXU-3A/B or CXU-2/B (titanium tetrachloride)
Filler weight:	Various (.16 lbs to .38 lbs)
Item weight:	25 lbs (11,000 grams)
Diameter:	4.00 in
Length:	Dependent on Mod (22.5 in to 25.07 in)
Fuze:	Impact or impact-inertia fired

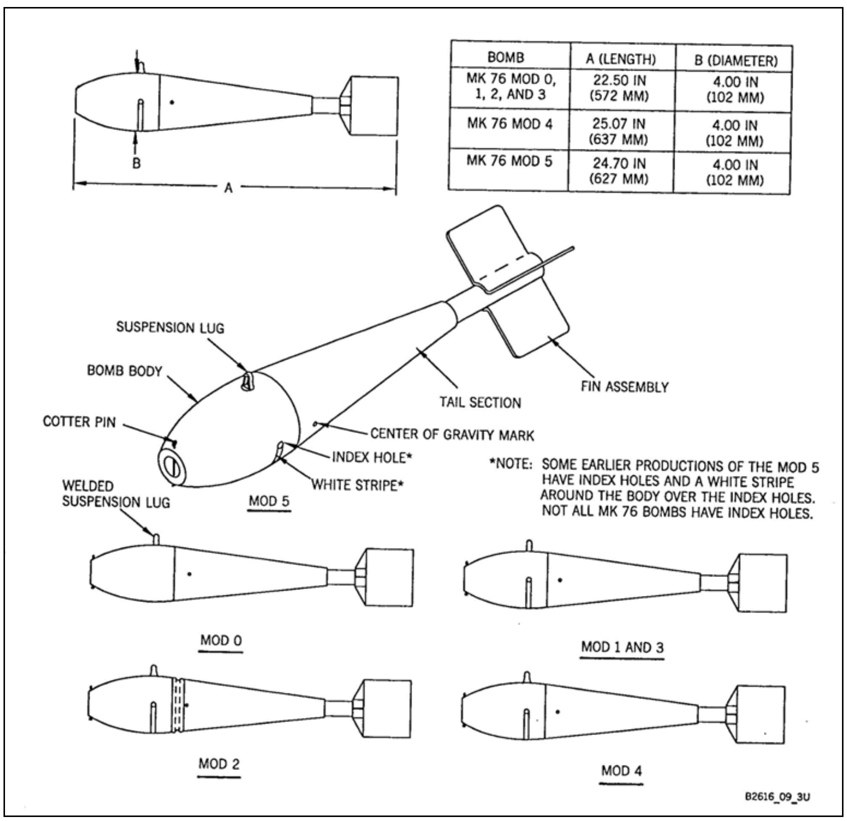
Spotting Charge. Photo by J. Pitcher

Usage: These are air-dropped, impact or impact-inertia-fired signal-generating practice bombs used to train aircrews in the bombing of surface targets.

Description: The Mk 76-series bombs are painted black or blue. The Mk 76 Mods 1, 2, 3, 4, and some Mod 5 bombs have a 0.25-inch (6-millimeter) white stripe over the index holes. The bombs contain no hazardous components. Hazardous components are contained in the signal cartridge or spotting charge. These bombs are signal-generating, impact-or impact-inertia-fired practice/simulated bombs. These bombs use either the Mk 4-series, Mk 5 Mod 0, CXU-3/B, CXU-3A/B signal cartridge, or the CXU-2/B spotting charge. The Mk 76-series and BDU-33-series bombs are cast iron with sheet steel fin assemblies.

***Titanium tetrachloride** is a colorless to pale yellow liquid that has fumes with a strong odor. If it comes in contact with water, it rapidly forms hydrochloric acid, as well as titanium compounds. Titanium tetrachloride is not found naturally in the environment and is made from minerals that contain titanium. It is used to make titanium metal and other titanium-containing compounds, such as titanium dioxide, which is used as a white pigment in paints and other products and to produce other chemicals. Military use it as a component of spotting charges. Titanium tetrachloride is very irritating to the eyes, skin, mucous membranes, and the lungs. Breathing in large amounts can cause serious injury to the lungs. Contact with the liquid can burn the eyes and skin.

***Red Phosphorus** may be harmful if absorbed through skin, ingested, or inhaled, and may cause irritation of the skin, eyes, upper respiratory tract, gastrointestinal tract, and mucous membranes. Inhalation of red phosphorus dust may cause bronchitis. Ingestion of red phosphorus may also cause stomach pains, vomiting, and diarrhea. Effects may vary from mild irritation to severe destruction of tissue depending on the intensity and duration of exposure. Prolonged and/or repeated skin contact may result in dermatitis. Chronic exposure may cause kidney and liver damage, anemia, stomach pains, vomiting, diarrhea, blood disorders, and cardiovascular effects. Chronic ingestion or inhalation may induce systemic phosphorus poisoning. If red phosphorus is contaminated with white phosphorus, chronic ingestion may cause necrosis of the jaw bone ("phossy-jaw").



HAZARDS: Explosive; Red phosphorus or Titanium tetrachloride; Smoke/incendiary.

References: ATSDR; The Aviation Ordnanceman; TRI-DDS website; MIDAS; Global Security.org.

Ordnance Technical Data Sheet
U.S. BOMB, 500-LB, PRACTICE, MK-82

Nomenclature:	MK-82, 500-lb, Practice Bomb
Ordnance Family:	Bomb
DODIC:	E9an or F243
Filler:	None (maybe fitted with spotting charge/signals)*
Filler weight:	Not Provided
Item weight:	226.80 kg (500 lbs)
Diameter:	274.00 mm (10.79 in)
Length:	1.67 m (65.90 in)
Fuze:	Impact
Hazards:	Ejection; EMR: Explosive; Frag; Movement; Proximity; Smoke/Incendiary

Usage: The MK-81 through MK-84 concrete or sand-filled practice bombs are used to train pilots in delivery techniques. These bombs normally do not contain an explosive filler or spotting charge. Explosive-loaded practice bombs have been found; therefore, all MK-81 through MK-84 concrete and sand-filled bombs should be treated as suspect. These bombs may contain live internal fuzes with boosters, live external fuzes and adapter-boosters, or a spotting charge adapter with a signal cartridge installed. They are all designed to function on impact, producing blast and fragmentation or a puff of white smoke.

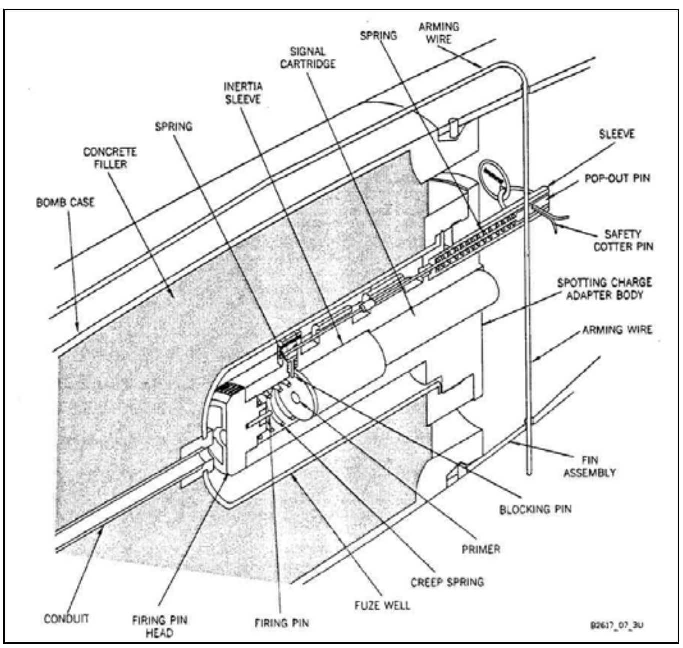
Description: The MK-82 (modified) bomb has a welded nose plate and the BDU-50/B bomb has a threaded nose with a plastic plug installed. The aft end of the MK-82 (modified) bomb is closed with a removable tail plate for filling operations and the BDU-50/B bomb is closed with a base plate, neither of which contain a threaded fuze well. The bomb body, conical fin assembly, and closure plugs are steel.

The MK-82 inert bomb is painted olive drab with a 38-millimeter (1.50-inch)-wide yellow band followed by a 51-millimeter (2.00-inch)-wide blue band on the nose. The markings SPOTTING CHARGE INSTALLED, (the date), and 6.25 POUNDS COMPOSITION C4, are stenciled in white on each side of the bomb next to the suspension lugs.

***Titanium tetrachloride** is a colorless to pale yellow liquid that has fumes with a strong odor. If it comes in contact with water, it rapidly forms hydrochloric acid, as well as titanium compounds. Titanium tetrachloride is not found naturally in the environment and is made from minerals that contain titanium. It is used to make titanium metal and other titanium-containing compounds, such as titanium dioxide, which is used as a white pigment in paints and other products and to produce other chemicals. Military use it as a component of spotting charges. Titanium tetrachloride is very irritating to the eyes, skin, mucous membranes, and the lungs. Breathing in large amounts can cause serious injury to the lungs. Contact with the liquid can burn the eyes and skin.

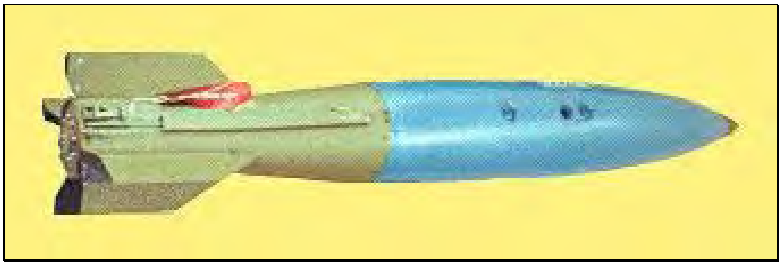
****Pyrotechnic** and screening devices contain combustible chemicals which, when ignited, rapidly generate a flame of intense heat, flash, infrared radiation, smoke or sound display (or combinations of these effects) for a variety of purposes. Compared to other explosive substances, pyrotechnics are more adversely affected by moisture, temperature, and rough handling. Some compositions may become more sensitive, and even ignite, when exposed to moisture or air. Mixtures which contain chlorates and sulfur are susceptible to spontaneous combustion. Most pyrotechnics produce a very hot fire that is difficult to extinguish and most burn without serious explosions. Many chemicals used in pyrotechnics produce toxic effects when ignited. Other pyrotechnics, which contain propelling charges, create an extremely hazardous missile hazard if accidentally ignited.

*** **Composition C-4**: This is a (91/9) RDX and plastic explosive composition. It is semi-plastic putty-like material, dirty white to light brown in color, less sensitive, more stable, less volatile and more brisant than composition C-3. It is a non-hydroscopic material that has found application in demolition blocks and specialized uses.



Reference: ORDATA Online, MIDIAS.

Ordnance Technical Data Sheet
U.S. BOMB, 1,000-LB, PRACTICE, MK-83

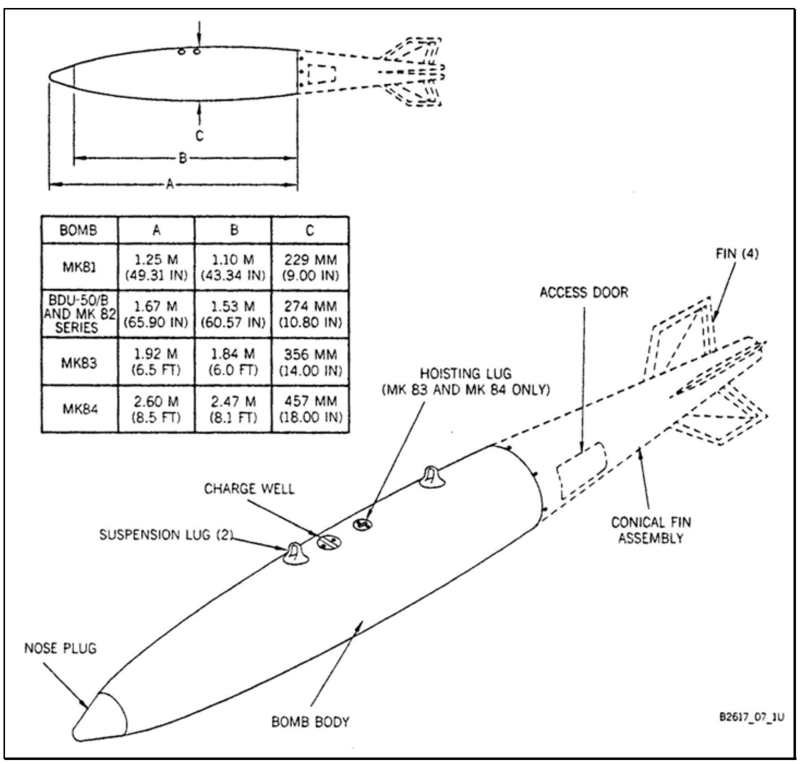


Nomenclature:	U.S. BOMB, 1,000-LB, PRACTICE, MK-83
Ordnance Family:	Bombs
DODIC:	E511
Explosive:	None
Item weight:	1,054 lbs
Diameter:	14 in (356 mm)
Length:	6.5 ft (1.92 m) nose to end of bomb body (does not include fin)
Frag Range:	20 m
Hazard:	Ejection; EMR; Frag; Explosive (HE); Movement; Proximity (VT); Smoke/Incendiary
Explosive Weight:	0 gm
Component Materials:	The bomb body, conical fin assembly, and closure plugs are steel.

Usage: The MK-81 through MK-84 concrete or sand-filled practice bombs are used to train pilots in delivery techniques. These bombs normally do not contain an explosive filler or spotting charge. Explosive-loaded practice bombs have been found; therefore, all MK-81 through MK-84 concrete and sand-filled bombs should be treated as suspect. These bombs may contain live internal fuzes with boosters, live external fuzes and adapter-boosters, or a spotting charge adapter with a signal cartridge installed. They are all designed to function on impact, producing blast and fragmentation or a puff of white smoke.

Description: The tail fuze cavity will be closed with a closure plug, spotting charge adapter, fuze, or conical plug. The nose fuze cavity will be closed with a fuze or nose plug. The nose plug will be either conical with two wrench flats, or streamlined with a spanner hole. Depending on the fuzing, the bombs may have an arming wire assembly, a lanyard, a cable, or an electrical charging receptacle installed. The charging well between the suspension lugs may be closed by a plug or may be fitted with an electrical charging receptacle, a lanyard lock, a fuze initiator, or an arming safety switch. The suspension lugs are 356 millimeters (14.00 inches) apart, except on the MK-84 they are 762 millimeters (30.00 inches) apart. The bombs may be fitted with conical or retarding fin assemblies. The bombs can be internally or externally fuzed. The arming assembly for a mechanical tail fuze may extend through the base or the side of the conical fin assembly, depending on the arming assembly used. An empty fuze cavity may be closed by a closure plug; however, the presence of a closure plug in a fuze cavity does not indicate the absence of a fuze. Bombs with certain fuzes have a closure plug screwed into the fuze cavity, making direct identification of the fuze impossible. When the fuze is not exposed, identification may be aided by observation of certain fuze-related features such as the type of closure plug in the fuze cavities and the components installed in the charging well. Other features such as the presence of arming vanes and reach rods may also aid in determining the type of fuze used.

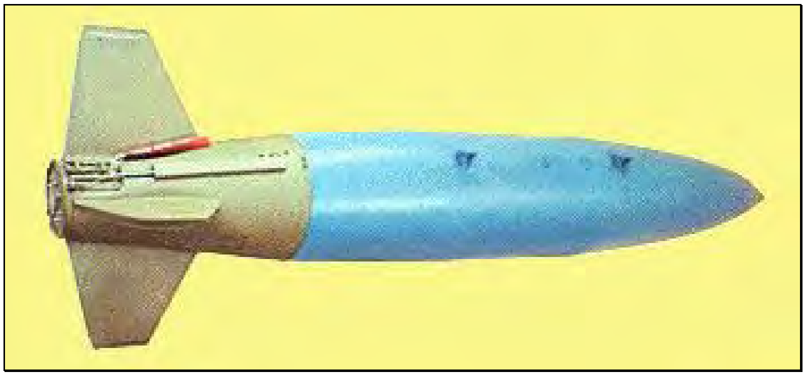
The MK-81 through MK-84 concrete- or sand-filled bombs are painted blue or olive drab, with white or black markings. Bombs fitted with a signal charge will have a brown or yellow band no wider than 76 millimeters (3.00 inches) circumscribed near the nose of the bomb. However, explosive-loaded practice bombs may be found without markings or color band indicating the explosive content. Inert-loaded MK-82 Mod 2 practice bombs may be found with an olive drab thermal coating and a 76-millimeter (3.00-inch)-wide blue nose band. Loading information is stenciled on the thermal coating. Thermally protected practice bombs are also die-stamped on the base plate to indicate their inert filler.



BOMB	A	B	C
MK81	1.25 M (49.31 IN)	1.10 M (43.34 IN)	229 MM (9.00 IN)
BDU-50/B AND MK 82 SERIES	1.67 M (65.90 IN)	1.53 M (60.57 IN)	274 MM (10.80 IN)
MK83	1.92 M (6.5 FT)	1.84 M (6.0 FT)	356 MM (14.00 IN)
MK84	2.60 M (8.5 FT)	2.47 M (8.1 FT)	457 MM (18.00 IN)

References: ORDATA Online; MIDAS.

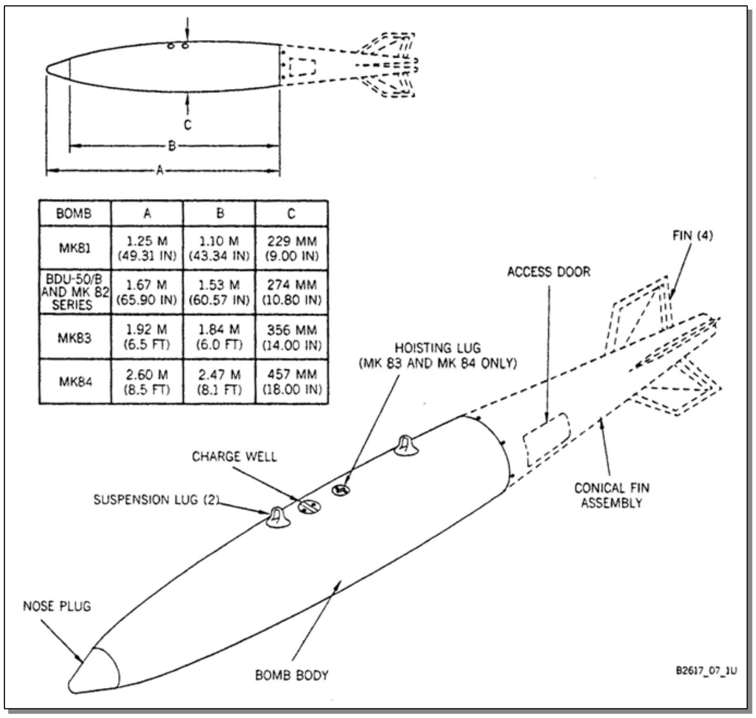
Ordnance Technical Data Sheet
U.S. BOMB, 2,000-LB, PRACTICE, MK 84



Nomenclature:	U.S. BOMB, 2,000-LB, PRACTICE, MK 84
Ordnance Family:	Bombs
DODIC:	E9bd
Filler:	Signal cartridge MK-4 Mod 3 (red phosphorus)
Item weight:	2,039 lbs
Diameter:	18 in (457 mm)
Length:	8.5 feet (2.6 m) without fin
Frag Range:	20 m
Hazard:	Ejection; EMR; Frag; Explosive (HE); Movement; Proximity (VT); Smoke/Incendiary

Usage: The MKs 81 through 84 concrete or sand-filled practice bombs are used to train pilots in delivery techniques. These bombs normally do not contain an explosive filler or spotting charge. Explosive-loaded practice bombs have been found; therefore, all MK-81 through MK-84 concrete and sand-filled bombs should be treated as suspect. These bombs may contain live internal fuzes with boosters, live external fuzes and adapter-boosters, or a spotting charge adapter with a signal cartridge installed. They are all designed to function on impact, producing blast and fragmentation or a puff of white smoke.

Description: MK-81 through MK-84 and MK-82 inert bombs. The tail fuze cavity will be closed with a closure plug, spotting charge adapter, fuze, or conical plug. The nose fuze cavity will be closed with a fuze or nose plug. The nose plug will be either conical with two wrench flats, or streamlined with a spanner hole. Depending on the fuzing, the bombs may have an arming wire assembly, a lanyard, a cable, or an electrical charging receptacle installed. The charging well between the suspension lugs may be closed by a plug or may be fitted with an electrical charging receptacle, a lanyard lock, a fuze initiator, or an arming safety switch. The suspension lugs are 356 millimeters (14.00 inches) apart, except on the MK-84 they are 762 millimeters (30.00 inches) apart. The bombs may be fitted with conical or retarding fin assemblies. The bombs can be internally or externally fuzed. The arming assembly for a mechanical tail fuze may extend through the base or the side of the conical fin assembly, depending on the arming assembly used. An empty fuze cavity may be closed by a closure plug; however, the presence of a closure plug in a fuze cavity does not indicate the absence of a fuze. Bombs with certain fuzes have a closure plug screwed into the fuze cavity, making direct identification of the fuze impossible. When the fuze is not exposed, identification may be aided by observation of certain fuze-related features such as the type of closure plug in the fuze cavities and the components installed in the charging well. Other features such as the presence of arming vanes and reach rods may also aid in determining the type of fuze used.



BOMB	A	B	C
MK81	1.25 M (49.31 IN)	1.10 M (43.34 IN)	229 MM (9.00 IN)
BDU-50/B AND MK 82 SERIES	1.67 M (65.90 IN)	1.53 M (60.57 IN)	274 MM (10.80 IN)
MK83	1.92 M (6.5 FT)	1.84 M (6.0 FT)	356 MM (14.00 IN)
MK84	2.60 M (8.5 FT)	2.47 M (8.1 FT)	457 MM (18.00 IN)

The MK-81 through MK-84 concrete- or sand-filled bombs are painted blue or olive drab, with white or black markings. Bombs fitted with a signal charge will have a brown or yellow band no wider than 76 millimeters (3.00 inches) circumscribed near the nose of the bomb. However, explosive-loaded practice bombs may be found without markings or color band indicating the explosive content. Inert-loaded MK-82 Mod 2 practice bombs may be found with an olive drab thermal coating and a 76-millimeter (3.00-inch)-wide blue nose band. Loading information is stenciled on the thermal coating. Thermally protected practice bombs are also die-stamped on the base plate to indicate their inert filler.

References: ORDATA Online; MIDAS.

BOEING

Backgrounder

Integrated Defense Systems
P.O. Box 516
St. Louis, MO 63166
www.boeing.com

Joint Direct Attack Munition

Description & Purpose:
The Joint Direct Attack Munition (JDAM) is a low-cost guidance kit produced by Boeing that converts existing unguided free-fall bombs into accurately guided "smart" weapons. The JDAM kit consists of a tail section that contains a Global Positioning System/Inertial Navigation System and body strakes for additional stability and lift.

Additional growth to the JDAM low-cost family of weapons includes Laser JDAM, the incorporation of a laser sensor that improves JDAM's current near-precision accuracy to precision accuracy and facilitates prosecution of targets of opportunity (including moving targets); JDAM Extended Range (JDAM ER), the incorporation of a low-cost wing set to extend JDAM's standoff range to greater than 40 miles, and the incorporation of JDAM guidance on other warheads such as naval mines, heavy penetrator warheads and new specialty warheads.

Customer(s):
Both the U.S. Air Force and U.S. Navy employ JDAM. Its first operational use was during Operation Allied Force in the Balkans in 1999. JDAM has been used extensively in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom. The first international sale was made to Israel in 2000. Since then, 18 additional international customers have purchased JDAM.

General Characteristics:
Currently, MK-84 2,000-pound and BLU-109 2,000-pound (900-kg) bombs (GBU-31); MK-83 (GBU-32); and MK-82 500-pound (225-kg) bombs (GBU-38) are in production to make the cost-effective JDAM. When employed, these weapons have proven highly accurate and can be delivered in any flyable weather. JDAM can be launched from more than 15 miles from the target with updates from GPS satellites to help guide the weapon to the target.

The JDAM production team includes Honeywell Inc. (inertial measurement unit); Rockwell Collins (global positioning system receiver); HR Textron (tail actuator subsystem); Lockheed Martin Tactical Defense Systems (mission computer); Lockely (tail fairing); Enser and Eagle-Picher (battery); and Stremel (strakes and cable cover).

Background:
The full-scale production decision (milestone III) for JDAM was made by the U.S. Department of Defense (DoD) in March 2001. In November 2004, Boeing delivered the 100,000th JDAM to the U.S. military. As of June 2008, Boeing has delivered more than 195,000 JDAM tail kits and still produces over 1,200 JDAMs every month. The DoD now plans to procure about 217,000 JDAM kits in several configurations to fit the various warheads.

Contact: Tim Deaton
Global Strike Systems
The Boeing Company
(314) 232-5886
timothy.r.deaton@boeing.com

August 2008

Raytheon

JSOW

Family of Precision Strike Weapons

The Joint Standoff Weapon is a modular, affordable, highly-lethal weapon revolutionizing strike warfare.

Benefits

- Increased weapon and platform survivability
- Multiple launch capability
- Tactical flexibility
- Jointness and interoperability
- Cost effective

Joint Standoff Weapon (JSOW)
This new generation glide weapon ensures warfighter survivability by enabling precision air strike launches from well-beyond most enemy air defenses, at kinematic standoff ranges up to 70 nm (130 km). JSOW Block II development significantly reduced JSOW unit costs and added Selective Availability/Anti-Spoofing Module (SAASM) Global Positioning System (GPS) capability. It was completed in 2006.

The family of JSOW precision strike weapons is modular in design with variants that can integrate different lethal submunitions, and a blast/fragmentation unitary warhead and a hardened target penetrator that can be programmed for blast and fragmentation effects. JSOW targets vary from all types of area targets to hard point targets. JSOW's low radar cross section and infrared signature are key stealth features and ensure a high probability of survival en route to heavily defended targets.

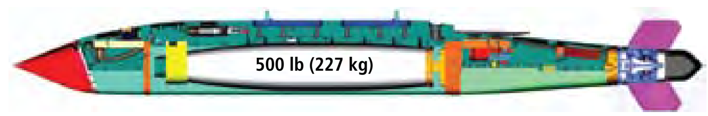
The blast/fragmentation unitary variant incorporates the insensitive 500-pound BLU-111 (MK-82). The BROACH penetrator/blast/fragmentation variant incorporates an uncooled Imaging Infrared (IIR) autonomous terminal seeker and tracker, and integrates the BROACH dual-stage blast/fragmentation and/or penetrator warhead. This variant enables precision attack of point targets.

Since 1999, JSOW has been combat proven in operations Southern Watch, NATO Allied Force, Enduring Freedom and Iraqi Freedom with more than 400 weapons employed. More than 3,400 JSOWs have been produced.

Operations
Today, JSOW variants can engage and destroy virtually the entire target set for U.S. forces spanning a range of threat environments. All JSOW variants are guided to the target area by a highly-integrated GPS and Inertial Measurement System. JSOW receives the targeting information in preplanned mode, in the cockpit with data received while airborne through onboard sensors, or through other third-party targeting assets. After the AGM-154C BROACH variant arrives in the target area, it utilizes the IIR seeker for autonomous guidance in the terminal phase of the flight to attack with precision accuracy.

Modularity/Growth
JSOW is designed to take advantage of new developments in payloads and sensors through design modularity of the air vehicle. The payload bay can accommodate lethal and nonlethal payloads — from warheads to pamphlets to sensor packages. The terminal seeker space can accept the latest sensors as they are developed.

JSOW-C with the BROACH Warhead



JSOW-A-1 with the BLU-111 Warhead

A technology demonstration phase is currently underway leading to a spring 2009 JSOW Extended Range (ER) Free Flight Test.

Performance

JSOW demonstrated all standoff accuracy and lethality requirements in a highly-successful development and operational test program. This demonstrated the ability to launch from high or low altitudes and accurately navigate to the target area via selected waypoints, further enhancing weapon and aircrew survivability.

JSOW A-1 (BLU-111) is currently in production for FMS only. JSOW C is currently in production for four international FMS customers.

The AGM-154C (BROACH) has demonstrated precision accuracy within approximately four feet in developmental and operational tests. The weapon is in full-rate production and achieved initial operating capability in February 2005.

JSOW C-1 adds a two-way datalink and moving maritime target capability, is in full-scale development and scheduled for initial operation capability in FY 2010.

JSOW is integrated on the F-15E, F-16, F/A-18, B-2 and B-52 aircraft. JSOW is also a threshold internal bay weapon for the F-35 Joint Strike Fighter initial operational capability. The aircraft compatibility built into the JSOW design will minimize integration costs for future aircraft platforms. The maturity and proven capabilities within the JSOW make this a user-friendly, highly-reliable, cost-effective system.

JSOW Specifications

Length:	160 in	(4.1 m)
Weight:	~1,050 lb	(475 kg)

Aircraft Compatibility:
- F-16, F-15E, F/A-18, B-2, B-52, P-3, F-35 (JSF), JAS 39 Gripen, Eurofighter 2000, Tornado
- Multiple carriage capable on BRU-55/BRU-57 twin launchers
- MIL-STD-1553/1760 and NATO STANAG 3837 AA interface for full capability

Range (unpowered):
- Low altitude 500-ft launch 12 nm (22 km)
- High altitude 40,000-ft launch 70 nm (130 km) maximum kinematic range

JSOW-ER (powered): – In technology demonstration phase
- ~155 nm (290 km) — Spiral 0

Warheads:

• 500-lb BROACH	Blast/fragmentation and/or penetrating warhead Demonstrated 5 ft (1.5 m) concrete penetration
• 500-lb BLU-111	Unitary blast/fragmentation warhead

Raytheon Company
Missile Systems
Air Warfare Systems
P.O. Box 11337
Tucson, Arizona
85734-1337 USA
520.663.8999 phone
520.663.8138 fax

www.raytheon.com

Raytheon
Customer Success Is Our Mission

APPENDIX E

Reference

B. Naval Surface Warfare Center, Corona: Laser Range Safety Report for Commander United States Naval Forces, Mariana Islands, Guam. September 2009.

This page intentionally left blank.

DEPARTMENT OF THE NAVY
NAVAL SURFACE WARFARE CENTER
CORONA DIVISION
PO BOX 5000
CORONA, CA 92878-5000

IN REPLY REFER TO
1200
Ser FT30/033
02 Sep 09

From: Commanding Officer, Naval Surface Warfare Center, Corona Division
To: Commanding Officer, Commander United States Naval Forces, Marianas Islands, Guam

Subj: LASER RANGE SAFETY REPORT FOR COMMANDER UNITED STATES NAVAL FORCES, MARIANAS ISLANDS, GUAM

Ref: (a) Commander, US Pacific Fleet N0534A09WR001D0
(b) OPNAVINST 5100.27B/MCO 5104.1C
(c) E-mail correspondences between Lt. Pike, CNM AT, Mr. Randall Wong, PMRF, Mr. Larry Rustigian, NSWC Corona, and Ms. Ashleigh Lizarraga, NSWC Corona, from 15 August 2009 through 25 August 2009.

Encl: (1) Range Laser Safety Report for Commander United States Naval Forces, Marianas Islands, Guam 27 August 2009.

1. In accordance with reference (a) tasking and funding, we conducted an on-site laser range safety survey on the Island of Guam under the ownership of Commander Naval Marianas Area Training (CNM AT) on 07 July 2009. The survey results are provided in enclosure (1). We determined that laser operations at CNM AT to be in full compliance with reference (b). The CNM AT Range Safety Department personnel provided comments and concurrence on the original draft by reference (c).

2. If additional information is required, please contact Mr. Larry Rustigian (FT33) at (951) 273-5029 or DSN 933-5029.

M. C. GAMMON
By direction

NAVAL SURFACE WARFARE CENTER CORONA DIVISION

LASER SAFETY SURVEY REPORT

For

COMNAVMARIANAS AREA TRAINING

27 August 2009

Prepared by:
Lorrie R. Agnew (TLSO, RLSS)

Compiled by:
Ashleigh Lizarraga (TLSO)

1. INTRODUCTION

1.1 The on-site laser safety survey was performed on the Island of Guam under the ownership of COMNAVMARIANAS Area Training (CNM AT) laser ranges on 07 July 2009.

1.2 The next range laser safety survey for CNM AT should be completed no later than July 2012.

1.3 CNM AT laser ranges are under the operational control of the United States Navy.

1.4 This report is valid for three (3) years from the date of this report, 27 August 2012.

2. CONDITIONS, LIMITATIONS, AND DISCLAIMERS

2.1 The safe lasing profiles discussed in this report are not to be construed as mandated aircraft flight paths, but rather as boundary limits at a given location that distinguish between safe and unsafe laser use conditions.

2.2 This evaluation addresses only the systems approved for general training scenarios by the Navy Laser Safety Review Board (LSRB). A separate evaluation should be done on a case-by-case basis by the Range Laser Safety Specialist (RLSS) on laser systems used in non-traditional modes, research & development applications, and prototype systems.

2.3 Force on force scenarios are not evaluated in this report and should only be allowed with the express consent of the Range LSO using safety measures established by the LSRB.

2.4 A magnetic declination of 1˚ 21' East from True North was used for this report. The magnetic declination changes by 0˚ 0' West per year from True North.

2.5 Bearings shown in the graphic images used to define the Laser Hazard Danger Zones (LHDZs) are referenced to True North and Magnetic North.

3. SOURCE DOCUMENTS/REFERENCES

3.1 OPNAVINST 5100.27B/MCO 5104.1C

3.2 NSWC Dahlgren Division ltr 8240.2 Ser G71-237 of 21 Jul 2003.

3.3 *W-517 Certification In-Brief* presented by Lieutenant Pike

3.4 Data for reporting has been sourced from multiple documents and geographic datums. Geographic datums used have included; North American Datum of 1927 (NAD27), North American Datum of 1983 (NAD83), and World Geodetic System of 1984 (WGS84). Coordinates are converted from NAD27 to WGS84 using GEOTRANS V2.2.2. Coordinates are converted from NAD27 to NAD83 and reverse by using CORPSCON. All coordinates shown in this report are referenced in WGS84.

3.5 The Military Grid Reference System (MGRS), Universal Transverse Mercator (UTM), and Geodetic (Latitude/Longitude – LAT/LONG) grid coordinates were used to describe the various ranges, target areas, and firing locations.

4. DESCRIPTION

4.1 **Location.** W-517 is located in Guam, which is the largest southernmost island of the Mariana Archipelago. The island is approximately 6,000 miles West of San Francisco; 3,700 miles Southwest of Honolulu; 1,500 miles Southeast of Tokyo; 2,100 miles Southeast of Hongkong; 1,500 miles East of Manila; and 3,100 miles Northwest of Sydney at 13 North latitude and 144 East longitude.

4.2 **Restricted Airspace**. W-517 does not lie within restricted airspace.

4.3 **CNM AT Target Areas (TAs).** CNM AT consists of one (1) Target Area that is designated for Aerial Lasing only. The area is bounded as follow:

4.3.1 CNM AT TA W-517 TA is defined by the following coordinates:

Geodetic		
Latitude	**Longitude**	**MGRS**
12 54 59.3N	144 33 17.4E	55PBQ3468029166
12 55 04.4N	144 42 38.5E	55PBQ5160329166
12 44 57.4N	144 36 48.2E	55PBQ4086610601
12 45 01.5N	144 30 33.8E	55PBQ2957110832

4.4 **CNM AT Firing Line (FL).** CNM AT consists of one (1) Firing Line that is designated for Aerial Lasing only. The area is bounded as follow:

4.4.1 CNM AT FL W-517 FL is defined by the following coordinates:

Geodetic		
Latitude	**Longitude**	**MGRS**
12 59 1.3N	144 34 23.8E	55PBQ3675536587
12 59 1.2N	144 42 29.4E	55PBQ5139336446

4.5 **Aerial Lasing**. All operations on W-517 consist of Aerial Lasing.

5. RANGE CERTIFICATION

5.1 **Survey.** Mr. Lorrie Agnew and Ms. Ashleigh Lizarraga performed the physical site inspection, took all GPS readings, and provided all GIS support to all personnel in Guam on 07 Jul 2009. Mr. Agnew is a representative of the Naval Surface Warfare Center Corona Division, Force Training Department, Range Sustainment and Geomatic Engineering Branch (FT33) in Corona, CA. He holds certification as a Technical Laser Safety Officer (TLSO) and a Range Laser Safety Specialist (RLSS). Lieutenant Pike, and Commanding Officer Everly were also present during the inspection and took active roles in the In-Brief discussions. Electronics Technician Master Chief Robert Reilly, Lieutenant Conway, and Randall Wong were not present during the on-site inspection, but as well took active roles.

5.2 **Analysis.** Mr. Agnew also performed the analysis for CNM AT Safety Report. Mr. Agnew is from the Naval Surface Warfare Center Corona Division, Force Training Department, Range Sustainment and Geomatic Engineering Branch (FT33) in Corona, CA. He holds a certification as a Technical Laser Safety Officer (TLSO) and a Range Laser Safety Specialist (RLSS).

5.3 **Report.** Ms. Lizarraga gathered information for the compilation of the CNM AT Laser Safety Report. Ms. Ashleigh Lizarraga is a representative of the Naval Surface Warfare Center Corona Division, Force Training Department, Range Sustainment and Geomatic Engineering Branch (FT33) in Corona, CA. She holds a certification as a Technical Laser Safety Officer (TLSO).

6. EVALUATION

6.1 **Aerial Lasing.** The approved aerial lasing systems are limited to 5mrad and 10mrad buffer angles; satisfying both, helo stationary and moving.

6.2 Appendix A contains images of the TAs with a corresponding coordinate information table for each aerial operation.

6.3 Appendix B contains images of the safe lasing profiles in nautical miles (nmi) and feet (ft).

6.4 Appendix C contains all coordinates in UTM, Geodetic, and MGRS formats.

7. RESULTS

7.1 **Aerial Lasing**. Aerial lasing is permitted on all TAs and listed in Appendix B, provided the pilot and crew adhere to the approved laser Standard Operating Procedures (SOPs) and Range Regulations. Table 7-1 displays the available flight headings for the TAs. The safe lasing profiles are contained in Appendix B.

Table 7-1: Training Areas with Appropriate Headings

TAs	Heading (Magnetic)
W-517 (Helo in Hover)	Left Lateral Limit: 204° Right Lateral Limit: 179°
W-517 (Fast Mover)	Left Lateral Limit: 000° Right Lateral Limit: 360°

7.2 Nominal Ocular Hazard Distance (NOHD) was used to generate the LHDZ when analyzing the Helo in Hover/Moving operation. Only systems with a maximum NOHD (12cm aided) of 87.59 km or less are approved.

8. RECOMMENDATIONS & FINDINGS

8.1 For this report, natural terrain mitigation based on the laser system's platform was used. If the natural terrain of the range does not contain the laser energy, then it is the responsibility of the Range Laser Safety Officer to contact NSWC Dahlgren for specific information such as Nominal Ocular Hazard Distances (NOHDs), Optical Densities (ODs), and other laser weapon system parameters to determine whether the hazardous energy levels are within the limits of the range boundary. If a Standard Operating Procedure (SOP) for a certain exercise proscribes scenarios that are less restrictive than described in this report, then it will be the Range Safety Department's responsibility to ensure safe laser use.

8.2 CNM AT has a laser safety program that is in compliance with OPNAVINST 5100.27B/MCO 5104.1C.

8.3 All laser systems used on CNM AT laser ranges are to be used only against targets located within the designated TAs.

8.4 CNM AT should post visible markings that indicate the extreme boundaries of the TAs.

8.5 No adverse conditions to aerial lasing were observed on CNM AT laser ranges during the on-site inspection.

8.6 If standing water, glass, or any other reflective materials becomes present within or near any of the established TAs or LHDZs, then it will be the responsibility of the training facility LSO to either suspend the exercise or ensure personnel that are not within the Nominal Ocular Hazard Distance (NOHD) of the system in use.

8.7 All laser operators should meet the following minimum requirements:

8.7.1 Have received the appropriate laser range briefing from the training facility LSO prior to use of any laser range, if deemed necessary by the LSO.

8.7.2 Are familiar in detail with CNM AT Safety Program and adhere to the procedures established therein.

8.7.3 Communicate with range safety/control during laser operations, if deemed necessary by the training facility LSO.

8.7.4 Fire aerial lasers only after positive identification of the approved targets.

8.8 The following are suggested general laser safety guidelines that apply to laser personnel during laser exercises:

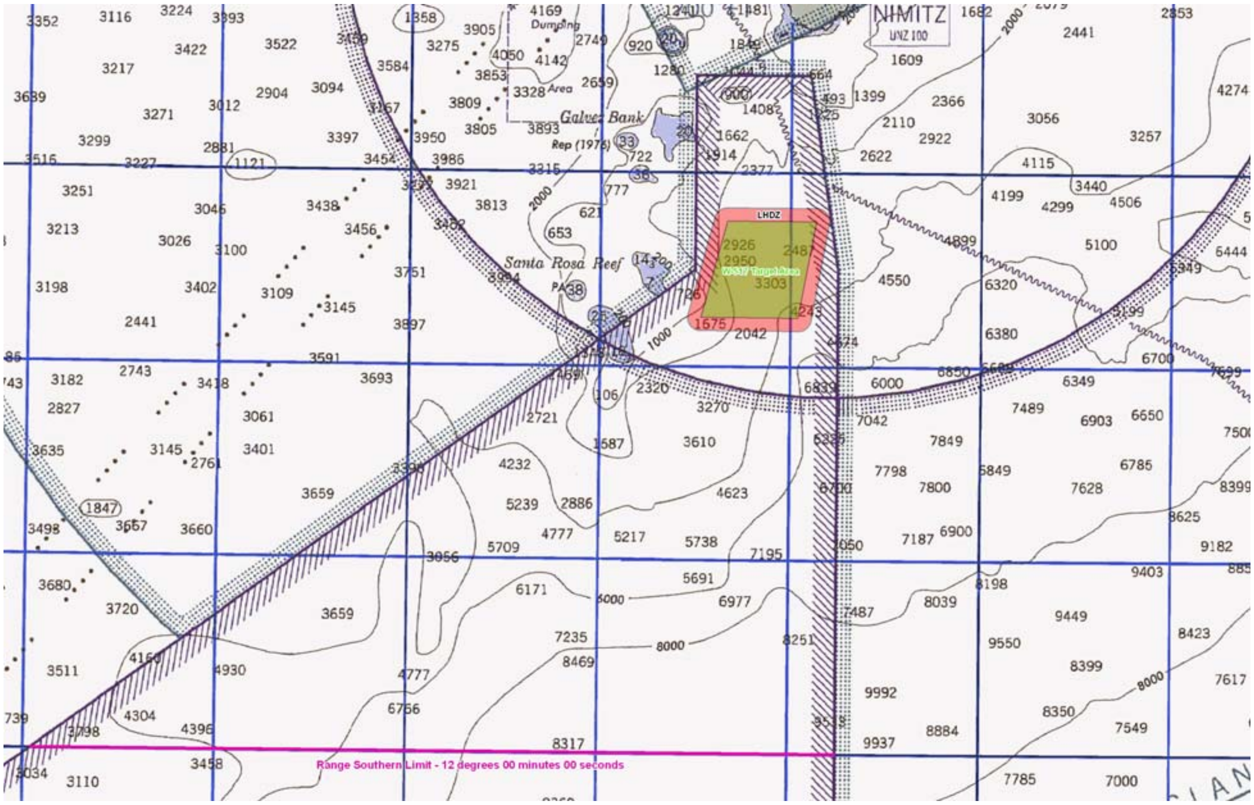
8.8.1 Prior to laser operations, pilots should make a ‘cold pass’ to ensure that the TAs and corresponding LHDZs are clear of unauthorized personnel.

8.8.2 The training facility LSO should ensure that all personnel in the vicinity of the laser range remain outside the TAs and LHDZs during laser operations and/or wear the appropriate eye and skin protection.

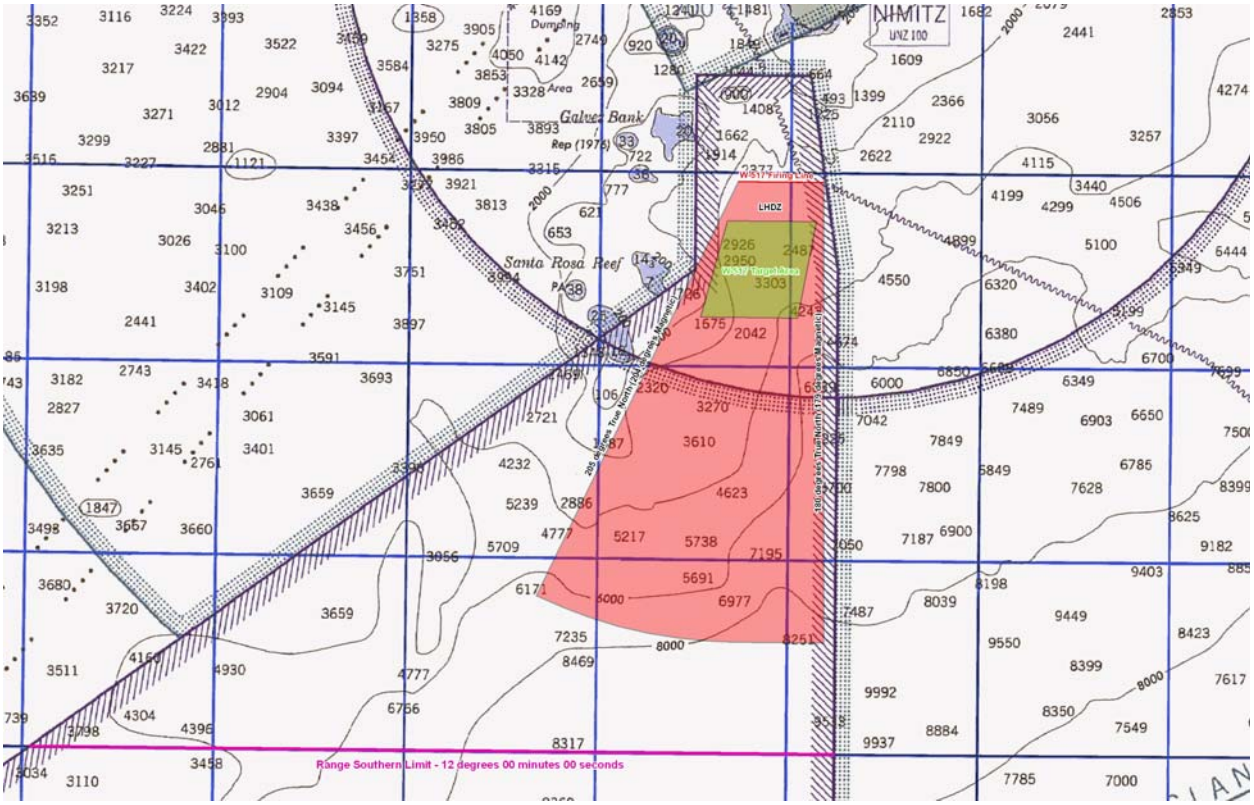
8.9 Applicable Notice to Airmen (NOTAM) and Local Notice to Mariners (NOMAR) should be issued as required for any planned operations.

Appendix A

Airborne Laser Systems Laser Danger Zones



TA	Maximum Allowable Buffer	Aircraft Heading
W-517	5 mrad	000 to 360 degrees.
TA Coordinates (MGRS)	55PBQ3468029166 to 55PBQ5160329166 to 55PBQ4086610601 to 55PBQ2957110832 to 55PBQ3468029166.	
Approved Platform(s)	Fixed Wing Aircraft System.	



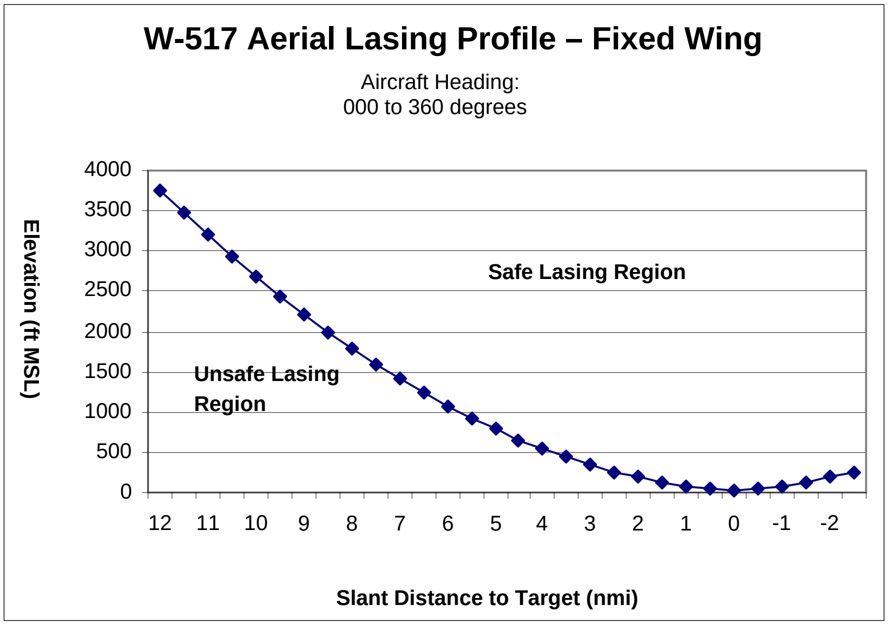
<table>
<tr><th>TA</th><th>FL</th><th colspan="2">Maximum Allowable Buffer</th><th>Lateral Limits</th></tr>
<tr><td>W-517</td><td>W-517</td><td colspan="2">10 mrad</td><td>Left Lateral Limit: 204° Magnetic
Right Lateral Limit: 179° Magnetic</td></tr>
<tr><td colspan="2">FL Coordinates</td><td colspan="3">55PBQ3675536587 to
55PBQ5139336446.</td></tr>
<tr><td colspan="2">LTA Coordinates (MGRS)</td><td colspan="3">55PBQ3468029166 to
55PBQ5160329166 to
55PBQ4086610601 to
55PBQ2957110832 to
55PBQ3468029166.</td></tr>
<tr><td colspan="2">Approved Platform(s)</td><td colspan="3">Helicopter
in Hover/Moving.</td></tr>
</table>

*Only systems with a maximum NOHD (12cm aided) of 87.59 km are approved.

Appendix B

Airborne Laser Systems

Safe Lasing Profiles



Slant Distance (nmi)	Altitude (feet)	Slant Distance (nmi)	Altitude (feet)
12.0	3753	4.5	657
11.5	3468	4.0	541
11.0	3194	3.5	436
10.5	2932	3.0	342
10.0	2680	2.5	259
9.5	2440	2.0	188
9.0	2211	1.5	128
8.5	1994	1.0	79
8.0	1787	0.5	41
7.5	1592	0.0	15
7.0	1408	-0.5	41
6.5	1235	-1.0	79
6.0	1074	-1.5	128
5.5	924	-2.0	188
5.0	785	-2.5	259

Appendix C

COMNAVMARIANAS Area Training TA Coordinates Table

	UTM				Geodetic		Military
ID	**Zone**	**Hemisphere**	**Easting**	**Northing**	**Latitude**	**Longitude**	**MGRS**
W-517	55	N	234680	1429166	12 54 59.3N	144 33 17.4E	55PBQ3468029166
	55	N	251603	1429027	12 55 04.4N	144 42 38.5E	55PBQ5160329166
	55	N	248066	1410601	12 44 57.4N	144 36 48.2E	55PBQ4086610601
	55	N	229571	1410832	12 45 01.5N	144 30 33.8E	55PBQ2957110832

COMNAVMARIANAS FL Coordinates Table

	UTM				Geodetic		Military
ID	Zone	Hemisphere	Easting	Northing	Latitude	Longitude	MGRS
W-517	55	N	236755	1436587	12 59 1.3N	144 34 23.8E	55PBQ3675536587
	55	N	251393	1436446	12 59 1.2N	144 42 29.4E	55PBQ5139336446

Last Page

APPENDIX E

Reference

C. NAVSEA Warfare Center Newport, Portable Underwater Training Range Concept of Operations, pages 8 – 16 (summary), Doc. No. PUTR-PM-002 Version 1, 10 OCT 2006

This page intentionally left blank.

1 INTRODUCTION

1.1 Document Purpose

The purpose of this document is to establish a preliminary Concept of Operations (ConOps) for the planned PUTR, reflecting both the capabilities and characteristics of the planned system and the expected operational training environments in which it will be used. This ConOps is intended to promote understanding of the respective roles of the Navy training ranges and training customer activities. Specifically, this ConOps accomplishes the following:

- Relates the key design features and functional capabilities of the PUTR to the FDNF USW exercise requirements to be served.

- Establishes the PUTR operational context in terms of physical and environmental surroundings, participants, and event planning and control in accordance with Reference (A), the PUTR Capability Development Document (CDD).

- Develops a logical sequence of operations for the PUTR, defining the roles of the training range activity and supported customers throughout the cycle of system preparation, transportation, deployment, operation, recovery, and post-exercise restoration and storage for the next cycle.

1.2 Document Organization

This ConOps is organized as follows:

- Section 1, Introduction (this section): Defines the objectives and perspectives guiding the development of the PUTR system. References are provided to PUTR documents describing program background and requirements.

- Section 2, Operational Context: Presents the PUTR mission requirements and related top-level performance requirements, and describes the operational and support environments in which PUTR will be used.

- Section 3, Functional Description: Describes and illustrates the overall PUTR design concept and system architecture, subsystem functions, and principles of operation.

- Section 4, PMRF/Range User Interaction: Explains the role of each key individual involved in the PUTR employment cycle, and describes the information exchanges among operators and between them and the PUTR system.

- Section 5, Acronyms and Abbreviations: Defines the acronyms and abbreviations used in this document.

1.3 References

All PUTR documentation will be located on SCOUTTRACK and on the Code 70 Server at *L:\PUTR\ISO\CM\Approved,* for approved documents or *L:\PUTR\ISO\CM\In Review*, for documents that are in process or in review. SCOUTTRACK is a secure website which will provide access to program information and documentation and is available to all members of the PUTR Team. The following are PUTR documents describing the program plan and requirements:

A) Training Instrumentation Operational Requirement/Acquisition Program Baseline Abbreviated Capability Development Document (CDD) Short Form

B) Integrated Master Schedule (IMS) for the Portable Undersea Training Range (PUTR)

C) System Subsystem Specification (SSS) for the Portable Undersea Training Range (PUTR)

D) Systems Engineering Management Plan, (SEMP)

E) Configuration Management Plan

F) Acquisition Logistics Support Plan (ALSP)

1.4 System Purpose

PUTR employs modern technologies to support coordinated USW training for FDNF and SUBPAC. The PUTR provides a self-contained, portable, undersea training capability supporting current Navy requirements to exercise and evaluate sensor systems, weapons systems, and crews in environments that replicate potential combat areas. This is of critical importance for USW due to the impact of the environment on sensor and weapon performance. The PUTR will complement the capabilities of existing fixed ranges by facilitating training of FDNF Anti Submarine Warfare (ASW) assets that are operating in environmentally approved remote areas not serviced by conventional fixed undersea range facilities.

1.5 System Capability Overview

The PUTR system provides command and control and real-time tracking and data display for several vehicles equipped with MK 84 acoustic pingers. Acoustically tracked vehicles include submarines, surface ships, weapons, targets, and unmanned undersea vehicles. The PUTR system is planned for use at operating sites near Maui, Okinawa, Guam, and near the Southern California Offshore Range (SCORE). The PUTR capability resides in a group of acoustic, electronic, and mechanical components, all transportable by sea, land or air. At-sea deployment and recovery of PUTR subsystems can be accomplished by a vessel of opportunity with capabilities comparable to the Acoustic Pioneer, shown in Figure 1.1-1. Many hardware components will be Commercial-Off-The-Shelf (COTS) and Government-Off-The-Shelf (GOTS) items that can be easily replaced or upgraded.

Figure 1.1-1. Acoustic Pioneer

1.6 History of Development

The PUTR Transponder Subsystem builds upon the existing Portable Acoustic Range (PAR) and Australian Portable Tracking Range (PTR) technologies. PAR successfully demonstrated MK 84 tracking in deep-water, and PTR successfully demonstrated shallow-water tracking. The PUTR Transponder Subsystem will merge the two range concepts into a common hardware base, and provide enhancements to overcome shortcomings of the existing PAR and PTR systems. The PUTR system utilizes existing PMRF Underwater Tracking System (UTS) software and PMRF Range Operations and Control System (ROCS) software.

2 OPERATIONAL CONTEXT

The PUTR initiative responds to the emergent training needs of advanced FDNF assets by providing a capability to safely and effectively conduct coordinated USW training in realistic environments. The PUTR provides a fully portable training range capability; easily deployed and recovered using existing naval assets or commercial vessels of opportunity. The PUTR provides a valuable adjunct to existing fixed-range training facilities, able to satisfy the training requirements of USW forces in remote operating areas anywhere in the world. The PUTR will reduce the need for Environmental Impact Studies (EIS) and Environmental Assessments (EA) by enabling training in areas relatively free of environmental and encroachment constraints. The PUTR will be capable of tracking submarines, surface ships, weapons, targets, and unmanned undersea vehicles (UUVs), equipped with a MK 84 tracking pinger and distribute the data to display systems aboard ship, or at a shore site via satellite.

2.1 Mission Requirements

The primary mission of the PUTR is to support complete coordinated training of forward deployed USW assets such as ships, submarines, torpedoes, UUVs, and undersea targets. PUTR can support in-water tracking of weapons deployed by naval aircraft. Tracking of the aircraft itself requires integration of assets such as the Large Area Tracking Range (LATR). Integration of LATR is not planned in the current system, but could be integrated in future enhancements. As a training range, PUTR is required to support voice/data communication components for range safety in compliance with Department of Defense (DoD) and Range Commanders Council (RCC) standards. Acoustic remote control of MK 30 Mod-1 targets is required.

2.1.1 Primary Users

The primary users of PUTR are FDNF. These units are USW mission capable surface ships such as destroyers, frigates and cruisers. Each may be outfitted with one or more helicopters. Carriers may also embark a squadron of ASW helicopters to provide limited close-in support. Fast attack submarines (SSNs) will use the PUTR, either alone or in conjunction with surface ships. Submarines may act as targets for surface ships or other submarines. The range support vessel may deploy, control, and recover MK 30 Mod-1 acoustic targets.

2.1.2 Mission Engagement Scenarios

The principal type of exercise conducted on the PUTR would be ASW for a wide range of platforms (e.g., ships and aircraft), non-explosive exercise weapons, and training-related devices. Submarines, surface ships, and aircraft all conduct ASW and would be the principal users of PUTR. The requirements of threat realism on the PUTR necessitate training with a variety of sensors, non-explosive exercise weapons, target submarine simulators, and other associated hardware. Many of the materials used on the PUTR are recovered after use; however, some would be abandoned in place. All ordnance used would be non-explosive.

Submarines, surface ships, and aircraft conduct ASW, either individually or as a coordinated force, against submarine targets. Submarine targets include both actual submarines and other mobile targets that simulate the operations of an actual submarine. All undersea target platforms will be equipped with a Fleet standard MK 84 Tracking Pinger. ASW exercises are complex and highly variable. These exercises have been grouped into the four representative scenarios described below. Table 2.1-1 provides additional details regarding the four training scenarios. Table 2.1-2 provides a comprehensive list of the typical platforms supported by PUTR. Table 2.1-3 describes the typical target simulators supported by PUTR. Table 2.1-4 describes typical exercise weapons systems utilized in PUTR training scenarios. Table 2.1-5 describes typical sensor systems utilized in PUTR training scenarios.

- **Scenario 1: One Ship with Helicopter vs. One Submarine.** A ship, with a helicopter embarked, approaches the range area and launches its helicopter to conduct a "stand-off" localization and attack against a submarine serving as a target for the first half of the exercise. Typically, for the second half of the exercise, the ship deploys the helicopter to localize and attack. In some exercises, the ship conducts its own "close in" attack simulation. Each exercise period typically involves the firing of one exercise torpedo by the ship or the helicopter or, in some cases, by both. Some ships carry two helicopters, but only one participates in the exercise at any one time. While the ship is searching for the submarine, the submarine may practice simulated attacks against the ship.

- **Scenario 2: One Submarine vs. Another Submarine**. Two submarines on the range practice locating and attacking each other. If only one submarine is available for the exercise, it practices attacks against a target simulator, such as a MK 30, Mod-1 Mobile Target, or MK 39 Expendable Mobile ASW Training Target (EMATT), or a range support boat. A single submarine may practice shallow water maneuvers without any attack simulation.

- **Scenario 3: Two Ships and Two Helicopters vs. One Submarine**. This scenario involves the same action as Scenario 1, but with two ships and two helicopters searching for, locating, and attacking one submarine. Typically, one ship and helicopter at a time are actively prosecuting while the other ship and helicopter are repositioning. While the ships are searching for the submarine, the submarine may practice simulated attacks against the ships.

- **Scenario 4: One Aircraft vs. One Submarine.** An aircraft flies over the range area and the crew conducts a localized search for a target submarine using available sensors. After the crew detects the submarine, it simulates an attack. Each exercise period typically involves the firing of one exercise torpedo; additional attack phases may be conducted with simulated torpedo firings.

Table 2.1-1: Portable Undersea Training Range Scenarios

Component	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Exercise Participants	One ship and one helicopter vs. submarine target	One submarine vs. one submarine target	Two surface ships and two helicopters vs. submarine target (AKA; "Group SAILEX")	One fixed or rotary wing aircraft vs. one submarine target
Non-explosive Exercise Weapons Used	Lightweight and heavyweight exercise torpedoes	Heavyweight exercise torpedoes	Lightweight and heavyweight exercise torpedoes	Lightweight exercise torpedoes
Active Acoustic Sensors/ Sources Used	Ships' sonar, sonobuoys, range pingers, dipping sonar, torpedo sonar, fathometers, and underwater communication devices	Submarine sonar, range pingers, fathometers, torpedo sonar, and underwater communication devices	Ships' sonar, sonobuoys, range pingers, dipping sonar, torpedo sonar, fathometers, and underwater communication devices	Sonobuoys, dipping sonar, range pingers, fathometers, torpedo sonar, and underwater communication devices
Other Devices Used	Sonobuoys (active and passive), target simulators, expendable bathythermographs, submarine acoustic countermeasures	Submarine acoustic countermeasures, submarine target simulators, expendable bathythermographs	Sonobuoys (active and passive), target simulators, expendable temperature probes, submarine acoustic countermeasures	Sonobuoys (active and passive), target simulators, submarine acoustic countermeasures, expendable bathythermographs
Duration of Exercise	Six hours	Six hours	Six hours	Six hours
Frequency of Exercise	5 events per year	3 events per year	5 events per year	10 events per year
Comments	Submarine targets can be an actual submarine or submarine target.	One submarine simulates a quiet diesel submarine. The other attempts to detect, locate, and simulate attack.	None	Submarine targets can be an actual submarine or submarine target.

Table 2.1-2: Typical Platforms Used in PUTR Training Scenarios

Item	Description
COMBATANT PLATFORMS	
Surface Ships	Multi-mission surface combatants including destroyers, cruisers, and frigates.
Submarines	Submarines are designed to seek and destroy enemy submarines and surface ships. The two types are attack submarines and ballistic missile submarines.
Helicopters	Helicopters operate from zero to 760 m (2,500 ft). Ship-based, anti-submarine & anti-surface threat capability. General purpose is to extend/increase ship sensor/weapon capabilities against submarines, surface ships, and patrol craft. Equipped with search radar, electronic support, dipping sonar, acoustic data link, magnetic anomaly detection gear, and active & passive sonobuoys. SH60 Seahawk is a twin-engine helicopter. SH-60B is based on cruisers, destroyers, and frigates, while SH-60F is carrier based. SH-60R is an upgrade of the SH-60B.
Fixed Wing Aircraft	Naval aircraft operate from near the surface to 3,050 m (10,000 ft). They have advanced submarine detection sensors such as active and passive sonobuoys, directional frequency and ranging (DIFAR), and magnetic anomaly detection (MAD) gear, and have the longest on-station time of any ASW aircraft.
Range Support Craft	Approximate 61-m (200-ft) range support boat. The boat is used for launching and recovering targets, and for recovering exercise torpedoes. On some days, the range boat would retrieve multiple pieces of equipment.

Table 2.1-3: Typical Target Simulators Used in PUTR Training Scenarios

Item	Description
TARGET SIMULATORS	
MK 30 ASW Target Simulator	The MK 30, a torpedo-sized, electrically propelled target, is the current standard US Navy submarine target simulator. The target has a 54-cm (21-in) diameter, a 6.2-m (20-ft) length, and a 1,220-kg (2,700-lb.) weight. It can be launched from a surface craft or dropped by a helicopter, and may be recovered by either surface craft or helicopters. The MK 30 can tow a 92-m (300-ft) array consisting of a hydrophone, a projector (to simulate submarine signatures), and a magnetic source (to trigger magnetic anomaly detection [MAD] gear). They either run a preprogrammed trajectory or are controllable by acoustic signals transmitted from the range. The MK 30 can run for about six hours (depending on the speed selected) and is then fully recovered at the end of each run. It is reconditioned and reused. MK 30 targets will be equipped with a Fleet standard MK 84 Pinger.
MK 39 Expendable Mobile ASW Training Target (EMATT)	EMATT is an electrically propelled air- or ship-launched submarine simulator. It is 12.4 cm x 91.4 cm (4.9 x 36 in) and weighs 9.6 kg (21 lb). EMATT acts as an echo repeater for active SONARs and as a transponder for the MK 48 torpedo. The EMATT also can deploy a 30.5-m (100-ft) wire to produce a recognizable MAD signature. It contains lithium batteries. Following deployment from a launch aircraft, the EMATT separates from its parachute assembly. The parachute is jettisoned and sinks away from the unit. When the EMATT enters the water following the launch from the test aircraft, it typically travels 9 m (30 ft) downward, then activates itself and begins its preprogrammed run for several hours. At the completion of the run, the EMATT scuttles.

Table 2.1-4: Typical Exercise Weapons Used in PUTR Training Scenarios

Item	Description
EXERCISE WEAPONS	
MK 46, MK 54, and MK 50 Lightweight Exercise Torpedoes	MK 46 is a deep-diving, high-speed lightweight torpedo that is launched from helicopters, fixed-wing aircraft, and surface ships. It has an OTTO II fuel propulsion system and uses active acoustic homing. The MK 50 lightweight torpedo was specifically developed to counter the most advanced submarine threats. The MK 50 is carried by aircraft or fired from surface ship torpedo tubes. It has a stored chemical energy propulsion system (SCEPS). The MK 54 is a hybrid torpedo comprised of the MK 50 acoustic front end and MK 46 propulsion system. The MK 54 is launched similar to the MK 46. An exercise torpedo that actually "runs" is referred to as an "EXTORP". Only about 10 percent of the lightweight shots would be "runners". All MK 54 shots are "runners". The remaining shots are non-running "dummy" torpedo shapes called "REXTORPs". All torpedoes are recovered.
MK 48 Heavyweight Mod 4, Mod 5, Mod 6, Mod 7, ADCAP Exercise Torpedo (EXTORP)	MK 48 is the current standard US Navy heavyweight torpedo for use by submarines and has an OTTO-fueled propulsion system. It uses active or passive sonar for target detection and tracking. The MK 48 ADCAP (advanced capability) is an extensively modified version of the MK 48 torpedo, capable of greater speed and endurance. The torpedo uses passive and active acoustic homing modes, and also can operate via wire guidance from the submarine. All MK 48 exercise shots would be EXTORPS. All torpedoes would be recovered.

Table 2.1-5: Typical Sensors Utilized in PUTR Training Scenarios

Item	Description
SENSORS	
SONARs	There are two basic types of SONARs, active and passive. Both are used to search for, detect, localize, classify, and track submarines. Passive systems do not emit any energy. Active sonar systems are deployed on ships and submarines. Submarines are also equipped with several types of auxiliary sonar systems for ice and mine avoidance, for top and bottom sounders to determine the submarine's distance from the surface and the bottom in the water column, and for acoustic communications. SONARs are evaluated in detail for their potential effect on marine animals.
Dipping Sonar	Dipping sonar are active or passive sonar devices that are lowered on cable by helicopters to detect or maintain contact with underwater targets. SH-60 B helicopters do not have dipping sonar. SH-60F (carrier based) do have dipping SONAR, and would be involved in Scenario 1 runs when 60Fs are used, or about 10 percent of the time Scenario 1 is run. The SH-60R, a planned replacement for the SH-60B, will also have dipping SONAR.
Expendable Bathythermograph (XBT)	The XBT is thermal sensor deployed from surface ships. The sensor is mounted inside a small, streamlined body that sinks to the bottom. Signals from the sensor are transmitted up a wire to a receiver on board the vessel. Data collected by the XBT are used to calculate sound speed profile (SSP). After use, the body and wire are abandoned in place.

2.2 Operational Configuration

2.2.1 Basic PUTR Operational Configuration

The basic PUTR operational configuration is shown in Figure 2.2-1, which consists of an array of bottom-mounted transponders, transponder subsurface link (hub), a range support vessel with a Shipboard Range Operations Center (SROC), and a satellite link to a shore-based Remote Display Center. Acoustic data telemetry between the transponders and the Shipboard Processing Unit (SPU) in the SROC is via the transponder subsurface link (hub) suspended below the range support vessel. The SROC capabilities include acoustic remote control of the deployed in-water hardware, command and control functions, data processing, tracking, and display of Time Space Positional Information (TSPI) data by the SROC Display Center. Command and control functions include radio and underwater voice communications (WQC Hi-Band) and MK 30 Mod-1 Acoustic Command Link (ACL). PUTR Build 2 incorporates more transponders and one or more Station Keeping Buoys (SKB) as uplink receivers to expand the area of tracking coverage.

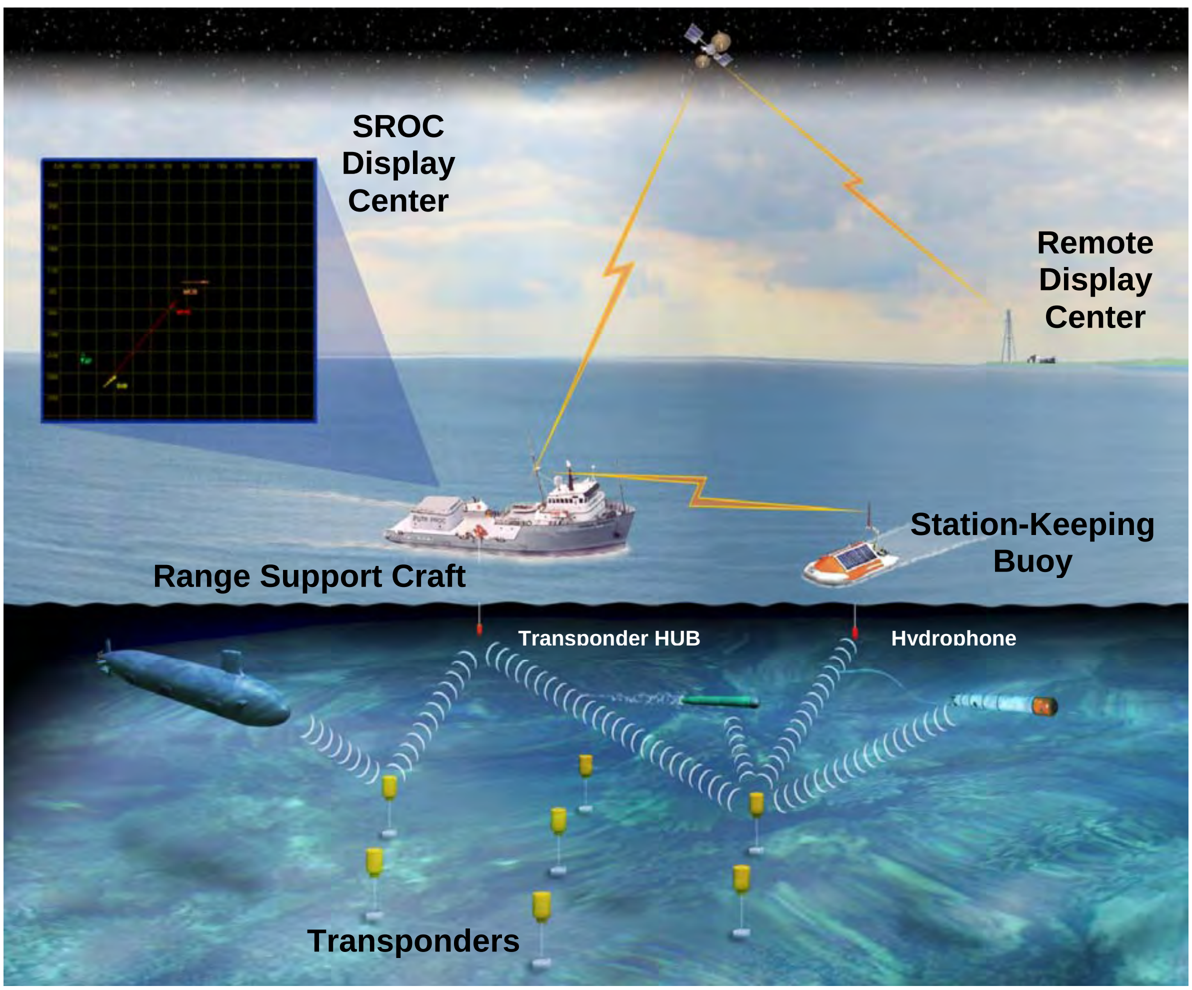


Figure 2.2-1. Portable Undersea Training Range Operational Configuration

APPENDIX F

MARINE MAMMAL MODELING

This section contains a description of the modeling performed of MIRC noise sources.

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX F Marine Mammal Modeling

F.1 Background and Overview

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the unauthorized take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States.

The Endangered Species Act of 1973 (ESA) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of their ecosystems. A species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future. There are marine mammals, already protected under MMPA, listed as either endangered or threatened under ESA, and afforded special protections. Actions involving sound in the water include the potential to harass marine animals in the surrounding waters. Demonstration of compliance with MMPA and the ESA, using best available science, has been assessed using criteria and thresholds accepted or negotiated, and described here.

Sections of the MMPA (16 United States Code [U.S.C.] 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity, other than commercial fishing, within a specified geographical region. Through a specific process, if certain findings are made and regulations are issued, or if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if the National Marine Fisheries Service (NMFS) finds that the taking will have no more than a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking, and requirements pertaining to the mitigation, monitoring, and reporting of such taking are set forth.

NMFS has defined negligible impact in 50 Code of Federal Regulations (CFR) 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Subsection 101(a) (5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The National Defense Authorization Act of 2004 (NDAA) (Public Law 108-136) removed the small numbers limitation and amended the definition of "harassment" as it applies to a military readiness activity to read as follows:

> (i) *any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or*
>
> (ii) *any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].*

The sound sources generated by the proposed action will be located in an area that is inhabited by species listed as threatened or endangered under the Endangered Species Act (ESA, 16 USC §§ 1531-1543). Operation of the sound sources, that is, transmission of acoustic signals in the water column, could potentially cause harm or harassment to listed species.

"Harm" defined under ESA regulations is "…an act which actually kills or injures…" (50 CFR 222.102) listed species. "Harassment" is an "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3).

F.2 Acoustic Sources

The MIRC acoustic sources are categorized as either broadband (producing sound over a wide frequency band) or narrowband (producing sound over a frequency band that is small in comparison to the center frequency). In general, the narrowband sources in this exercise are Anti-Submarine Warfare (ASW) sonars and the broadband sources are explosives. This delineation of source types has a couple of implications. First, the transmission loss used to determine the impact ranges of narrowband ASW sonars can be adequately characterized by model estimates at a single frequency. Broadband explosives, on the other hand, produce significant acoustic energy across several frequency decades of bandwidth. Propagation loss is sufficiently sensitive to frequency as to require model estimates at several frequencies over such a wide band.

Second, the types of sources have different sets of harassment metrics and thresholds. Energy metrics are defined for both types. However, explosives are impulsive sources that produce a shock wave that dictates additional pressure-related metrics (peak pressure and positive impulse). Detailed descriptions of both types of sources are provided in the following subsections.

F.2.1 Sonars

F.2.1.1 Sonar Device Descriptions

The majority of training and research, development, testing, and evaluation activities in the MIRC involve five types of narrowband sonars. Exposure estimates are calculated for each sonar according to the manner in which it operates. For example, the AN/SQS 53 and AN/SQS 56 are hull-mounted, mid-frequency active (MFA) surface ship sonars that operate for many hours at a time (although sound is output—the "active" portion—only a small fraction of that time), so it is most useful to calculate and report surface ship sonar exposures per hour of operation. The BQQ-10 submarine sonar is also reported per hour of operation. However, the submarine sonar is modeled as pinging only twice per hour. The AN/AQS-22 is a helicopter-deployed sonar, which is lowered into the water, pings several times, and then moves to a new location; this sonar is used for localization and tracking a suspected contact as opposed to searching for contacts. For the AN/AQS-22, it is most helpful to calculate and report exposures per dip. The AN/SSQ-62 is a sonobuoy that is dropped into the water from an aircraft or helicopter and pings about 10 to 30 times in an hour. For the AN/SSQ-62, it is most helpful to calculate and report exposures per sonobuoy. For the MK-48 torpedo, the sonar is modeled for a typical training event and the MK-48 reporting metric is the number of torpedo runs. Table F-1 presents the deployment platform, frequency class, the metric for reporting exposures, and the units for each sonar.

Table F-1: Active Sonars Modeled in the MIRC

Sonar	Description	Frequency Class	Exposures Reported	Units
MK-48[1]	Torpedo sonar	High-frequency	Per torpedo	One torpedo run
AN/SQS-53	Surface ship sonar	Mid-frequency	Per hour	120 sonar pings per hour
AN/SQS-56	Surface ship sonar	Mid-frequency	Per hour	120 sonar pings per hour
AN/SSQ-62	Sonobuoy sonar	Mid-frequency	Per sonobuoy	8 sonobuoys per hour
AN/SSQ-125 AEER	Sonobuoy sonar	Mid-frequency	Per sonobuoy	1 sonobuoy per hour; 50 pings total
AN/AQS-22	Helicopter-dipping sonar	Mid-frequency	Per dip	2 dips per hour
BQQ-10[2]	Submarine sonar	Mid-frequency	Per hour	2 sonar pings per hour
MK-84 Pinger	Range tracking pinger mounted on ships, submarines, and UUV	High Frequency	Per pinger	Day of operation
PUTR Transponder	Array of bottom mounted transponders	High or Mid-Frequency (selectable)	Per PUTR transponder array	Day of operation

Note[1]: MK-48 source described here is the high-frequency active (HFA) sonar on the torpedo; the explosive source of the detonating torpedo is described in the next subsection. MK-48 torpedo sonar is modeled as representative of all torpedo sonar (MK-46, MK-50, and MK-54).

Note[2]: BQQ-10 is modeled as representative of all MFA submarine sonar (BQQ-10, BQQ-5, and BSY-1)

The acoustic modeling that is necessary to support the take estimates for each of these sonars relies upon a generalized description of the manner of the sonar's operating modes. This description includes the following:

- "Effective" sound exposure level – This is the level relative to 1 μPa^2-s of the integral over frequency and time of the square of the pressure and is given by the total sound exposure level across the band of the source, scaled by the pulse length (10 $\log_{10}$ [pulse length]).
- Source depth – Depth of the source in meters.
- Nominal frequency – Typically the center band of the source emission. These are frequencies that have been reported in open literature and are used to avoid classification issues. Differences between these nominal values and actual source frequencies are small enough to be of little consequence to the output impact volumes.
- Source directivity – The source beam is modeled as the product of a horizontal beam pattern and a vertical beam pattern. Two parameters define the horizontal beam pattern:
    - Horizontal beam width – Width of the source beam (degrees) in the horizontal plane (assumed constant for all horizontal steer directions).
    - Horizontal steer direction – Direction in the horizontal in which the beam is steered relative to the direction in which the platform is heading

  The horizontal beam is assumed to have constant level across the width of the beam with flat, 20-dB down sidelobes at all other angles.

  Similarly, two parameters define the vertical beam pattern:

    - Vertical beam width – Width of the source beam (degrees) in the vertical plane measured at the 3-dB down point. (assumed constant for all vertical steer directions).
    - Vertical steer direction – Direction in the vertical plane that the beam is steered relative to the horizontal (upward looking angles are positive).

  To avoid sharp transitions that a rectangular beam might introduce, the power response at vertical angle θ is

  $$\text{Power} = \max \{ \sin^2 [n(\theta_s - \theta)] / [n \sin (\theta_s - \theta)]^2, \ 0.01 \},$$

  Where θ_s is the vertical beam steer direction, and
  $n = 2*L/\lambda$ (L = array length, λ = wavelength),

  The beamwidth of a line source is determined by n (the length of the array in half-wavelengths) as $\theta_w = 180^o/n$.

- Ping spacing – Distance between pings. For most sources this is generally just the product of the speed of advance of the platform and the repetition rate of the sonar. Animal motion is generally of no consequence as long as the source motion is greater than the speed of the animal (nominally, 3 knots). For stationary (or nearly stationary) sources, the "average" speed of the animal is used in place of the platform speed. The attendant assumption is that the animals are all moving in the same constant direction.

Many of the actual parameters and capabilities of these sonars are classified. Parameters used for modeling were derived to be as representative as possible taking into account the manner with which the sonar would be used in various training scenarios. However, when there was a wide range of potential modeling input values, the default was to model using a nominal parameter likely to result in the most impact, so that the model would err towards the maximum potential exposures.

For the sources that are essentially stationary (AN/SSQ-62 , AN/SSQ-125, and AN/AQS-22), emission spacing is the product of the ping cycle time and the average animal speed.

F.2.1.2 Metrics for Physiological Effect Thresholds

Effect thresholds used for acoustic impact modeling in this document are expressed in terms of Sound Exposure Level (SEL), which is total sound exposure received over time in an area, or in terms of Sound Pressure Level (SPL), which is the level (root mean square) without reference to any time component for the exposure at that level. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) are more closely related to the sound exposure than to the exposure SPL.

The SEL for each individual ping is calculated from the following equation:

$$SEL = SPL + 10\log_{10}(\text{duration})$$

The SEL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher SEL.

If an animal is exposed to multiple pings, the sound exposure level in each individual ping is summed to calculate the total SEL. Since mammalian Threshold Shift (TS) data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward 1997), basing the effect thresholds on the total received SEL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure. Therefore, estimates are conservative because recovery is not taken into account (given that generally applicable recovery times have not been experimentally established) and as a result, intermittent exposures from sonar are modeled as if they were continuous exposures.

The total SEL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total SEL and determine whether the received SEL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 μPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 μPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 μPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 μPa and duration = 2 seconds.

F.2.1.3 Derivation of an Effects Threshold for Marine Mammals Based on Sound Exposure Level

As described in detail in Section 3.7 of this EIS/OEIS, SEL (EFD level) exposure threshold established for onset-TTS is 195 dB re 1 μPa^2-s. This result is corroborated by the short-duration tone data of Finneran *et al*. (2000, 2003) and the long-duration sound data from Nachtigall *et al*. (2003a, b). Together, these data demonstrate that TTS in small odontocetes is correlated with the received SEL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s. Absent any additional data for other species and being that it is likely that small odontocetes are more sensitive to the mid-frequency active/high-frequency active (MFA/HFA) frequency levels of concern, this threshold is used for analysis for all cetacea.

The PTS thresholds established for use in this analysis are based on a 20 dB increase in exposure SEL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure SEL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959). Using this estimation method (20 dB up from onset-TTS) for the Mariana Islands Range Complex (MIRC) analysis, the PTS threshold for cetacea is 215 dB re 1μPa^2-s, and for monk seals it is 224 dB re 1μPa^2-s.

F.2.1.4 Derivation of a Behavioral Effect Threshold for Marine Mammals Based on Sound Pressure Level (SPL)

Over the past several years, the Navy and NMFS have worked on developing alternative criteria to replace and/or to supplement the acoustic thresholds used in the past to estimate the probability of marine mammals being behaviorally harassed by received levels of MFA and HFA sonar. Following publication of the Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Navy continued working with NMFS to refine a mathematically representative curve for assessment of behavioral effects modeling associated with the use of MFA/HFA sonar. As detailed in Section 4.1.2, the NMFS Office of Protected Resources made the decision to use a risk function and applicable input parameters to estimate the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA/HFA sonar. This decision was based on the recommendation of the two NMFS scientists, consideration of the independent reviews from six scientists, and NMFS MMPA regulations affecting the Navy's use of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar (U.S. Department of the Navy 2002; National Oceanic and Atmospheric Administration 2007).

The particular acoustic risk function developed by the Navy and NMFS is derived from a solution in Feller (1968) with input parameters modified by NMFS for MFA/HFA sonar for mysticetes, odontocetes, and pinnipeds. In order to represent a probability of risk in developing this function, the function would have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and

- The function should be reasonably convenient for algebraic manipulations.

As described in U.S. Department of the Navy (2001), the mathematical function below is adapted from a solution in Feller (1968):

$$R = \frac{1 - \left(\frac{L-B}{K}\right)^{-A}}{1 - \left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);

L = Received Level (RL) in dB

B = basement RL in dB (120 dB)

K = the RL increment above basement in dB at which there is 50 percent risk

A=risk transition sharpness parameter (8 for Mysticetes and 10 for Odontocetes)

It is important to note that the probabilities associated with acoustic modeling do not represent an individual's probability of responding; they identify the proportion of an exposed population (as represented by an evenly distributed density of marine mammals per unit area) that is likely to respond to an exposure. In addition, modeling does not take into account reductions from any of the Navy's standard protective mitigation measures which should significantly reduce or eliminate actual exposures that may have otherwise occurred during training.

F.2.2 Explosives

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. The acoustic energy of an explosive is, generally, much greater than that of a sonar, so careful treatment of them is important, since they have the potential to injure. Three source parameters influence the effect of an explosive: the weight of the explosive warhead, the type of explosive material, and the detonation depth. The net explosive weight (NEW) accounts for the first two parameters. The NEW of an explosive is the weight of only the explosive material in a given round, referenced to the explosive power of trinitrotoluene (TNT).

F.2.2.1 Explosive Source Descriptions

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss). Since most MIRC explosive sources are munitions that detonate essentially upon impact, the effective source depths are quite shallow, and therefore the surface-image interference effect can be pronounced. In order to limit the cancellation effect (and thereby provide exposure estimates that tend toward the worst case), relatively deep detonation depths are used. A source depth of 1 foot is used for gunnery rounds. For the missile and bombs, a source depth of 2 meters (m) is used. For Extended Echo Ranging/Improved Extended Echo Ranging (EER/IEER) a nominal depth of 20 m is used to ensure that the source is located within any significant surface duct, resulting in maximum potential exposures. Table F-2 gives the ordnances of interest in the MIRC, their NEWs, and their expected detonation depths.

Table F-2: Explosive Sources Modeled in MIRC

Ordnance	Net Explosive Weight for Modeling	Detonation Depth for Modeling
5" Naval gunfire	9.54 lbs	1 ft
76 mm Rounds	1.6 lbs	1 ft
HELLFIRE	16.4 lbs	2 m
Maverick	78.5 lbs	2 m
Harpoon / SLAM-ER	448 lbs	2 m
MK-82/GBU-31 JDAM/GBU-10	945 lbs	2 m
MK-83/GBU-32 JDAM	574 lbs	2 m
MK-84/GBU-38 JDAM/GBU-12	238 lbs	2 m
MK-48	851 lbs	50 ft
Demolition Charges	10 lbs	Bottom
EER/IEER	5 lbs	20 m

The exposures expected to result from these ordnances are generally computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time or space, allowing for sufficient animal movement as to ensure that a different population of animals is harassed by each ordnance detonation. There may be rare occasions when multiple successive explosions (MSEs) are part of a static location event. For these events, the Churchill FEIS approach was extended to cover MSE events occurring at the same location. For MSE exposures, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot; this is consistent with the treatment of multiple arrivals in Churchill. For positive impulse, it is consistent with the Churchill FEIS to use the maximum value over all impulses received.

For MSEs, the acoustic criterion for sub-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. For MSE events potential behavioral disturbances were modeled at the 177 dB sub-TTS threshold. A special case in which simple addition of the exposure estimates may not be appropriate is addressed by the modeling of a "representative" Sink Exercise (SINKEX). In a SINKEX, a decommissioned surface ship is towed to a specified deep-water location and there used as a target for a variety of weapons. Although no two SINKEXs are ever the same, a representative case derived from past exercises is described in the *Programmatic SINKEX Overseas Environmental Assessment* (March 2006) for the Western North Atlantic.

In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. A torpedo is used after all munitions have been expended if the target is still afloat. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case with maximum exposure.

The sequence of weapons firing for the representative SINKEX is described in Table F-3. Guided weapons are nearly 100 percent accurate and are modeled as hitting the target (that is, no underwater acoustic effect) in all but two cases: (1) the Maverick is modeled as a miss to represent the occasional miss, and (2) the MK-48 torpedo intentionally detonates in the water column immediately below the hull of the target. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. Note that these hit/miss ratios are artificially low in order to demonstrate a worst-case scenario; they should not be taken as indicative of weapon or platform reliability.

Table F-3: Representative SINKEX Weapons Firing Sequence

Time (Local)	Event Description
0900	Range Control Officer receives reports that the exercise area is clear of non-participant ship traffic, marine mammals, and sea turtles.
0909	2 HELLFIRE missiles fired, both hit target.
0915	2 HARM missiles fired, both hit target (5 minutes apart).
0940	8 Maverick missiles fired, 6 hit target, 2 misses (5 minutes apart).
1205	5 Harpoon/4 SLAM-ER missiles fired, all hit target (1 minute apart).
1300-1335	7 live and 3 inert MK 82 bombs dropped – 7 hit target, 2 live and 1 inert miss target (4 minutes apart).
1355-1410	4 MK 83/84 series bombs dropped – 3 hit target, 1 misses target (5 minutes apart).
1500	Surface gunfire commences – 400 5-inch rounds fired (one every 6 seconds), 280 hit target, 120 miss target.
1700	MK 48 Torpedo fired, hits, and sinks target.
As required.	2 Demolition Charges if needed to sink target.

F.2.2.2 Explosive Source Criteria

For explosions of ordnance planned for use in the Mariana Islands Range Complex (MIRC), in the absence of any mitigation or monitoring measures, there is a very small chance that a marine mammal could be injured or killed when exposed to the energy generated from an explosive force. Analysis of noise impacts is based on criteria and thresholds initially presented in U.S. Navy Environmental Impact Statements for ship shock trials of the Seawolf submarine and the Winston Churchill (DDG 81), and subsequently adopted by NMFS. Explosive source criteria thresholds are presented in Table F-4.

Non-lethal injurious impacts (Level A Harassment) are defined in those documents as tympanic membrane (TM) rupture and the onset of slight lung injury. The threshold for Level A Harassment corresponds to a 50-percent rate of TM rupture, which can be stated in terms of an Sound Exposure Level (SEL) value of 205 dB re 1 μPa^2-s. TM rupture is well-correlated with permanent hearing impairment. Ketten (1998) indicates a 30-percent incidence of permanent threshold shift (PTS) at the same threshold.

Table F-4: Level A and B Harassment Threshold–Explosives

Threshold Type (Explosives)	Threshold Level
Level A – 50 percent Eardrum rupture	205 dB
Temporary Threshold Shift (TTS) (peak one-third octave energy)	182 dB
Sub-TTS Threshold for Multiple Successive Explosions (peak one-third octave energy)	177 dB
Temporary Threshold Shift (TTS) (peak pressure)	23 psi
Level A – Slight lung injury (positive impulse)	13 psi-ms
Mortality – 1 percent Mortal lung injury (positive impulse)	31 psi-ms

The criteria for onset of slight lung injury were established using partial impulse because the impulse of an underwater blast wave was the parameter that governed damage during a study using mammals, not peak pressure or energy (Yelverton 1981). Goertner (1982) determined a way to calculate impulse values for injury at greater depths, known as the Goertner "modified" impulse pressure. Those values are valid only near the surface because as hydrostatic pressure increases with depth, organs like the lung, filled with air, compress. Therefore the "modified" impulse pressure thresholds vary from the shallow depth starting point as a function of depth.

The shallow depth starting points for calculation of the "modified" impulse pressures are mass-dependent values derived from empirical data for underwater blast injury (Yelverton 1981). During the calculations, the lowest impulse and body mass for which slight, and then extensive, lung injury found during a previous study (Yelverton *et al*. 1973) were used to determine the positive impulse that may cause lung injury. The Goertner model is sensitive to mammal weight such that smaller masses have lower thresholds for positive impulse so injury and harassment will be predicted at greater distances from the source for them. Impulse thresholds of 13.0 and 31.0 psi-ms, found to cause slight and extensive injury in a dolphin calf, were used as thresholds in the analysis contained in this document.

Level B (non-injurious) Harassment includes temporary (auditory) threshold shift (TTS), a slight, recoverable loss of hearing sensitivity. One criterion used for TTS, the total SEL of the signal, is a threshold of 182 dB re 1 μPa^2-s maximum SEL level in any 1/3-octave band above 100 Hz for toothed whales (e.g., dolphins). A second criterion, a maximum allowable peak pressure of 23 psi, has recently been established by NMFS (NMFS 2005; DoN 2008a, 2008b) to provide a more conservative range for TTS when the explosive or animal approaches the sea surface, in which case explosive energy is reduced, but the peak pressure is not. NMFS applies the more conservative of these two.

F.3 Environmental Provinces

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. In turn, propagation loss as a function of range responds to a number of environmental parameters:

- Water depth
- Sound speed variability throughout the water column
- Bottom geo-acoustic properties, and
- Surface roughness, as determined by wind speed

Due to the importance that propagation loss plays in ASW, the Navy has, over the last four to five decades, invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases of these environmental parameters, which are accepted as standards for Navy modeling efforts.

- Water depth – Digital Bathymetry Data Base Variable Resolution (DBDBV)
- Sound speed – Generalized Digital Environmental Model (GDEM)
- Bottom loss – Low-Frequency Bottom Loss (LFBL), Sediment Thickness Database, and High-Frequency Bottom Loss (HFBL), and
- Wind speed – U.S. Navy Marine Climatic Atlas of the World

This section provides a discussion of the relative impact of these various environmental parameters. These examples then are used as guidance for determining environmental provinces (that is, regions in which the environmental parameters are relatively homogenous and can be represented by a single set of environmental parameters) within the MIRC.

F.3.1 Impact of Environmental Parameters

Within a typical operating area, the environmental parameter that tends to vary the most is bathymetry. It is not unusual for water depths to vary by an order of magnitude or more, resulting in significant impacts upon the ZOI calculations. Bottom loss can also vary considerably over typical operating areas, but its impact on ZOI calculations tends to be limited to waters on the continental shelf and the upper portion of the slope. Generally, the primary propagation paths in deep water, from the source to most of the ZOI volume, do not involve any interaction with bottom. In shallow water, particularly if the sound velocity profile directs all propagation paths to interact with the bottom, bottom loss variability can play a larger role.

The spatial variability of the sound speed field is generally small over operating areas of typical size. The presence of a strong oceanographic front is a noteworthy exception to this rule. To a lesser extent, variability in the depth and strength of a surface duct can be of some importance. In the mid-latitudes, seasonal variation often provides the most significant variation in the sound speed field. For this reason, both summer and winter profiles are modeled for each selected environment.

F.3.2 Environmental Provincing Methodology

The underwater acoustic environment can be quite variable over ranges in excess of 10 kilometers. For ASW applications, ranges of interest are often sufficiently large as to warrant the modeling of the spatial variability of the environment. In the propagation loss calculations, each of the environmental parameters is allowed to vary (either continuously or discretely) along the path from acoustic source to receiver. In such applications, each propagation loss calculation is conditioned upon the particular locations of the source and receiver.

On the other hand, the range of interest for marine animal harassment by most Naval activities is more limited. This reduces the importance of the exact location of source and marine animal and makes the modeling required more manageable in scope.

In lieu of trying to model every environmental profile that can be encountered in an operating area, this effort utilizes a limited set of representative environments. Each environment is characterized by a fixed water depth, sound velocity profile, and bottom loss type. The operating area is then partitioned into homogeneous regions (or provinces) and the most appropriately representative environment is assigned to each. This process is aided by some initial provincing of the individual environmental parameters. The Navy-standard high-frequency bottom loss database in its native form is globally partitioned into nine classes. Low-frequency bottom loss is likewise provinced in its native form, although it is not considered in the process of selecting environmental provinces. Only the broadband sources produce acoustic energy at the frequencies of interest for low-frequency bottom loss (typically less than 1 kHz); even for those sources the low-frequency acoustic energy is secondary to the energy above 1 kHz. The Navy-standard sound velocity profiles database is also available as a provinced subset. Only the Navy-standard bathymetry database varies continuously over the world's oceans. However, even this environmental parameter is easily provinced by selecting a finite set of water depth intervals. For this analysis "octave-spaced" intervals (10, 20, 50, 100, 200, 500, 1,000, 2,000, and 5,000 m) provide an adequate sampling of water depth dependence.

ZOI volumes are then computed using propagation loss estimates derived for the representative environments. Finally, a weighted average of the ZOI volumes is taken over all representative environments; the weighting factor is proportional to the geographic area spanned by the environmental province.

The selection of representative environments is subjective. However, the uncertainty introduced by this subjectivity can be mitigated by selecting more environments and by selecting the environments that occur most frequently over the operating area of interest.

As discussed in the previous subsection, ZOI estimates are most sensitive to water depth. Unless otherwise warranted, at least one representative environment is selected in each bathymetry province. Within a bathymetry province, additional representative environments are selected as needed to meet the following requirements.

- In shallow water (less than 1,000 meters), bottom interactions occur at shorter ranges and more frequently; thus significant variations in bottom loss need to be represented.
- Surface ducts provide an efficient propagation channel that can greatly influence ZOI estimates. Variations in the mixed layer depth need to be accounted for if the water is deep enough to support the full extent of the surface duct.

Depending upon the size and complexity of the operating area, the number of environmental provinces tends to range from 5 to 20.

F.3.3 Description of Environmental Provinces

The MIRC encompasses a large area about the Mariana Islands. For this analysis, the general operating area is bounded to the north and south by latitude lines of 7°N and 20°N and to the east and west by meridians of 138°E and 150°E.

7° 0' 30.07"	149° 16' 14.85"
6° 59' 24.6"	138° 1' 29.72"
20° 0' 24.56"	138° 0' 11.24"
20° 3' 27.55"	149° 17' 41.03"

SINKEX operations may occur anywhere within the general operating area as long as the water depth is greater than 1,000 fathoms and the nearest land is at least 50 nm away. This SINKEX region is partitioned into three sub-areas as described below.

- SINKEX East: An area east of Guam; bounded in latitude by 14° N and 16° N, and in longitude by 146° 30'E and 149° 12'E.
- SINKEX South: All of Warning Area 517 that is more than 50 nm offshore. W-517 is an irregularly-shaped region with the following vertices:

  13°-10'N 144°-30'E

  13°-10'N 144°-42'E

  12°-50'N 144°-45'E

  11°-00'N 144°-45'E

  11°-00'N 143°-00'E

  11°-45'N 143°-00'E

  11°-50'N 144°-30'E
- SINKEX General: All suitable SINKEX areas other than SINKEX East and SINKEX South.

The acoustic sonars described in subsection F.2 are deployed throughout the general operating area. The explosive sources, other than demolition charges, are limited to the three SINKEX sub-areas. The use of demolition charges is limited to Agat Bay and Outer Apra Harbor inshore areas.

This subsection describes the representative environmental provinces selected for the MIRC. For all of these provinces, the average wind speed, winter and summer, is 11 knots.

The general operating area of the MIRC contains a total of 9 distinct environmental provinces. These represent various combinations of five bathymetry regions, 10 Sound Velocity Profile (SVP) provinces, and 6 High-Frequency Bottom Loss (HFBL) regions.

The bathymetry provinces represent depths ranging from 200 meters to typical deep-water depths (more than 5,000 meters). Nearly all of the MIRC is characterized as deep-water (depths of 2,000 meters or more). The remaining water depths (1,000 meters and less) provide only small contributions to the analysis. The distribution of the bathymetry provinces over the MIRC is provided in Table F-5.

Table F-5: Distribution of Bathymetry Provinces in MIRC

Province Depth (m)	Frequency of Occurrence
200	0.23 %
500	0.64 %
1,000	1.98 %
2,000	17.69 %
5,000	79.46 %

Ten SVP provinces describe the sound speed field in the MIRC; however, the variability among the 10 provinces is relatively small as demonstrated by the summer profiles presented in Figure F-1. The dominant difference among the profiles is the steepness of the thermocline.

The seasonal variation is likewise of limited dynamic range, as might be expect given that the range is located in temperate waters. The surface sound speed of the winter profile is only a few m/s slower than the summer profile as depicted in Figure F-2. Both seasons exhibit a well-formed surface duct with average mixed layers of approximately 50 meters and 75 meters in the summer and winter, respectively.

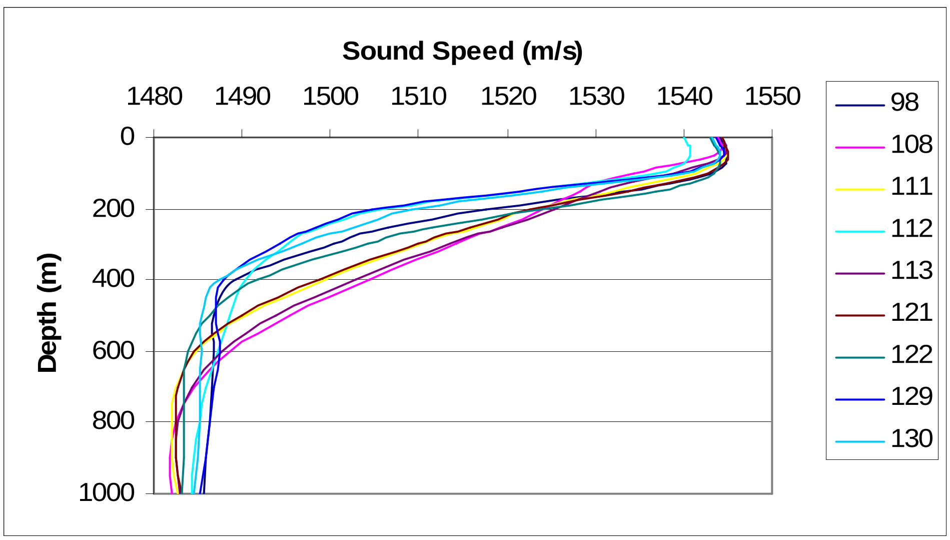


Figure F-1: Summer SVPs in MIRC

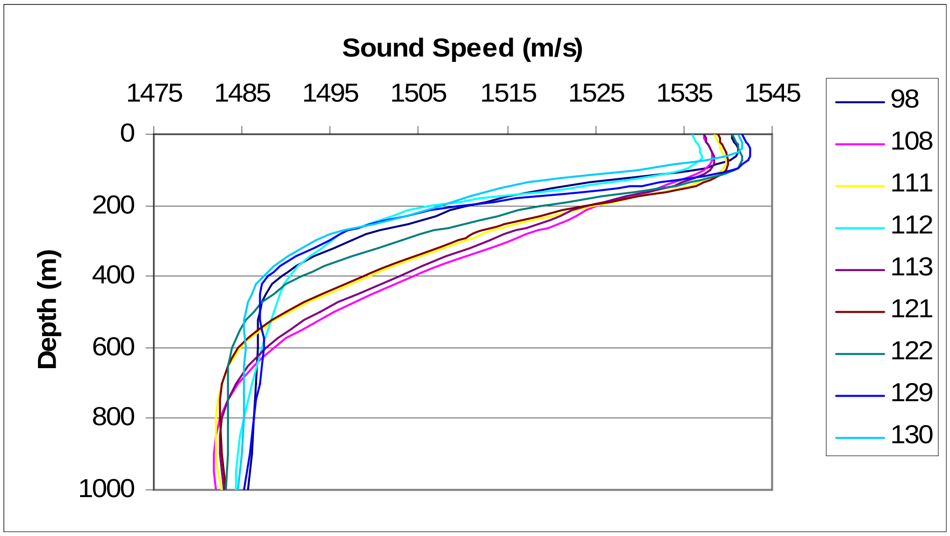


Figure F-2: Winter SVPs in MIRC.

The distribution of the ten SVP provinces across the MIRC is provided in Table F-6.

Table F-6: Distribution of SVP Provinces in MIRC

SVP Province	Frequency of Occurrence
98	22.65 %
108	2.21 %
111	14.50 %
112	0.38 %
113	15.59 %
118	2.56 %
121	3.81 %
122	18.99 %
129	5.80 %
130	13.51 %

The HFBL classes represented in the MIRC primarily range from moderate-loss bottoms (class 4, 5 and 6) to high-loss bottoms (classes 7 or 8). The distribution of HFBL classes summarized in Table F-7 indicates that approximately two-thirds of the MIRC is a high-loss bottom, with most of the remaining 40 percent a moderate-loss bottom.

Table F-7. Distribution of High-Frequency Bottom Loss Classes in MIRC

HFBL Class	Frequency of Occurrence
2	0.25 %
4	11.00 %
5	20.94 %
6	3.75 %
7	13.87 %
8	50.19 %

The logic for consolidating the environmental provinces focuses upon water depth, using the sound speed profile (in deep water) and the HFBL class (in shallow water) as secondary differentiating factors. The first consideration was to ensure that all five bathymetry provinces are represented. Then within each bathymetry province further partitioning of provinces proceeded as follows:

- The three shallowest bathymetry provinces are each represented by one environmental province. In each case, the bathymetry province is dominated by a single, high-loss bottom, so that the secondary differentiating environmental parameter is of no consequence.
- The 2,000-meter bathymetry province consists of two environmental provinces. The vast majority of this bathymetry province consists of high-loss bottoms making the SVP provinces making the more important secondary differentiating environmental parameter. The variance in the sound speed field, which is generally quite small, is represented by two SVP provinces.
- The 5,000-meter bathymetry province is far and away the most prevalent water depth in the MIRC. Although the environmental variability across this bathymetry province is relatively small, its sheer size relative to the other water depths warrants some partitioning to capture some of this variability. This is accomplished by subdividing this bathymetry province into four environmental provinces, one for each of the four most prevalent SVP provinces.

The resulting nine environmental provinces used in the MIRC acoustic modeling are described in Table F-8.

Table F-8: Distribution of Environmental Provinces in the MIRC Study Area

Environmental Province	Water Depth	SVP Province	HFBL Class	LFBL Province	Sediment Thickness	Frequency of Occurrence
1	200 m	122	8	– 98*	0.22 secs	0.23%
2	500 m	122	8	– 98*	0.16 secs	0.64%
3	1,000 m	122	8	62	0.2 secs	1.98%
4	2,000 m	122	8	62	0.19 secs	13.37%
5	2,000 m	111	8	62	0.19 secs	4.32%
6	5,000 m	98	5	13	0.18 secs	26.94%
7	5,000 m	122	8	13	0.1 secs	21.78%
8	5,000 m	111	4	43	0.39 secs	15.47%
9	5,000 m	113	4	43	0.32 secs	15.27%

* Negative province numbers indicate shallow water provinces

The percentages given in Table F-8 indicate the frequency of occurrence of each environmental province across the general operating area in the MIRC. The distributions of the environments within each of the SINKEX sub-areas are, by definition, limited to the two deepest bathymetry provinces as indicated in Table F-9.

Table F-9. Distribution of Environmental Provinces within SINKEX Sub-Areas

Environmental Province	SINKEX East	SINKEX South	SINKEX General
4	1.62%	0.00%	13.07%
5	0.00%	0.11%	2.98%
6	15.32%	99.89%	35.49%
7	83.06%	0.00%	13.68%
8	0.00%	0.00%	17.00%
9	0.00%	0.00%	17.78%

F.4 Impact Volumes and Impact Ranges

Many naval actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

The impact volume associated with a particular activity is defined as the volume of water in which some acoustic metric exceeds a specified threshold. The product of this impact volume with a volumetric animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. The acoustic metric can either be an sound exposure term (sound exposure level, either in a limited frequency band or across the full band) or a pressure term (such as peak pressure or positive impulse). The thresholds associated with each of these metrics define the levels at which half of the animals exposed will experience some degree of harassment (ranging from behavioral change to mortality).

Impact volume is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range, which is defined as the maximum range at which a particular threshold is exceeded for a single source emission, defines the range to which marine mammal activity is monitored in order to meet mitigation requirements.

With the exception of explosive sources, the sole relevant measure of potential harm to the marine wildlife due to sonar activities is the accumulated (summed over all source emissions) sound exposure level received by the animal over the duration of the activity. Harassment measures for explosive sources include sound exposure level and pressure-related metrics (peak pressure and positive impulse).

Regardless of the type of source, estimating the number of animals that may be injured or otherwise harassed in a particular environment entails the following steps.

- Each source emission is modeled according to the particular operating mode of the sonar. The “effective” energy source level is computed by integrating over the bandwidth of the source, scaling by the pulse length, and adjusting for gains due to source directivity. The location of the source at the time of each emission must also be specified.
- For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal center frequency of the

source. If the source is relatively broadband, an average over several frequency samples is required.

- The accumulated energy within the waters that the source is "operating" is sampled over a volumetric grid. At each grid point, the received energy from each source emission is modeled as the effective sound exposure level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point and summed. For the peak pressure or positive impulse, the appropriate metric is similarly modeled for each emission. The maximum value of that metric, over all emissions, is stored at each grid point.
- The impact volume for a given threshold is estimated by summing the incremental volumes represented by each grid point for which the appropriate metric exceeds that threshold.
- Finally, the number of takes is estimated as the "product" (scalar or vector, depending on whether an animal density depth profile is available) of the impact volume and the animal densities.

This section describes in detail the process of computing impact volumes (that is, the first four steps described above). This discussion is presented in two parts: active sonars and explosive sources. The relevant assumptions associated with this approach and the limitations that are implied are also presented. The final step, computing the number of takes is discussed in subsection F.5.

F.4.1 Computing Impact Volumes for Active Sonars

This section provides a detailed description of the approach taken to compute impact volumes for active sonars. Included in this discussion are:

- Identification of the underwater propagation model used to compute transmission loss data, a listing of the source-related inputs to that model, and a description of the output parameters that are passed to the energy accumulation algorithm.
- Definitions of the parameters describing each sonar type.
- Description of the algorithms and sampling rates associated with the energy accumulation algorithm.

F.4.1.1 Transmission Loss Calculations

TL data are pre-computed for each of two seasons in each of the environmental provinces described in the previous subsection using the Gaussian Ray Bundle (GRAB) propagation loss model (Keenan 2000). The TL output consists of a parametric description of each significant eigenray (or propagation path) from source to animal. The description of each eigenray includes the departure angle from the source (used to model the source vertical directivity later in this process), the propagation time from the source to the animal (used to make corrections to absorption loss for minor differences in frequency and to incorporate a surface-image interference correction at low frequencies), and the TL suffered along the eigenray path.

The eigenray data for a single GRAB model run are sampled at uniform increments in range out to a maximum range for a specific "animal" (or "target" in GRAB terminology) depth. Multiple GRAB runs are made to sample the animal depth dependence. The depth and range sampling parameters are summarized in Table F-10. Note that some of the low-power sources do not require TL data to large maximum ranges.

Table F-10: TL Depth and Range Sampling Parameters by Sonar Type

Sonar	Range Step	Maximum Range	Depth Sampling
MK-48	10 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/SQS-53	10 m	200 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/AQS-22	10 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/ASQ-62	5 m	5 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/SQS-56	10 m	50 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
BQQ-10	20 m	150 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/SQS-53 Kingfisher Mode	10 m	200 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AN/SSQ-125	20 m	100 km	0 – km in 5-m steps 1 km – Bottom in 10-m steps
MK-84 Range Pinger	5 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
PUTR Transponders	5 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps

In a few cases, most notably the AN/SQS-53C for thresholds below approximately 180 dB, TL data may be required by the energy summation algorithm at ranges greater than covered by the pre-computed GRAB data. In these cases, TL is extrapolated to the required range using a simple cylindrical spreading loss law in addition to the appropriate absorption loss. This extrapolation leads to a conservative (or under) estimate of TL at the greater ranges. Modeling is still conducted down to the 120 dB level as in other TAP documents. The 180 dB only refers to the data used in the modeling process. The lower dB level at which there is actual GRAB transmission loss (TL) data available for modeling is 180 dB. From 180 dB to 120 dB the transmission loss must be extrapolated to complete the modeling.

Although GRAB provides the option of including the effect of source directivity in its eigenray output, this capability is not exercised. By preserving data at the eigenray level, this allows source directivity to be applied later in the process and results in fewer TL calculations.

The other important feature that storing eigenray data supports is the ability to model the effects of surface-image interference that persist over range. However, this is primarily important at frequencies lower than those associated with the sonars considered in this subsection. A detailed description of the modeling of surface-image interference is presented in the subsection on explosive sources.

F.4.1.2 Energy Summation

The summation of SEL over multiple pings in a range-independent environment is a trivial exercise for the most part. A volumetric grid that covers the waters in and around the area of sonar operation is initialized. The source then begins its set of pings. For the first ping, the TL from the source to each grid point is determined (summing the appropriate eigenrays after they have been modified by the vertical beam pattern), the "effective" energy source level is reduced by that TL, and the result is added to the accumulated SEL at that grid point. After each grid point has been updated, the accumulated energy at grid points in each depth layer is compared to the specified threshold. If the accumulated energy exceeds that threshold, then the incremental volume represented by that grid point is added to the impact volume for that depth layer. Once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for one ping.

The source is then moved along one of the axes in the horizontal plane by the specified ping separation range and the second ping is processed in a similar fashion. Again, once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for two pings. This procedure continues until the maximum number of pings specified has been reached.

Defining the volumetric grid over which energy is accumulated is the trickiest aspect of this procedure. The volume must be large enough to contain all volumetric cells for which the accumulated energy is likely to exceed the threshold but not so large as to make the energy accumulation computationally unmanageable.

Determining the size of the volumetric grid begins with an iterative process to determine the lateral extent to be considered. Unless otherwise noted, throughout this process the source is treated as omni directional and the only animal depth that is considered is the TL target depth that is closest to the source depth (placing source and receiver at the same depth is generally an optimal TL geometry).

The first step is to determine the impact range (R_{MAX}) for a single ping. The impact range in this case is the maximum range at which the effective energy source level reduced by the TL is greater than the threshold. Next, the source is moved along a straight-line track and SEL is accumulated at a point that has a CPA range of R_{MAX} at the mid-point of the source track. That total SEL summed over all pings is then compared to the prescribed threshold. If it is greater than the threshold (which, for the first R_{MAX}, it must be) then R_{MAX} is increased by 10 percent, the accumulation process is repeated, and the total energy is again compared to the threshold. This continues until R_{MAX} grows large enough to ensure that the accumulated SEL at that lateral range is less than the threshold. The lateral range dimension of the volumetric grid is then set at twice R_{MAX}, with the grid centered along the source track. In the direction of advance for the source, the volumetric grid extends of the interval from [$-R_{MAX}$, 3 R_{MAX}] with the first source position located at zero in this dimension. Note that the source motion in this direction is limited to the interval [0, 2 R_{MAX}]. Once the source reaches 2 R_{MAX} in this direction, the incremental volume contributions have approximately reached their asymptotic limit and further pings add essentially the same amount. This geometry is demonstrated in Figure F-3.

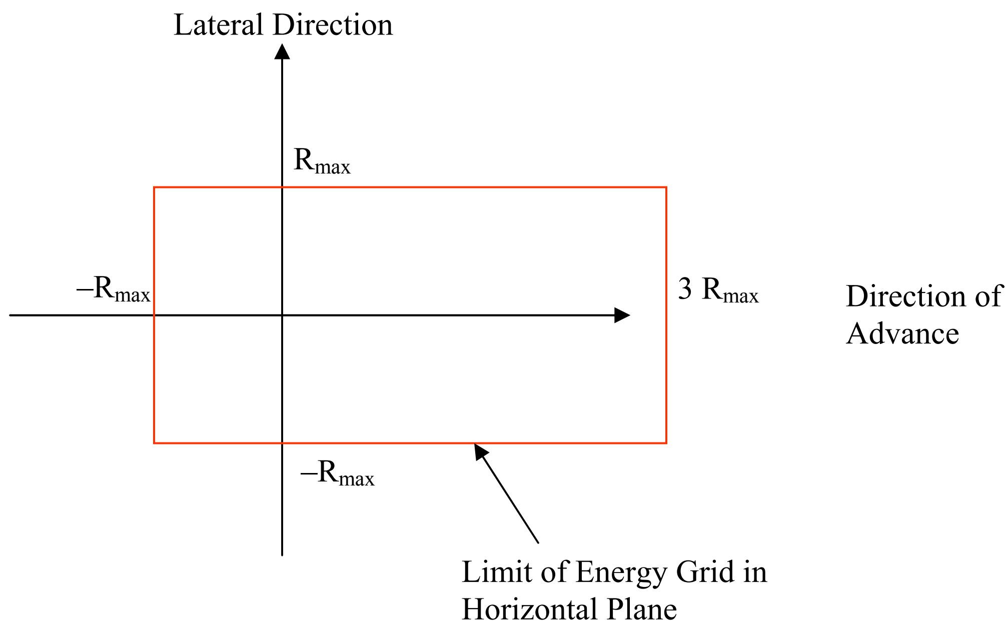


Figure F-3: Horizontal Plane of Volumetric Grid for Omni Directional Source

If the source is directive in the horizontal plane, then the lateral dimension of the grid may be reduced and the position of the source track adjusted accordingly. For example, if the main lobe of the horizontal source beam is limited to the starboard side of the source platform, then the port side of the track is reduced substantially as demonstrated in Figure F-4.

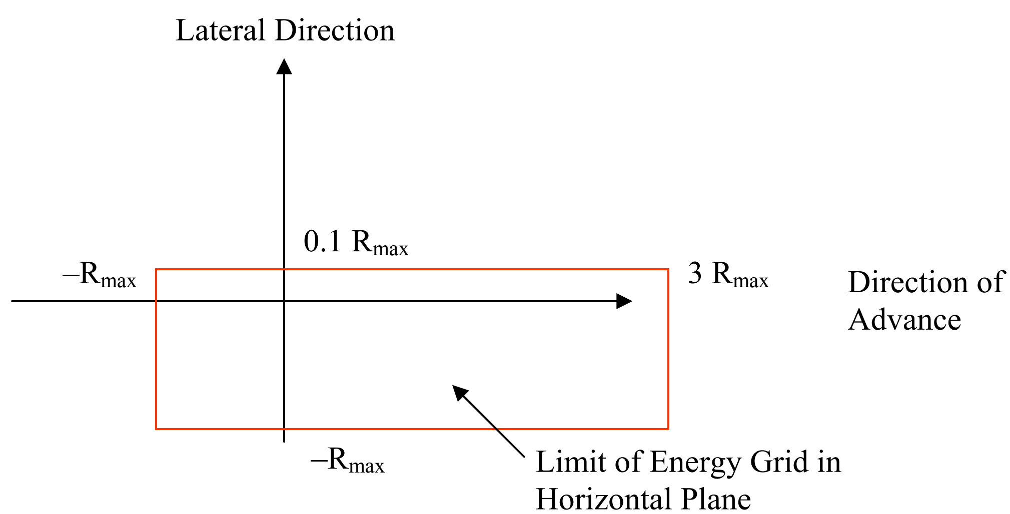


Figure F-4: Horizontal Plane of Volumetric Grid for Starboard Beam Source

Once the extent of the grid is established, the grid sampling can be defined. In both dimensions of the horizontal plane the sampling rate is approximately $R_{MAX}/100$. The round-off error associated with this sampling rate is roughly equivalent to the error in a numerical integration to determine the area of a circle with a radius of R_{MAX} with a partitioning rate of $R_{MAX}/100$ (approximately 1 percent). The depth-sampling rate of the grid is comparable to the sampling rates in the horizontal plane but discretized to match an actual TL sampling depth. The depth-sampling rate is also limited to no more than 10 meters to ensure that significant TL variability over depth is captured.

F.4.1.3 Impact Volume per Hour of Sonar Operation

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases varies with a number of parameters but eventually approaches some asymptotic limit. Beyond that point the increase in impact volume becomes essentially linear as depicted in Figure F-5.

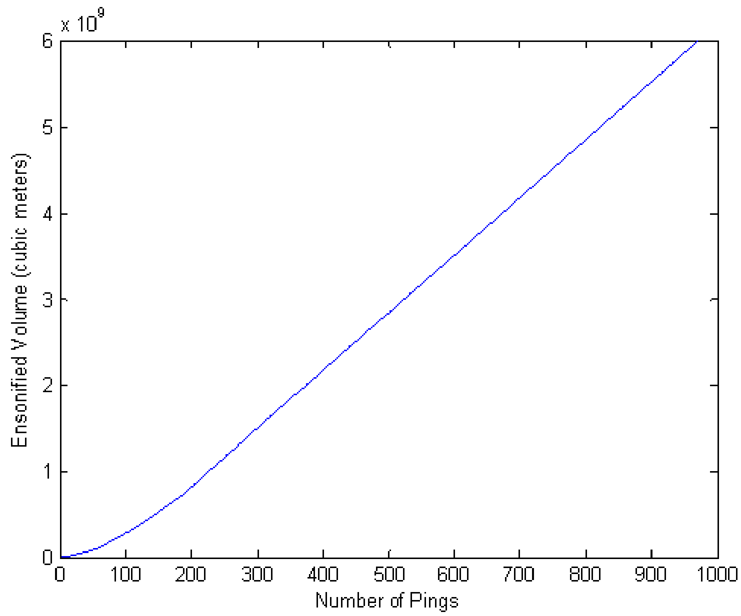


Figure F-5: 53C Impact Volume by Ping

The slope of the asymptotic limit of the impact volume in a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector, v_n, which contains the hourly impact volumes by depth for province n. Figure F-6 provides an example of an hourly impact volume vector for a particular environment.

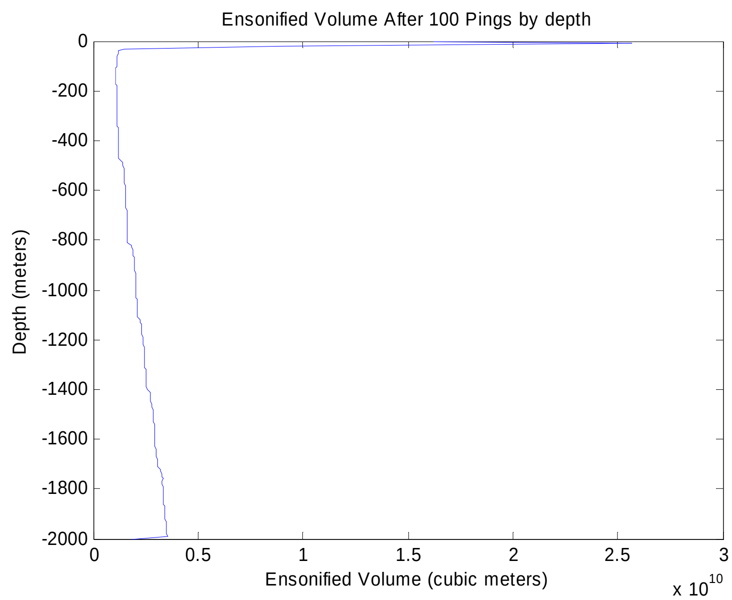


Figure F-6: Example of an Impact Volume Vector

F.4.2 Computing Impact Volumes for Explosive Sources

This section provides the details of the modeling of the explosive sources. This energy summation algorithm is similar to that used for sonars, only differing in details such as the sampling rates and source parameters. These differences are summarized in the following subsections. A more significant difference is that the explosive sources require the modeling of additional pressure metrics: (1) peak pressure, and (2) "modified" positive impulse. The modeling of each of these metrics is described in detail in the subsections of F.4.2.3.

F.4.2.1 Transmission Loss Calculations

Modeling impact volumes for explosive sources span requires the same type of TL data as needed for active sonars. However unlike active sonars, explosive ordnances and the EER source are broadband, contributing significant energy from tens of hertz to tens of kilohertz. To accommodate the broadband nature of these sources, TL data are sampled at seven frequencies from 10 Hz to 40 kHz, spaced every two octaves.

An important propagation consideration at low frequencies is the effect of surface-image interference. As either source or target approach the surface, pairs of paths that differ by a single surface reflection set up an interference pattern that ultimately causes the two paths to cancel each other when the source or target is at the surface. A fully coherent summation of the eigenrays produces such a result but also introduces extreme fluctuations that would have to be highly sampled in range and depth, and then smoothed to give meaningful results. An alternative approach is to implement what is sometimes called a semi-coherent summation. A semi-coherent sum attempts to capture significant effects of surface-image interference (namely the reduction of the field due to destructive interference of reflected paths as the source or target approach the surface) without having to deal with the more rapid fluctuations associated with a fully coherent sum. The semi-coherent sum is formed by a random phase addition of paths that have already been multiplied by the expression:

$$\sin^2 [\, 4\pi \, f \, z_s \, z_a \, / \, (c^2 \, t) \,]$$

where f is the frequency, z_s is the source depth, z_a is the animal depth, c is the sound speed and t is the travel time from source to animal along the propagation path. For small arguments of the sine function this expression varies directly as the frequency and the two depths. It is this relationship that causes the propagation field to go to zero as the depths approach the surface or the frequency approaches zero

This surface-image interference must be applied across the entire bandwidth of the explosive source. The TL field is sampled at several representative frequencies. However, the image-interference correction given above varies substantially over that frequency spacing. To avoid possible under sampling, the image-interference correction is averaged over each frequency interval.

F.4.2.2 Source Parameters

Unlike active sonars, explosive sources are defined by only two parameters: (1) net explosive weight, and (2) source detonation depth. Values for these source parameters are defined earlier in subsection F.2.2.

The effective energy source level, which is treated as a de facto input for the other sonars, is instead modeled directly for EER and munitions. For both, the energy source level is comparable to the model used for other explosives (Arons 1954; Weston 1960; McGrath 1971; Urick 1983; Christian and Gaspin 1974). The energy source level over a one-third octave band with a center frequency of f for a source with a net explosive weight of w pounds is given by:

$$ESL = 10 \log_{10} (0.26 f) + 10 \log_{10} (2 p_{max}^2 / [1/\theta^2 + 4 \pi f^2]) + 197 \text{ dB}$$

where the peak pressure for the shock wave at 1 meter is defined as

$$p_{max} = 21{,}600 (w^{1/3} / 3.28)^{1.13} \text{ psi} \qquad \text{(F-1)}$$

and the time constant is defined as:

$$\theta = [(0.058) (w^{1/3}) (3.28 / w^{1/3})^{0.22}] / 1{,}000 \text{ msec} \qquad \text{(F-2)}$$

In contrast to munitions that are modeled as omnidirectional sources, the EER source is a continuous line array that produces a directed source. The EER array consists of two explosive strips that are fired simultaneously from the center of the array. Each strip generates a beam pattern with the steer direction of the main lobe determined by the burn rate. The resulting response of the entire array is a bifurcated beam for frequencies above 200 Hz, while at lower frequencies the two beams tend to merge into one.

Since very short ranges are under consideration, the loss of directivity of the array needs to be accounted for in the near field of the array. This is accomplished by modeling the sound pressure level across the field as the coherent sum of contributions of infinitesimal sources along the array that are delayed according to the burn rate. For example, for frequency f the complex pressure contribution at a depth z and horizontal range x from an infinitesimal source located at a distance z’ above the center of the array is

$$p(r,z) = e^{i\phi}$$

where

$$\phi = kr' + \alpha z', \text{ and}$$
$$\alpha = 2\pi f / c_b$$

with k the acoustic wave number, c_b the burn rate of the explosive ribbon, and r’ the slant range from the infinitesimal source to the field point (x,z).

Beam patterns as function of vertical angle are then sampled at various ranges out to a maximum range that is approximately L^2 / □ where L is the array length and □ is the wavelength. This maximum range is a rule-of-thumb estimate for the end of the near field (Bartberger 1965). Finally, commensurate with the resolution of the TL samples, these beam patterns are averaged over octave bands.

A couple of sample beam patterns are provided in Figure F-7 and Figure F-8. In both cases, the beam response is sampled at various ranges from the source array to demonstrate the variability across the near field. The 80-Hz family of beam patterns presented in Figure F-7 shows the rise of a single main lobe as range increases.

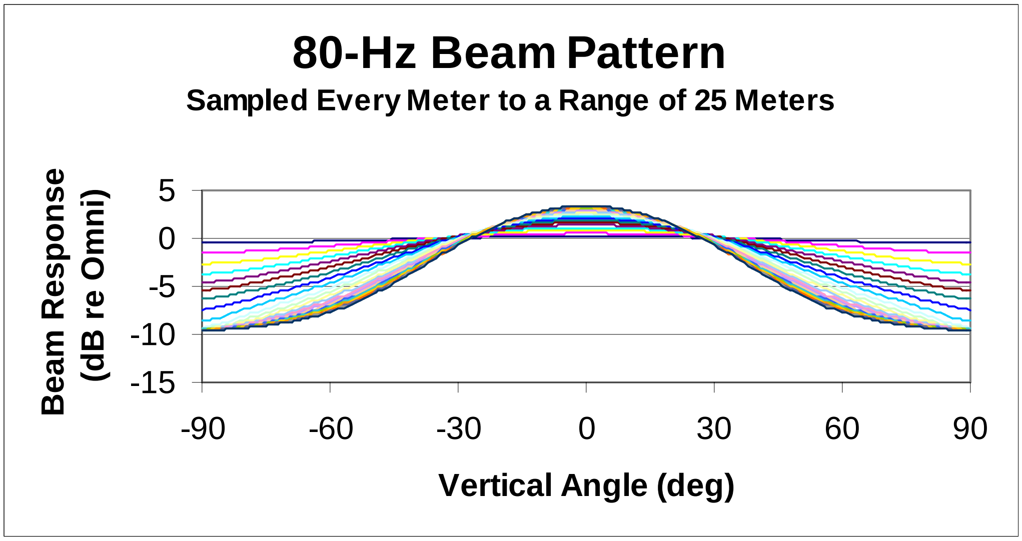


Figure F-7: 80-Hz Beam Patterns across Near Field of EER Source

On the other hand, the 1,250-Hz family of beam patterns depicted in Figure F-8 demonstrates the typical high-frequency bifurcated beam.

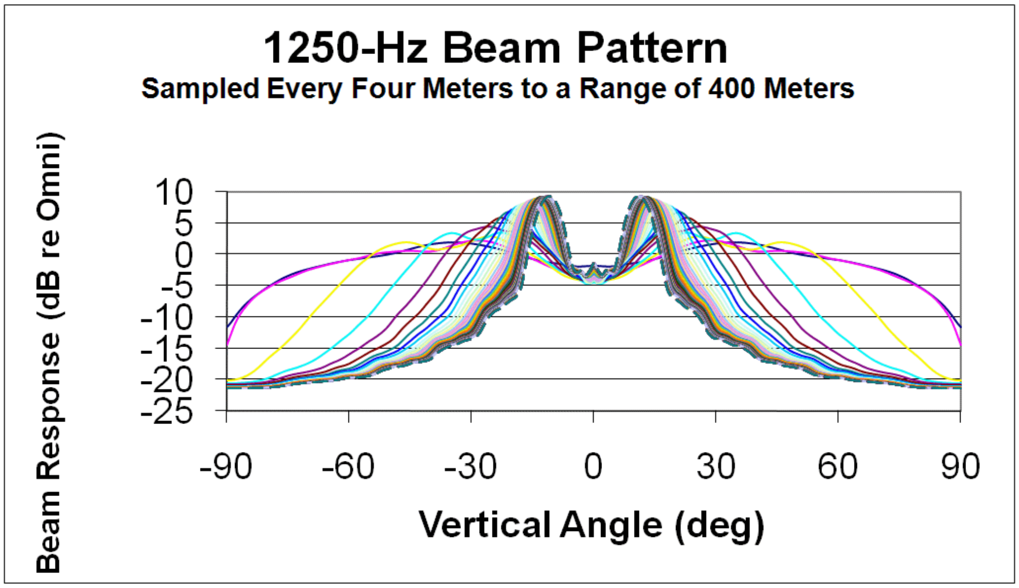


Figure F-8: 1,250-Hz Beam Patterns across Near Field of EER Source

F.4.2.3 Impact Volumes for Various Metrics

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own thresholds. The energy metric, peak one-third octave, is treated in similar fashion as the energy metric used for the active sonars, including the summation of energy if there are multiple source emissions. The other two, peak pressure and positive impulse, are not accumulated but rather the maximum levels are taken.

F.4.2.3.1 Peak One-Third Octave Energy Metric

The computation of impact volumes for the energy metric follows closely the approach taken to model the energy metric for the active sonars. The only significant difference is that SEL is sampled at several frequencies in one-third-octave bands and only the peak one-third-octave level is accumulated over time.

F.4.2.3.2 Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation at each range/animal depth combination. First, the transmission ratio, modified by the source level in a one-octave band and the vertical beam pattern, is averaged across frequency on an eigenray-by-eigenray basis. This averaged transmission ratio (normalized by the total broadband source level) is then compared across all eigenrays with the maximum designated as the peak arrival. Peak pressure at that range/animal depth combination is then simply the product of:

- The square root of the averaged transmission ratio of the peak arrival,
- The peak pressure at a range of one meter (given by equation F-1), and
- The similitude correction (given by $r^{-0.13}$, where r is the slant range along the eigenray estimated as tc with t the travel time along the dominant eigenray and c the nominal speed of sound).

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

F.4.2.3.3 "Modified" Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner (Goertner 1982). The Goertner model defines a "partial" impulse as

$$\int_0^{T_{min}} p(t)\, dt$$

where p(t) is the pressure wave from the explosive as a function of time t, defined so that p(t) = 0 for t < 0. This pressure wave is modeled as

$$p(t) = p_{max}\, e^{-t/\theta}$$

where p_{max} is the peak pressure at 1 meter (see, equation B-1), and θ is the time constant defined as

$$\theta = 0.058\ w^{1/3}\ (r/w^{1/3})^{0.22}\ \text{seconds}$$

with w the net explosive weight (pounds), and r the slant range between source and animal.

The upper limit of the "partial" impulse integral is

$$T_{min} = \min\ \{T_{cut}, T_{osc}\}$$

where T_{cut} is the time to cutoff and T_{osc} is a function of the animal lung oscillation period. When the upper limit is T_{cut}, the integral is the definition of positive impulse. When the upper limit is defined by T_{osc}, the integral is smaller than the positive impulse and thus is just a "partial" impulse. Switching the integral limit from T_{cut} to T_{osc} accounts for the diminished impact of the positive impulse upon the animals lungs that compress with increasing depth and leads to what is sometimes call a "modified" positive impulse metric.

The time to cutoff is modeled as the difference in travel time between the direct path and the surface-reflected path in an isospeed environment. At a range of r, the time to cutoff for a source depth z_s and an animal depth z_a is

$$T_{cut} = 1/c\ \{\ [r^2 + (z_a + z_s)^2]^{1/2} - [r^2 + (z_a - z_s)^2]^{1/2}\ \}$$

where c is the speed of sound.

The animal lung oscillation period is a function of animal mass M and depth z_a and is modeled as

$$T_{osc} = 1.17\ M^{1/3}\ (1 + z_a/33)^{-5/6}$$

where M is the animal mass (in kg) and z_a is the animal depth (in feet).

The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. So instead of the user specifying the threshold, it is computed as $K\ (M/42)^{1/3}\ (1 + z_a\ /\ 33)^{1/2}$. The coefficient K depends upon the level of exposure. For the onset of slight lung injury, K is 19.7; for the onset of extensive lung hemorrhaging (1 percent mortality), K is 47.

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical dolphin calf (with an average mass of 12.2 kg). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi-msec; for the onset of extensive lung hemorrhaging (1 percent mortality), the threshold at the surface is approximately 31 psi-msec.

As with peak pressure, the "modified" positive impulse at each grid point is compared to the derived threshold. If the impulse is greater than that threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

F.4.2.4 Impact Volume per Explosive Detonation

The detonations of explosive sources are generally widely spaced in time and/or space. This implies that the impact volume for multiple firings can be easily derived by scaling the impact volume for a single detonation. Thus the typical impact volume vector for an explosive source is presented on a per-detonation basis.

F.4.3 Impact Volume by Region

The MIRC is described by nine environmental provinces. The hourly impact volume vector for operations involving any particular source is a linear combination of the nine impact volume vectors with the weighting determined by the distribution of those nine environmental provinces within the range. Unique hourly impact volume vectors for winter and summer are calculated for each type of source and each metric/threshold combination.

F.5 Risk Function: Theoretical and Practical Implementation

This section discusses the recent addition of a risk function "threshold" to acoustic effects analysis procedure. This approach includes two parts, a new metric, and a function to map exposure level under the new metric to probability of harassment. What these two parts mean, how they affect exposure calculations, and how they are implemented are the objects of discussion.

Thresholds and Metrics

The term "thresholds" is broadly used to refer to both thresholds and metrics. The difference, and the distinct roles of each in effects analyses, will be the foundation for understanding the risk function approach, putting it in perspective, and showing that, conceptually, it is similar to past approaches.

Sound is a pressure wave, so at a certain point in space, sound is simply rapidly changing pressure. Pressure at a point is a function of time. Define p(t) as pressure (in micropascals) at a given point at time t (in seconds); this function is called a "time series." Figure F-9 gives the time series of the first "hallelujah" in Handel's Hallelujah Chorus.

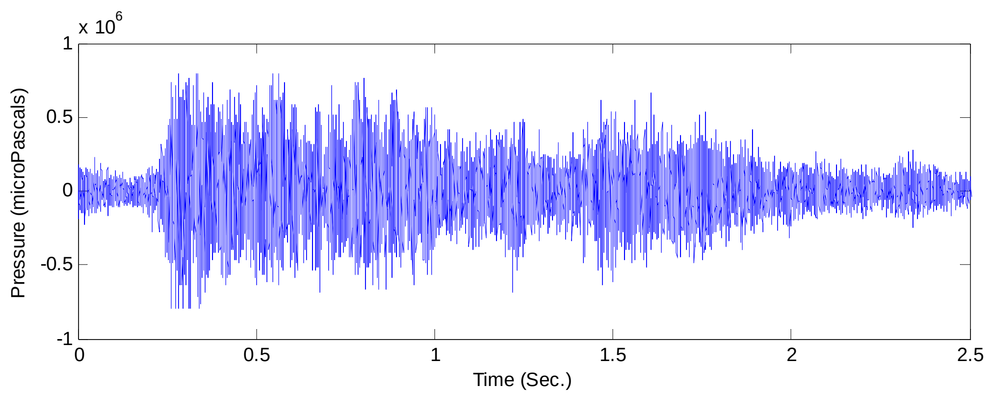


Figure F-9: Time Series

The time-series of a source can be different at different places. Therefore, sound, or pressure, is not only a function of time, but also of location. Let the function p(t), then be expanded to p(t;x,y,z) and denote the time series at point (x,y,z) in space. Thus, the series in Figure F-9 p(t) is for a given point (x,y,z). At a different point in space, it would be different.

Assume that the location of the source is (0,0,0) and this series is recorded at (0,10,-4). The time series above would be p(t;0,10,-4) for $0<t<2.5$.

As in Figure F-9, pressure can be positive or negative, but acoustic power, which is proportional to the square of the pressure, is always positive, this makes integration meaningful. Figure F-10 is $p^2(t;0,10,-4)$.

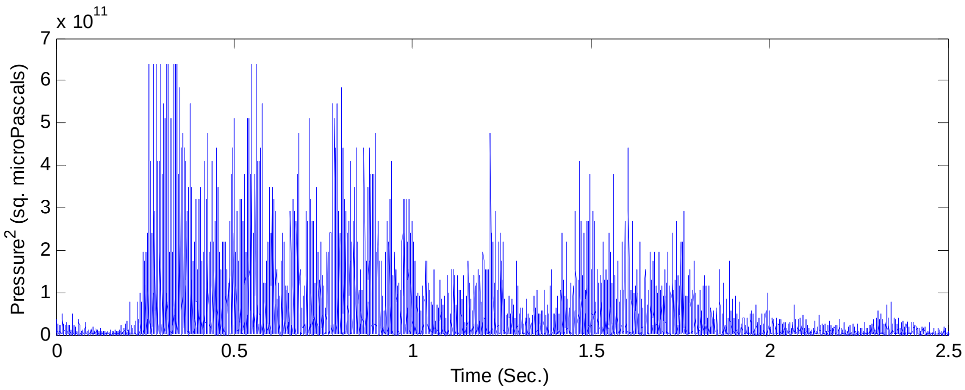


Figure F-10: Time Series Squared

The metric chosen to evaluate the sound field at the end of this first "hallelujah" determines how the time series is summarized from thousands of points, as in Figure F-9, to a single value for each point (x,y,z) in the space. The metric essentially "boils down" the four dimensional p(t,x,y,z) into a three dimensional function m(x,y,z) by dealing with time. There is more than one way to summarize the time component, so there is more than one metric.

Max Sound Pressure Level (SPL)

Because of the large dynamic range of the acoustic power, it is generally represented on a logarithmic scale using SPLs. SPL is actually the ratio of acoustic power density (power/unit area = $\frac{p^2}{Z}$ where Z = ρc is the acoustic impedance). This ratio is presented on a logarithmic scale relative to a reference pressure level, and is defined as:

$$SPL = 10\log_{10}(\frac{p^2}{p_{ref}^2}) = 20\log_{10}(abs\left(\frac{p}{p_{ref}}\right))$$

(Note that SPL is defined in dB re a reference pressure, even though it comes from a ratio of powers)

One way to characterize the power of the time series $p(t;x,y,z)$ with a single number over the 2.5 seconds is to only report the maximum SPL value of the function over time or,

$SPL_{\max} = \max\left\{10\log_{10}\left(p^2(t,x,y,z)\right)\right\}$ (relative to a reference pressure of 1) for 0<t<2.5

The $SPL_{\max}$ for this snippet of the Hallelujah Chorus is:

$$10\log_{10}\left(6.4\times10^{11}\,\mu Pa^2 / 1\mu Pa^2\right) = 118dB \text{ Re } 1\mu\text{Pa}$$

and occurs at 0.2606 seconds, as shown in Figure F-11.

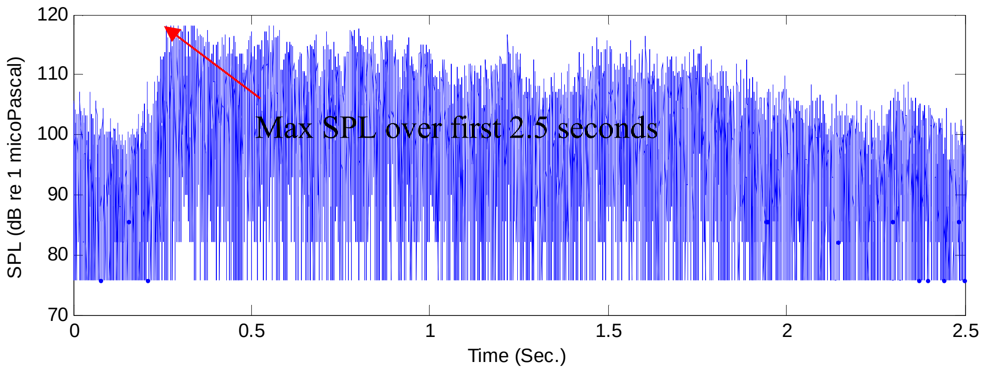


Figure F-11: Max SPL of Time Series Squared

Integration

$SPL_{\max}$ is not necessarily influenced by the duration of the sound (2.5 seconds in this case). Integrating the function over time gives the sound exposure level, which does take this duration into account. A simple integration of $p^2(t;x,y,z)$ over t is common and is proportional to the sound exposure level at (x,y,z). Because we will again be dealing in levels (logarithms of ratios), we neglect the impedance and simply measure the square of the pressure:

$$Energy = \int_0^T p^2(t,x,y,z)dt$$, where T is the maximum time of interest in this case 2.5.

The energy for this snippet of the Hallelujah Chorus is $8.47\times10^{10}\ \mu Pa^2 \cdot s$. This would more commonly be reported as an SEL:

$$SEL = 10\log_{10}\left(\frac{\int_0^T p^2(t,x,y,z)dt}{1.0\mu Pa^2 s}\right) = 109.3 \text{ dB Re } 1\mu\text{Pa}^2\text{s}$$

Energy is sometimes called "equal energy" because if p(t) is a constant function and the duration is doubled, the effect is the same as doubling the signal amplitude (y value). Thus, the duration and the signal have an "equal" influence on the energy metric.

Mathematically,

$$\int_0^{2T} p(t)^2\,dt = 2\int_0^T p(t)^2\,dt = \int_0^T 2p(t)^2\,dt$$

or a doubling in duration equals a doubling in energy equals a doubling in signal.

Sometimes, the integration metrics are referred to as having a "3 dB exchange rate" because if the duration is doubled, this integral increases by a factor of two, or 10log10(2)=3.01 dB. Thus, equal energy has "a 3 dB exchange rate."

After p(t) is determined (i.e., when the stimulus is over), propagation models can be used to determine p(t;x,y,z) for every point in the vicinity and for a given metric. Define

$$m_a(x, y, z, T) = \text{value of metric "a" at point (x,y,z) after time T}$$

So,

$$m_{energy}(x, y, z; T) = \int_0^T p(t)^2 \, dt$$

$$m_{\max SPL}(x, y, z; T) = \max(10 \log_{10}(p^2(t)))\ over\ [0, T]$$

Since modeling is concerned with the effects of an entire event, T is usually implicitly defined: a number that captures the duration of the event. This means that $m_a(x, y, z)$ is assumed to be measured over the duration of the received signal.

Three Dimensions versus Two Dimensions

To further reduce the calculation burden, it is possible to reduce the domain of $m_a(x, y, z)$ to two dimensions by defining $m_a(x, y) = \max\{m_a(x, y, z)\}$ over all z. This reduction is not used for this analysis, which is exclusively three-dimensional.

Threshold

For a given metric, a threshold is a function that gives the probability of exposure at every value of m_a. This threshold function will be defined as

$$D(m_a(x, y, z)) = \Pr(effect\ at\ m_a(x, y, z))$$

The domain of D is the range of $m_a(x, y, z)$, and its range is the number of thresholds.

An example of threshold functions is the Heavyside (or unit step) function, currently used to determine PTS and TTS in cetaceans. For PTS, the metric is $m_{energy}(x, y, z)$, defined above, and the threshold function is a Heavyside function with a discontinuity at 215 dB, shown in Figure F-12.

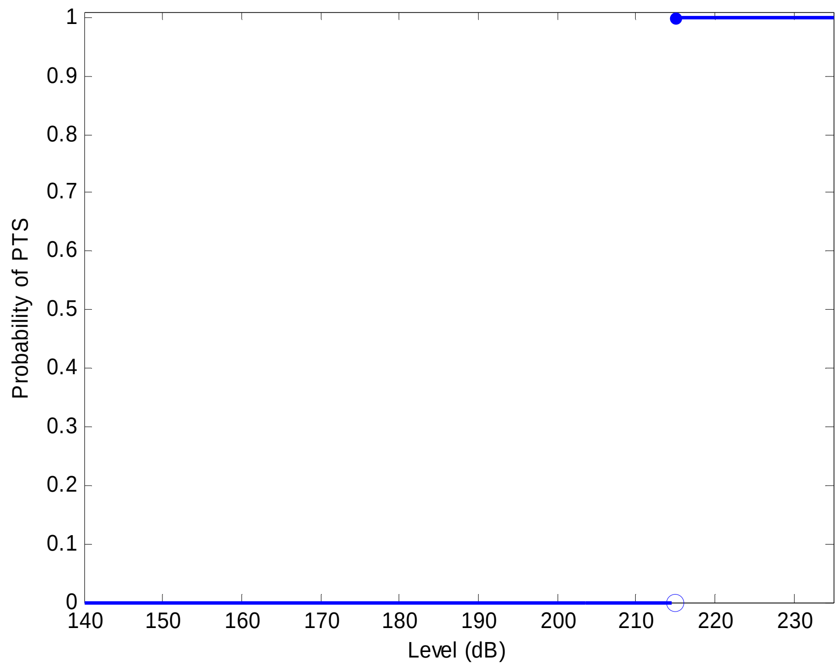


Figure F-12: PTS Heavyside Threshold Function

Mathematically, this D is defined as:

$$D(m_{energy}) = \begin{cases} 0 \;\; for \; m_{energy} < 215 \\ 1 \;\; for \; m_{energy} \geq 215 \end{cases}$$

Any function can be used for D, as long as its range is in [0,1]. The risk functions use normal Feller risk functions (defined below) instead of heavyside functions, and use the max SPL metric instead of the energy metric. While a heavyside function is specified by a single parameter, the discontinuity, a Feller function requires three parameters: the basement cutoff value, the level above the basement for 50 percent effect, and a steepness parameter. Mathematically, these Feller, "risk" functions, D, are defined as

$$D(m_{\max SPL}) = \begin{cases} \dfrac{1}{1+\left(\dfrac{K}{m_{\max SPL}-B}\right)^{A}} \;\; for \; m_{\max SPL} \geq B \\ 0 \;\; for \; m_{\max SPL} < B \end{cases}$$

where B=cutoff (or basement), K=the difference in level (dB) between the basement and the median (50 percent effect) harassment level, and A = the steepness factor. The risk function for odontocetes and pinnipeds uses the parameters:

B = 120 dB,
K = 45 dB, and
A = 10.

The risk function for mysticetes uses:

B = 120 dB,
K = 45 dB, and
A = 8.

Harbor porpoises are a special case. Though the metric for their behavioral harassment is also SPL, their risk function is a heavyside step function with a harassment threshold discontinuity (0 percent to 100 percent) at 120 dB. All other species use the continuous Feller cumulative distribution function (CDF) function for evaluating expected harassment.

Multiple Metrics and Thresholds

It is possible to have more than one metric, and more than one threshold in a given metric. For example, in this document, the criteria to define harassment have two metrics (energy for PTS and TTS, and max SPL for Feller risk function) to define MMPA Level A (PTS) and Level B harassment (TTS and Feller risk function), of which the most conservative is used to determine harassment; and three thresholds (two for energy, one for max SPL). The energy thresholds are heavyside functions, as described above, with discontinuities at 215 and 195 for PTS (Level A) and TTS (Level B), respectively. The max SPL effect is calculated from the Feller risk function (Level B) for odontocetes defined in the previous section.

Calculation of Expected Exposures

Determining the number of expected exposures for disturbance is the object of this analysis.

$$\text{Expected exposures in volume V=} \int_V \rho(V)D(m_a(V))dV$$

For this analysis, $m_a = m_{\max SPL}$, so

$$\int_V \rho(V)D(m_a(V)dV = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \rho(x,y,z)D(m_{\max SPL}(x,y,z))dxdydz$$

In this analysis, the densities are constant over the x/y plane, and the z dimension is always negative, so this reduces to

$$\int_{-\infty}^{0} \rho(z)\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz$$

Numeric Implementation

Numeric integration of $\int_{-\infty}^{\infty} \rho(z)\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz$ can be involved because, although the bounds are infinite, D is non-negative out to 141 dB, which, depending on the environmental specifics, can drive propagation loss calculations and their numerical integration out to more than 100 km.

The first step in the solution is to separate out the x/y-plane portion of the integral:

$$\text{Define f(z)=} \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdy\,.$$

Calculation of this integral is the most involved and time consuming part of the calculation. Once it is complete,

$$\int_{-\infty}^{0}\rho(z)\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}D(m_{\max SPL}(x,y,z))dxdydz=\int_{-\infty}^{0}\rho(z)f(z)dz,$$

which, when numerically integrated, is a simple dot product of two vectors.

Thus, the calculation of f(z) requires the majority of the computation resources for the numerical integration. The rest of this section presents a brief outline of the steps to calculate f(z) and preserve the results efficiently.

The concept of numerical integration is, instead of integrating over continuous functions, to sample the functions at small intervals and sum the samples to approximate the integral. The smaller the size of the intervals, the closer the approximation, but the longer the calculation, so a balance between accuracy and time is determined in the decision of step size. For this analysis, z is sampled in 5-meter steps to 1,000 meters in depth and 10-meter steps to 2,000 meters, which is the limit of animal depth in this analysis. The step size for x is 5 meters, and y is sampled with an interval that increases as the distance from the source increases. Mathematically,

$$z\in Z=\{0,5,...1000,1010,...,2000\}$$
$$x\in X=\{0,\pm5,...,\pm5k\}$$
$$y\in Y=\left\{0,\pm5*(1.005)^0,\pm5*\left[(1.005)^0+(1.005)^1\right],...,\pm5*\left[\sum_{i=0}^{j}(1.005)^i\right]\right\}$$

for integers k, j, which depend on the propagation distance for the source. For this analysis, k = 20,000 and j = 600.

With these steps, $f(z_0)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}D(m_{\max SPL}(x,y,z_0))dxdy$ is approximated as

$$\sum_{z\in Y}\sum_{x\in X}D(m_{\max SPL}(x,y,z_0))\Delta x\Delta y$$

where X,Y are defined as above.

This calculation must be repeated for each $z_0\in Z$, to build the discrete function f(z).

With the calculation of f(z) complete, the integral of its product with $\rho(z)$ must be calculated to complete evaluation of

$$\int_{-\infty}^{\infty}\rho(z)\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}D(m_{\max SPL}(x,y,z))dxdydz=\int_{-\infty}^{0}\rho(z)f(z)dz$$

Since f(z) is discrete, and $\rho(z)$ can be readily made discrete, $\int_{-\infty}^{0}\rho(z)f(z)dz$ is approximated numerically as $\sum_{z\in Z}\rho(z)f(z)$, a dot product.

Preserving Calculations for Future Use

Calculating f(z) is the most time-consuming part of the numerical integration, but the most time-consuming portion of the entire process is calculating $m_{\max SPL}(x,y,z)$ over the area range required for the minimum cutoff value (141 dB). The calculations usually require propagation estimates out to over 100 km, and those estimates, with the beam pattern, are used to construct a sound field that extends 200 km x 200 km (40,000 sq km), with a calculation at the steps for every value of X and Y, defined above. This is repeated for each depth, to a maximum of 2,000 meters.

Saving the entire $m_{\max SPL}$ for each z is unrealistic, requiring great amounts of time and disk space. Instead, the different levels in the range of $m_{\max SPL}$ are sorted into 0.5 dB wide bins; the volume of water at each bin level is taken from $m_{\max SPL}$, and associated with its bin. Saving this, the amount of water ensonified at each level, at 0.5 dB resolution, preserves the ensonification information without using the space and time required to save $m_{\max SPL}$ itself. Practically, this is a histogram of occurrence of level at each depth, with 0.5 dB bins. Mathematically, this is simply defining the discrete functions $V_z(L)$, where $L = \{.5a\}$ for every positive integer a, for all $z \in Z$. These functions, or histograms, are saved for future work. The information lost by saving only the histograms is *where* in space the different levels occur, although *how often* they occur is saved. But the thresholds (risk function curves) are purely a function of level, not location, so this information is sufficient to calculate f(z).

Applying the risk function to the histograms is a dot product:

$$\sum_{\ell \in L_1} D(\ell)V_{z_0}(\ell) \approx \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z_0))dxdy$$

So, once the histograms are saved, neither $m_{\max SPL}(x,y,z)$ nor f(z) must be recalculated to generate $\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz$ for a new threshold function.

For the interested reader, the following section includes an in-depth discussion of the method, software, and other details of the f(z) calculation.

Software Detail

The risk function metric uses the cumulative normal probability distribution to determine the probability that an animal is affected by a given SPL. The acoustic quantity of interest is the maximum SPL experienced over multiple pings in a range-independent environment. The procedure for calculating the impact volume at a given depth is relatively simple. In brief, given the SPL of the source and the TL curve, the received SPL is calculated on a volumetric grid. For a given depth, volume associated with each SPL interval is calculated. Then, this volume is multiplied by the probability that an animal will be affected by that SPL. This gives the impact volume for that depth, that can be multiplied by the animal densities at that depth, to obtain the number of animals affected at that depth. The process repeats for each depth to construct the impact volume as a function of depth.

The case of a single emission of sonar energy, one ping, illustrates the computational process in more detail. First, the sound pressure levels are segregated into a sequence of bins that cover the range encountered in the area. The SPL are used to define a volumetric grid of the local sound field. The impact volume for each depth is calculated as follows: for each depth in the volumetric grid, the SPL at each x/y plane grid point is calculated using the SPL of the source, the TL curve, the horizontal beam pattern of the source, and the vertical beam patterns of the source. The sound pressure levels in this grid become the bins in the volume histogram. Figure F-13 shows a volume histogram for a low-power sonar. Level bins are 0.5 dB in width and the depth is 50 meters in an environment with water depth of 100 meters. The oscillatory structure at very low levels is due the flattening of the TL curve at long distances from the source, which magnifies the fluctuations of the TL as a function of range. The "expected" impact volume for a given level at a given depth is calculated by multiplying the volume in each level bin by the risk function probability function at that level. Total expected impact volume for a given depth is the sum of these "expected" volumes. Figure F-14 is an example of the impact volume as a function of depth at a water depth of 100 meters.

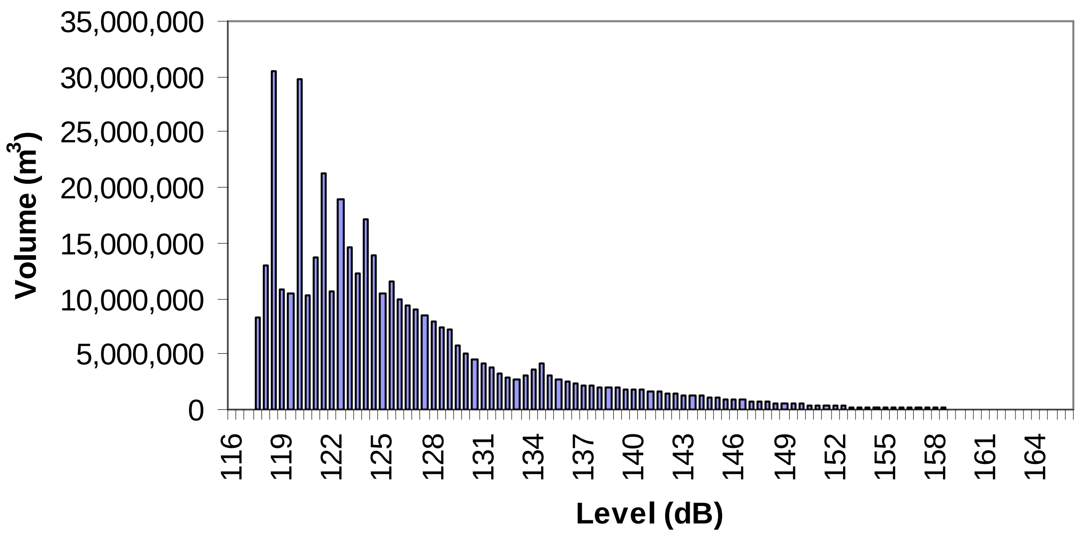


Figure F-13: Example of a Volume Histogram

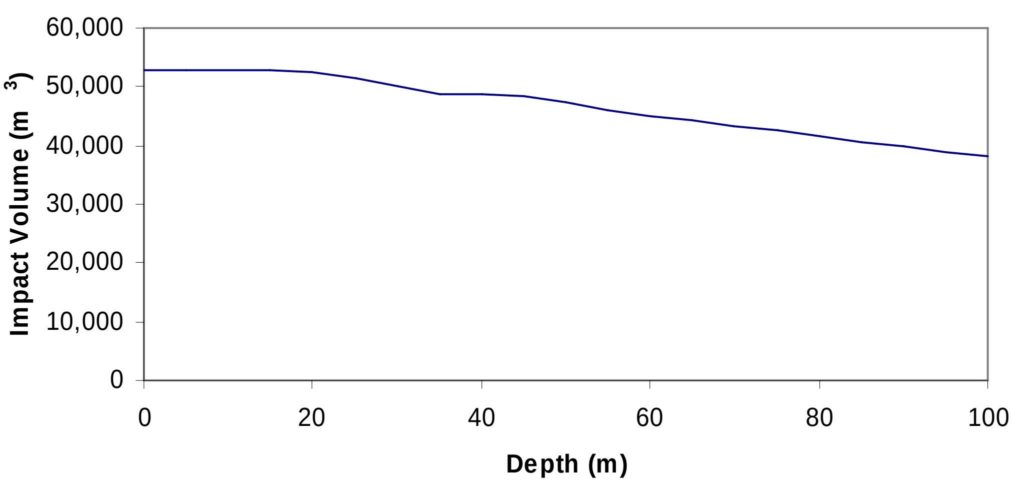


Figure F-14: Example of the Dependence of Impact Volume on Depth

The volumetric grid covers the waters in and around the area of sonar operation. The grid for this analysis has a uniform spacing of 5 meters in the x-coordinate and a slowly expanding spacing in the y-coordinate that starts with 5 meters spacing at the origin. The growth of the grid size along the y-axis is a geometric series. Each successive grid size is obtained from the previous by multiplying it by 1+Ry, where Ry is the y-axis growth factor. The n^{th} grid size is related to the first grid size by multiplying by $(1+Ry)^{(n-1)}$. For an initial grid size of 5 meters and a growth factor of 0.005, the 100^{th} grid increment is 8.19 meters. The constant spacing in the x-coordinate allows greater accuracy as the source moves along the x-axis. The slowly increasing spacing in y reduces computation time, while maintaining accuracy, by taking advantage of the fact that TL changes more slowly at longer distances from the source. The x-and y-coordinates extend from –Rmax to +Rmax, where Rmax is the maximum range used in the TL calculations. The z direction uses a uniform spacing of 5 meters down to 1,000 meters and 10 meters from 1,000 to 2,000 meters. This is the same depth mesh used for the effective energy metric as described above. The depth mesh does not extend below 2,000 meters, on the assumption that animals of interest are not found below this depth.

The next three figures indicate how the accuracy of the calculation of impact volume depends on the parameters used to generate the mesh in the horizontal plane. Figure F-15 shows the relative change of impact volume for one ping as a function of the grid size used for the x-axis. The y-axis grid size is fixed at 5m and the y-axis growth factor is 0, i.e., uniform spacing. The impact volume for a 5 meters grid size is the reference. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1 percent. A grid size of 5 meters for the x-axis is used in the calculations. Figure F-16 shows the relative change of impact volume for one ping as a function of the grid size used for the y-axis. The x-axis grid size is fixed at 5 meters and the y-axis growth factor is 0. The impact volume for a 5-meter grid size is the reference. This figure is very similar to that for the x-axis grid size. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1 percent. A grid size of 5 meters is used for the y-axis in our calculations. Figure F-17 shows the relative change of impact volume for one ping as a function of the y-axis growth factor. The x-axis grid size is fixed at 5 meters and the initial y-axis grid size is 5 meters. The impact volume for a growth factor of 0 is the reference. For growth factors from 0 to 0.01, the change is less than 0.1 percent. A growth factor of 0.005 is used in the calculations.

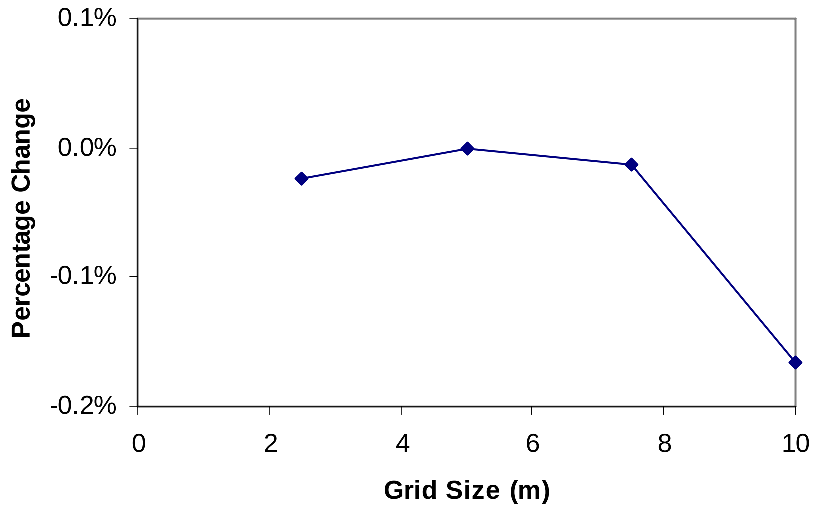


Figure F-15: Change of Impact Volume as a Function of X-Axis Grid Size.

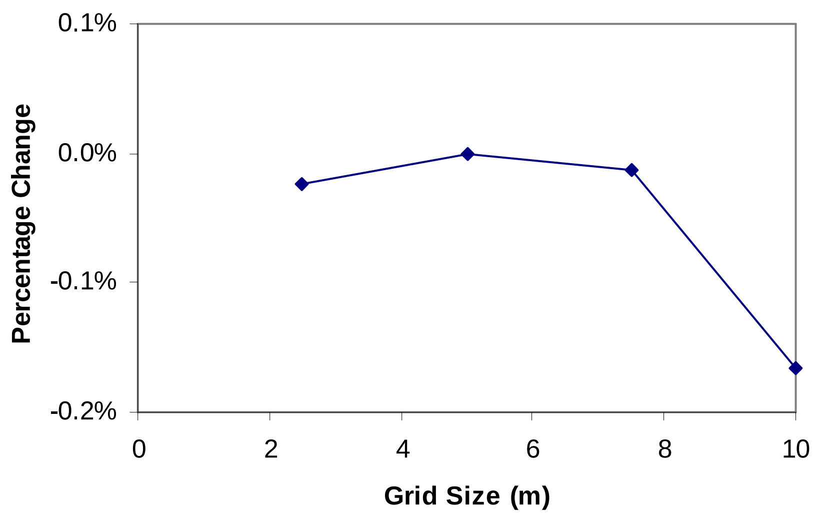


Figure F-16: Change of Impact Volume as a Function of Y-Axis Grid Size

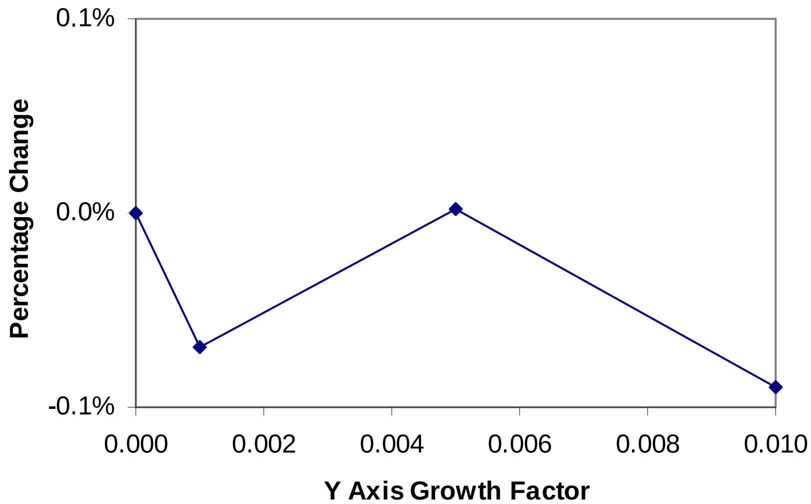


Figure F-17: Change of Impact Volume as a Function of Y-Axis Growth Factor

Another factor influencing the accuracy of the calculation of impact volumes is the size of the bins used for SPL. The SPL bins extend from 100 dB (far lower than required) up to 300 dB (much higher than that expected for any sonar system). Figure F-18 shows the relative change of impact volume for one ping as a function of the bin width. The x-axis grid size is fixed at 5 meters the initial y-axis grid size is 5 meters, and the y-axis growth factor is 0.005. The impact volume for a bin size of 0.5 dB is the reference. For bin widths from 0.25 dB to 1.00 dB, the change is about 0.1 percent. A bin width of 0.5 is used in our calculations.

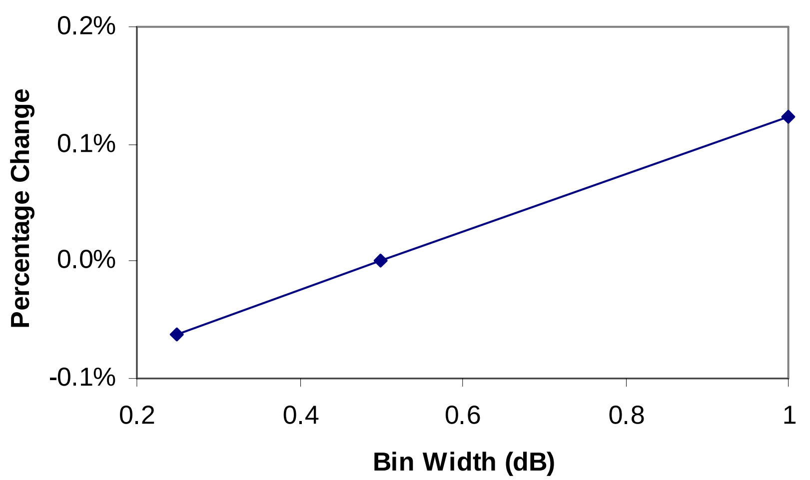


Figure F-18: Change of Impact Volume as a Function of Bin Width

Two other issues for discussion are the maximum range (Rmax) and the spacing in range and depth used for calculating TL. The TL generated for the energy accumulation metric is used for risk function analysis. The same sampling in range and depth is adequate for this metric because it requires a less demanding computation (i.e., maximum value instead of accumulated energy). Using the same value of Rmax needs some discussion since it is not clear that the same value can be used for both metrics. Rmax was set so that the TL at Rmax is more than needed to reach the energy accumulation threshold of 173 dB for 1,000 pings. Since energy is accumulated, the same TL can be used for one ping with the source level increased by 30 dB (10 $\log_{10}(1{,}000)$). Reducing the source level by 30 dB, to get back to its original value, permits the handling of a sound pressure level threshold down to 143 dB, comparable to the minimum required. Hence, the TL calculated to support energy accumulation for 1,000 pings will also support calculation of impact volumes for the risk function metric.

The process of obtaining the maximum SPL at each grid point in the volumetric grid is straightforward. The active sonar starts at the origin and moves at constant speed along the positive x-axis emitting a burst of energy, a ping, at regularly spaced intervals. For each ping, the distance and horizontal angle connecting the sonar to each grid point is computed. Calculating the TL from the source to a grid point has several steps. The TL is made up of the sum of many eigenrays connecting the source to the grid point. The beam pattern of the source is applied to the eigenrays based on the angle at which they leave the source. After summing the vertically beamformed eigenrays on the range mesh used for the TL calculation, the vertically beamformed TL for the distance from the sonar to the grid point is derived by interpolation. Next, the horizontal beam pattern of the source is applied using the horizontal angle connecting the sonar to the grid point. To avoid problems in extrapolating TL, only grid points with distances less than R_{max} are used. To obtain the SPL at a grid point, the SPL of the source is reduced by that TL. For the first ping, the volumetric grid is populated by the calculated SPL at each grid point. For the second ping and subsequent pings, the source location increments along the x-axis by the spacing between pings and the SPL for each grid point is again calculated for the new source location. Since the risk function metric uses the maximum of the SPLs at each grid point, the newly calculated SPL at each grid point is compared to the SPL stored in the grid. If the new level is larger than the stored level, the value at that grid point is replaced by the new SPL.

For each bin, a volume is determined by summing the ensonified volumes with a maximum SPL in the bin's interval. This forms the volume histogram shown in Figure F-13. Multiplying by the risk function probability function for the level at the center of a bin gives the impact volume for that bin. The result can be seen in Figure F-14, which is an example of the impact volume as a function of depth.

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases for the risk function metric is essentially linear with the number of pings. Figure F-19 shows the dependence of impact volume on the number of pings. The function is linear; the slope of the line at a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector which contains the hourly impact volumes by depth for a province. Figure F-20 provides an example of an hourly impact volume vector for a particular environment. Given the speed of the sonar platform, the hourly impact volume vector could be displayed as the impact volume vector per kilometer of track.

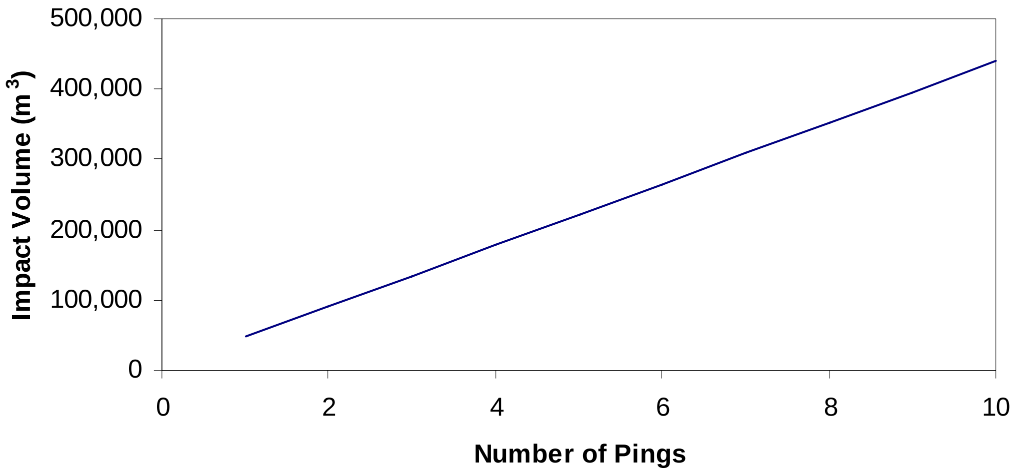


Figure F-19: Dependence of Impact Volume on the Number of Pings

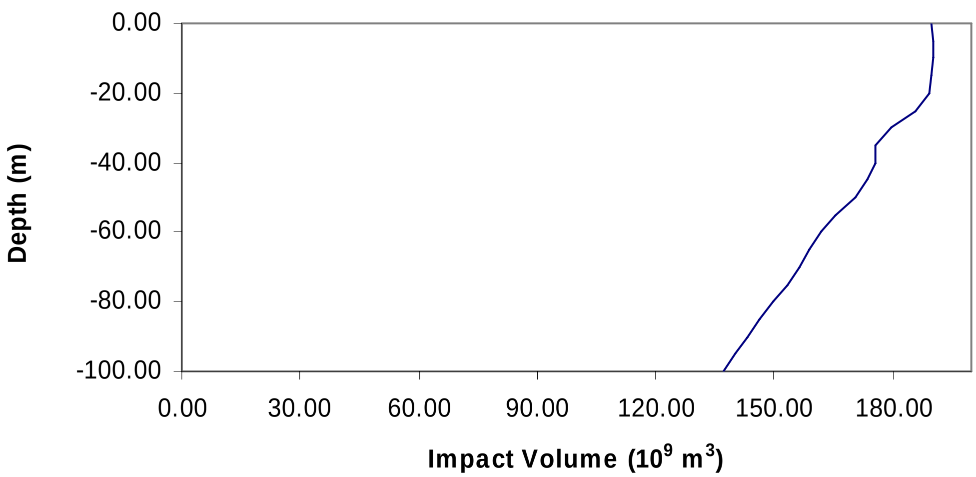


Figure F-20: Example of an Hourly Impact Volume Vector

F.6 Harassments

This section defines the animal densities and their depth distributions for the MIRC. This is followed by a series of tables providing harassment estimates per unit of operation for each source type (active sonars and explosives).

F.6.1 Animal densities

Densities are usually reported by marine biologists as animals per square kilometer, which is an area metric. This gives an estimate of the number of animals below the surface in a certain area, but does not provide any information about their distribution in depth. The impact volume vector (see subsection A.4.3) specifies the volume of water ensonified above the specified threshold in each depth interval. A corresponding animal density for each of those depth intervals is required to compute the expected value of the number of exposures. The two-dimensional area densities do not contain this information, so three-dimensional densities must be constructed by using animal depth distributions to extrapolate the density at each depth. The required depth distributions are presented in the biology subsection.

F.6.2 MMPA Harassment Exposure Estimates

The following sperm whale example demonstrates the methodology used to create a three-dimensional density by merging the area densities with the depth distributions. The sperm whale surface density is 0.0028 whales per square kilometer. From the depth distribution report, "depth distribution for sperm whales based on information in the Amano paper is: 19 percent in 0-2 m, 10 percent in 2-200 m, 11 percent in 201-400 m, 11 percent in 401-600 m, 11 percent in 601-800 m and 38 percent in >800 m." So the sperm whale density at 0-2 m is 0.0028*0.19/0.002 = 0.266 per cubic km, at 2-200 m is 0.0028*0.10/0.198 = 0.001414 per cubic km, and so forth.

In general, the impact volume vector samples depth in finer detail than given by the depth distribution data. When this is the case, the densities are apportioned uniformly over the appropriate intervals. For example, suppose the impact volume vector provides volumes for the intervals 0-2 meters, 2-10 meters, and 10-50 meters. Then for the depth-distributed densities discussed in the preceding paragraph,

- 0.266 whales per cubic km is used for 0-2 meters,
- 0.001414 whales per cubic km is used for the 2-10 meters, and
- 0.001414 whales per square km is used for the 10-50 meters.

Once depth-varying, three-dimensional densities are specified for each species type, with the same depth intervals and the ensonified volume vector, the density calculations are finished. The expected number of ensonified animals within each depth interval is the ensonified volume at that interval multiplied by the volume density at that interval and this can be obtained as the dot product of the ensonified volume and animal density vectors.

Since the ensonified volume vector is the ensonified volume per unit operation (i.e., per hour, per sonobuoy, etc), the final harassment count for each animal is the unit operation harassment count multiplied by the number of units (hours, sonobuoys, etc). The number of unit operations for each source are provided in Table F-1.

F.6.3 Post Acoustic Modeling Analysis

The acoustic modeling results include additional analysis to account for land mass, multiple ships, and number of animals that could be exposed. Specifically, post modeling analysis is designed to consider:

- Acoustic footprints for sonar sources must account for land masses.
- Acoustic footprints for sonar sources should not be added independently, which would result in overlap with other sonar systems used during the same active sonar activity. As a consequence, the area of the total acoustic footprint would be larger than the actual acoustic footprint when multiple ships are operating together.
- Acoustic modeling should account for the maximum number of individuals of a species that could potentially be exposed to sonar within the course of 1 day or a discreet continuous sonar event if less than 24 hours.

When modeling the effect of sound projectors in the water, the ideal task presents modelers with complete *a priori* knowledge of the location of the source(s) and transmission patterns during the times of interest.

In these cases, calculation inputs include the details of source path, proximity of shoreline, high-resolution density estimates, and other details of the scenario. However, in the MIRC, there are sound-producing events for which the source locations, and transmission patterns are unknown, but still require analysis to predict effects. For these cases, a more general modeling approach is required: "We will be operating somewhere in this large area for X minutes. What are the potential effects on average?"

Modeling these general scenarios requires a statistical approach to incorporate the scenario nuances into harassment calculations. For example, one may ask: "If an animal receives 130 decibel (dB) SPL when the source passes at closest point of approach (CPA) on Tuesday morning, how do we know it doesn't receive a higher level on Tuesday afternoon?" This question cannot be answered without knowing the path of the source (and several other facts). Because the path of the source is unknown, the number of an individual's re-exposures cannot be calculated directly. But it can, on average, be accounted for by making appropriate assumptions.

Table F-11 lists unknowns created by uncertainty about the specifics of a future proposed action, the portion of the calculation to which they are relevant, and the assumption that allows the effect to be computed without the detailed information.

The following sections discuss three topics that require action details, and describe how the modeling calculations used the general knowledge and assumptions to overcome the future-action uncertainty with respect to re-exposure of animals, land shadow, and the effect of multiple-ship training events.

Table F-11: Unknowns and Assumptions

Unknowns	Relevance	Assumption
Path of ship (esp. with respect to animals)	Ambiguity of multiple exposures, Local population: upper bound of harassments	Most conservative case: ships are everywhere within Sonar Operating Area
Source(s) locations	Ambiguity of multiple exposures, land shadow	Equal distribution of action in each modeling area
Direction of sonar transmission	Land shadow	Equal probability of pointing any direction
Number of ships	Effect of multiple ships	Average number of ships per training event
Distance between ships	Effect of multiple ships	Average distance between ships

F.6.3.1 Multiple Exposures in General Modeling Scenario

Consider the following hypothetical scenario. A box is painted on the surface of a well-studied ocean environment with well-known sound propagation characteristics. A sonar source and 100 whales are inserted into that box and a curtain is drawn. What will happen? The details of what will happen behind the curtain are unknown, but the existing knowledge, and general assumptions, can allow for a calculation of average effects.

For the first period of time, the source is traveling in a straight line and pinging at a given rate. In this time, it is known how many animals, on average, receive their max SPLs from each ping. As long as the source travels in a straight line, this calculation is valid. However, after an undetermined amount of time, the source will change course to a new and unknown heading.

If the source changes direction 180 degrees and travels back through the same swath of water, all the animals the source passes at closest point of approach (CPA) before the next course change have already been exposed to what will be their maximum SPL, so the population is not "fresh." If the direction does not change, only new animals will receive what will be their maximum SPL from that source (though most have received sound from it), so the population is completely "fresh." Most source headings lead to a population of a mixed "freshness," varying by course direction. Since the route and position of the source over time are unknown, the freshness of the population at CPA with the source is unknown. This ambiguity continues through the remainder of the exercise.

What is known? The source and, in general, the animals remain in the vicinity of the OPAREA. Thus, if the farthest range to a possible effect from the source is X kilometers (km), no animals farther than X km outside of the OPAREA can be harassed. The intersection of this area with a given animal's habitat multiplied by the density of that animal in its habitat represents the maximum number of animals that can be harassed by activity in that OPAREA, which shall be defined as "the local population." Two details: first, this maximum should be adjusted down if a risk function is being used, because not 100% of animals within X km of the OPAREA border will be harassed. Second, it should be adjusted up to account for animal motion in and out of the area.

The ambiguity of population freshness throughout the training event means that multiple exposures cannot be calculated for any individual animal. It must be dealt with generally at the population level.

Solution to the Ambiguity of Multiple Exposures in the General Modeling Scenario

At any given time, each member of the population has received a maximum SPL (possibly zero) that indicates the probability of harassment during the training event. This probability indicates the contribution of that individual to the expected value of the number of harassments. For example, if an animal receives a level that indicates 50 percent probability of harassment, it contributes 0.5 to the sum of the expected number of harassments. If it is passed later with a higher level that indicates a 70 percent chance of harassment, its contribution increases to 0.7. If two animals receive a level that indicates 50 percent probability of harassment, they together contribute 1 to the sum of the expected number of harassments. That is, we statistically expect exactly one of them to be harassed. Let the expected value of harassments at a given time be defined as "the harassed population" and the difference between the local population (as defined above) and the harassed population be defined as "the unharassed population." As the training event progresses, the harassed population will never decrease and the unharassed population will never increase.

The unharassed population represents the number of animals statistically "available" for harassment. Since we do not know where the source is, or where these animals are, we assume an average (uniform) distribution of the unharassed population over the area of interest. The densities of unharassed animals are lower than the total population density because some animals in the local population are in the harassed population.

Density relates linearly to expected harassments. If action A, in an area with a density of 2 animals per square kilometer (km^2) produces 100 expected harassments, then action A in an area with 1 animal per km^2 produces 50 expected harassments. The modeling produces the number of expected harassments per ping starting with 100 percent of the population unharassed. The next ping will produce slightly fewer harassments because the pool of unharassed animals is slightly less.

For example, consider the case where 1 animal is harassed per ping when the local population is 100, 100 percent of which are initially unharassed. After the first ping, 99 animals are unharassed, so the number of animals harassed during the second ping are

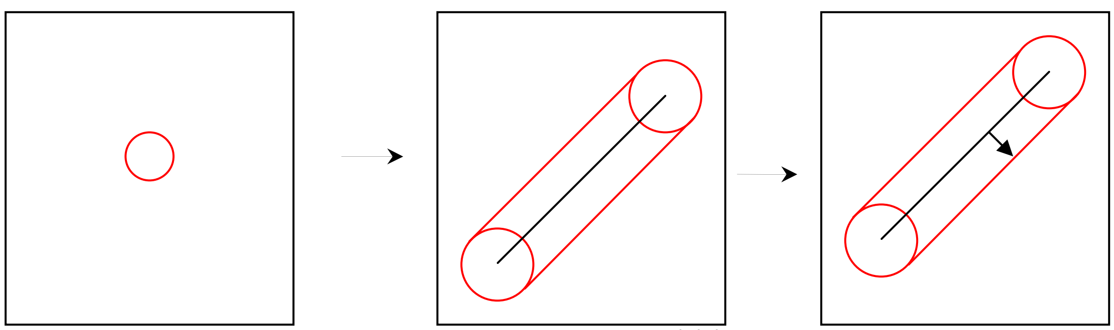
$$10\left(\frac{99}{100}\right) = 1(.99) = 0.99 \text{ animals}$$

and so on for the subsequent pings.

Mathematics

A closed form function for this process can be derived as follows.

Define H = number of animals harassed per ping with 100 percent unharassed population. H is calculated by determining the expected harassment for a source moving in a straight line for the duration of the exercise and dividing by the number of pings in the exercise (Figure F-21).



$$\text{H} = \int\int\int \rho(z)D(L(x,y,z))dxdydz\,/\text{N\_pings}$$

Figure F-21: Process of Calculating H

The total unharassed population is then calculated by iteration. Each ping affects the unharassed population left after all previous pings:

Define P_n = unharassed population after ping n

P_0 = local population

$$P_1 = P_0 - H$$

$$P_2 = P_1 - H\left(\frac{P_1}{P_0}\right)$$

...

$$P_n = P_{n-1} - H\left(\frac{P_{n-1}}{P_0}\right)$$

Therefore,

$$P_n = P_{n-1}\left(1-\left(\frac{H}{P_0}\right)\right) = P_{n-2}\left(1-\left(\frac{H}{P_0}\right)\right)^2 = ... = P_0\left(1-\left(\frac{H}{P_0}\right)\right)^n$$

Thus, the total number of harassments depends on the per-ping harassment rate in an unharassed population, the local population size, and the number of operation hours.

Local Population: Upper Bound on Harassments

As discussed above, Navy planners have confined periods of sonar use to training areas. The size of the harassed population of animals for an action depends on animal re-exposure, so uncertainty about the precise source path creates variability in the "harassable" population. Confinement of sonar use to a sonar training area allows modelers to compute an upper bound, or worst case, for the number of harassments with respect to location uncertainty. This is done by assuming that every animal which enters the training area at any time in the exercise (and also many outside) is “harassable” and creates an upper bound on the number of harassments for the exercise. Since this is equivalent to assuming that there are sonars transmitting simultaneously from each point in the confined area throughout the action length, this greatly overestimates the take from an exercise.

NMFS has defined a 24-hour "refresh rate," or amount of time in which an individual can be harassed no more than once. The Navy has determined that, in a 24-hour period, all sonar activities in the MIRC transmit for a subset of that time (Table F-12).

Table F-12: Duration of 53C Use During 24-hour Period

Exercise	Longest continuous interval of 53C use in 24-hour period
Multi-Strike Group	12 hours
TRACKEX-TORPEX	8 hours

The most conservative assumption for a single ping is that it harasses the entire population within the range (a gross over-estimate). However, the total harassable population for multiple pings will be even greater, since animal motion over the period in the Table F-12 can bring animals into range that otherwise would be out of the harassable population.

Animal Motion Expansion

Though animals often change course to swim in different directions, straight-line animal motion would bring the more animals into the harassment area than a "random walk" motion model. Since precise and accurate animal motion models exist more as speculation than documented fact and because the modeling requires an undisputable upper bound, calculation of the upper bound for MIRC modeling areas uses a straight-line animal motion assumption. This is a conservative assumption.

For a circular area, the straight-line motion in any direction produces the same increase in harassable population. However, since the ranges are non-circular polygons, choosing the initial fixed direction as perpendicular to the longest diagonal produces greater results than any other direction. Thus, the product of the longest diagonal and the distance the animals move in the period of interest gives an overestimate of the expansion in range modeling areas due to animal motion. The MIRC expansions use this estimate as an absolute upper bound on animal-motion expansion.

Figure F-22 illustrates an example that illustrates the overestimation, which occurs during the second arrow:

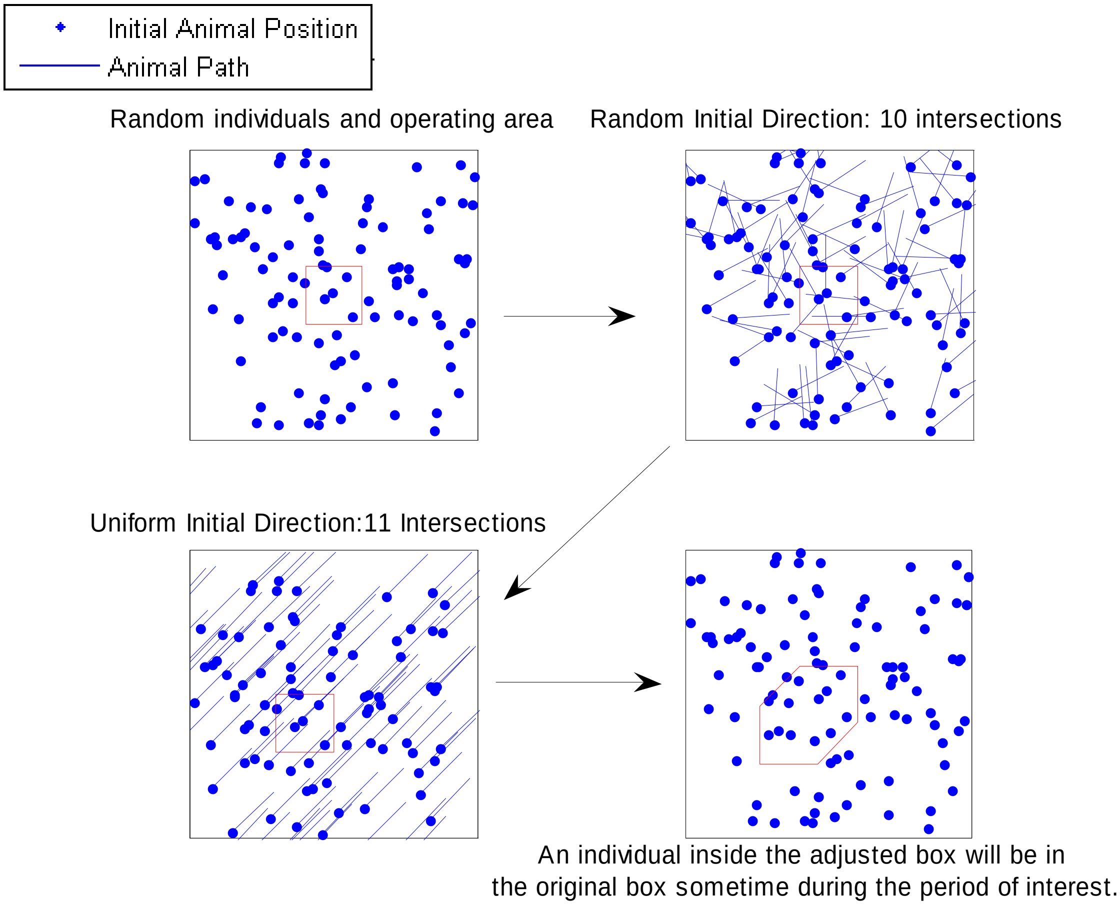


Figure F-22: Process of Setting an Upper Bound on Individuals Present in Area

It is important to recognize that the area used to calculate the harassable population, shown in Figure F-22 will, in general, be much larger than the area that will be within the ZOI of a ship for the duration of its broadcasts. For a source moving faster than the speed of the marine animals, a better (and much smaller) estimate of the harassable population would be that within the straight line ZOI cylinder shown in Figure F-22. Using this smaller population would lead to a greater dilution of the unharassed population per ping and would greatly reduce the estimated harassment.

Risk Function Expansion

The expanded area contains the number of animals that will enter the range over the period of interest. However, an upper bound on harassments must also include animals outside the area that would be affected by a source transmitting from the area's edge. A gross overestimation could simply assume pinging at every point on the range border throughout the exercise and would include all area with levels from a source on the closest border point greater than the risk function basement. In the case of MIRC, this would include all area within approximately 150 km from the edge of the adjusted box. This basic method would give a crude and exaggerated upper bound, since only a tiny fraction of this out-of-range area can be ensonified above threshold for a given ping. A more refined upper bound on harassments can be found by maintaining the assumption that a sonar is transmitting from each point in the adjusted box and calculating the expected ensonified area, which would give all animals inside the area a 100 percent probability of harassment, and those outside the area a varying probability, based on the risk function.

$$\int_0^{L^{-1}(120\,dB)} D(L(r))dr ,$$

Where L is the SPL function with domain in range and range in level,
r is the range from the sonar operating area,
L^{-1}(120 dB) is the range at which the received level drops to 120 dB, and
D is the risk function (probability of harassment vs. level).

At the corners of the polygon, additional area can be expressed as

$$\frac{[\pi - \theta] \int_0^{L^{-1}(120\,dB)} D(L(r))rdr}{2\pi}$$

with D, L, and r as above, and
θ the inner angle of the polygon corner, in radians.

For the risk function and transmission loss of the MIRC, this method adds an area equivalent by expanding the boundaries of the adjusted box by four kilometers. The resulting shape, the adjusted box with a boundary expansion of 4 km, does not possess special meaning for the problem. But the number of individuals contained by that shape, is the harassable population and an absolute upper bound on possible harassments for that operation.

Figure F-23 illustrates the growth of area for the sample case above. The shapes of the boxes are unimportant. The area after the final expansion, though, gives an upper bound on the "harassable," or initially unharassed population which could be affected by training activities.

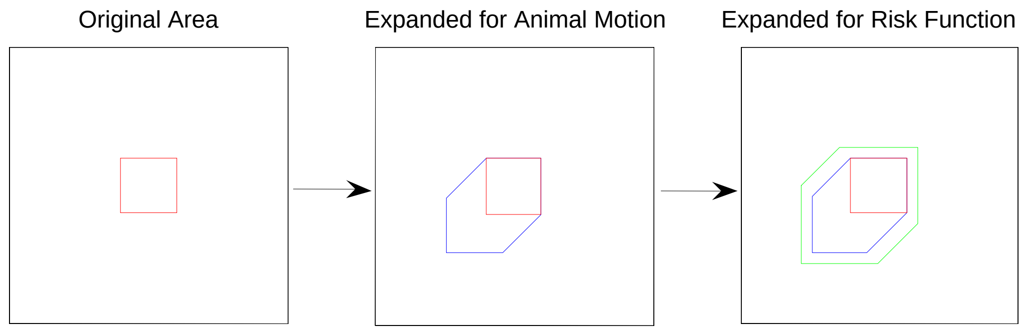


Figure F-23: Process of Expanding Area to Create Upper Bound of Harassments

For the most powerful source, the 53C, the expected winter rate of harassment for pantropical spotted dolphins is approximately 0.133743 harassments per ping. The exercise will transmit sonar pings for 12 hours in a 24 hour period, as given in the action table above, with 120 pings per hour, a total of 120*12=1,440 pings in a 24 hour period.

The MIRC has an area of approximately 1,872,094 square kilometers and a diagonal of 1,940 km. Adjusting this with straight-line (upper bound) animal motion of 5.5 kilometers per hour for 12 hours, animal motion adds 1,940*5.5*12= 128,040 square kilometers to the area. Using the risk function to calculate the expected range outside the MIRC adds another 20,728 square kilometers, bringing the total upper-bound of the affected area to 2,020,862 square km.

For this analysis, pantropical spotted dolphins have an average density of 0.0226 animals per square kilometer, so the upper bound number of pantropical spotted dolphins that can be affected by 53C activity in the MIRC during a 24 hour period is 2,020,862 *0.0226=45,671 dolphins.

In the first ping, 0.133743 pantropical spotted dolphins will be harassed. With the second ping, $0.133743\left(\frac{45671-0.133743}{45671}\right)=0.13374261$ pantropical spotted dolphins will be harassed. Using the formula derived above, after 12 hours of continuous operation, the remaining **unharassed** population is

$$P_{1440}=P_0\left(1-\left(\frac{h}{P_0}\right)\right)^{1440}=45671\left(1-\left(\frac{0.133743}{45671}\right)\right)^{1440}\approx 45478.82$$

So the **harassed** population will be 45671-45478.82 = 192.18 animals.

Contrast this with linear accumulation of harassments without consideration of the local population and the dilution of the unharassed population:

Harassments = 0.133743 *1,440=192.6 animals

The difference in harassments is very small, as a percentage of total harassments, because the size of the MIRC implies a large "harassable" population relative to the harassment per ping of the 53C. In cases where the harassable population is not as large, with respect to the per ping harassments, the difference in harassments between linear accumulation and density dilution is more pronounced. Note that these numbers were calculated without consideration of land-shadow and multiple-ship effects.

F.6.3.2 Land Shadow

The risk function considers the possibility of harassment possible if an animal receives 120 dB SPL, or above. In the open ocean of the MIRC, this can occur as far away as 150 km, so over a large "effect" area, sonar sound could, but does not necessarily, harass an animal. The harassment calculations for a general modeling case must assume that this effect area covers only water fully populated with animals, but in some portions of the MIRC, land partially encroaches on the area, obstructing sound propagation.

As discussed in the introduction of "Additional Modeling Considerations" Navy planners do not know the exact location and transmission direction of the sonars at future times. These factors however, completely determine the interference of the land with the sound, or "land shadow," so a general modeling approach does not have enough information to compute the land shadow effects directly. However, modelers can predict the reduction in harassments at any point due to land shadow for different pointing directions and use expected probability distribution of activity to calculate the average land shadow for operations in each range.

For the ranges, in each alternative, the land shadow is computed over a dense grid in each operations area. Figure F-24 shows the grid for the MIRC.

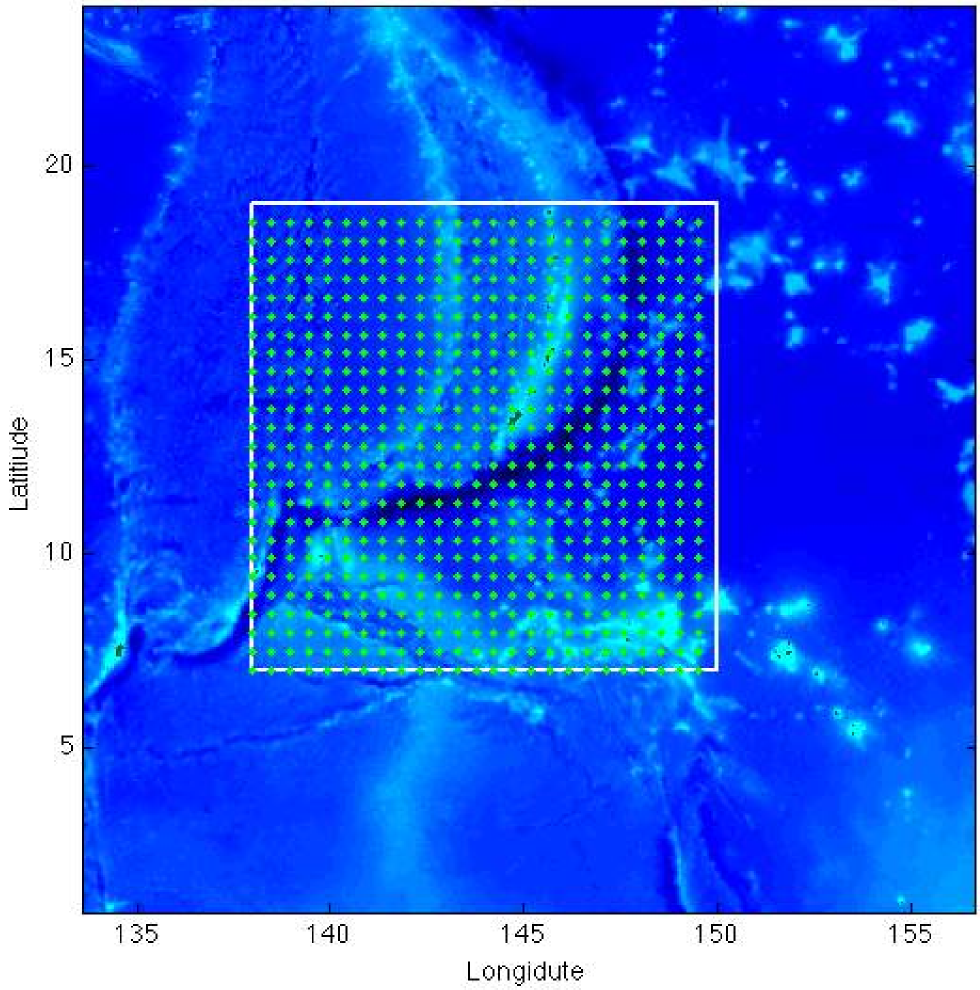


Figure F-24: Illustrative Grid for MIRC Study Area. Each green point represents approximately 100 points on the actual grid used for land shadow calculation, which samples every km.

For each of the coastal points that are within 150 km of the grid, the azimuth and distance is computed. In the computation, only the minimum range at each azimuth is computed. Figure F-25 shows the minimum range compared with azimuth for the sample point.

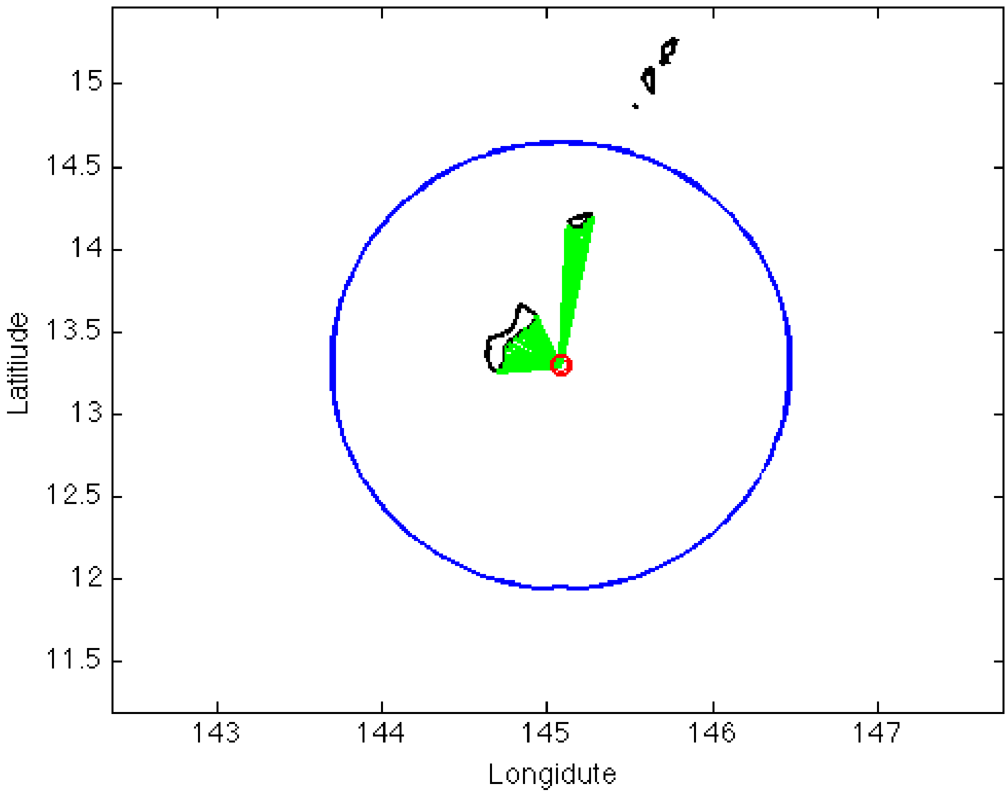


Figure F-25: The nearest point at each azimuth (with 1^o spacing) to a sample grid point (red circle) is shown by the green lines.

Now, the average of the distances to shore, along with the angular profile of land is computed (by summing the unique azimuths that intersect the coast) for each grid point. The values are then used to compute the land shadow for the grid points.

Computing the Land Shadow Effect at Each Grid Point

The effect of land shadow is computed by determining the levels, and thus the distances from the sources, that the harassments occur. Table F-13 gives a mathematical extrapolation of the distances and levels at which harassments occur, with average propagation in the MIRC. Figure F-26 provides the percentage of behavioral harassments for every 5-degree band of received level from the 53C/D sonar.

Table F-13: Behavioral Harassments at each Received Level Band from 53C

Received Level (dB SPL)	Distance at which Levels Occur in MIRC	Percent of Behavioral Harassments Occurring at Given Levels
Below 150	15 km - 150 km	< 2%
150>Level>160	6 km – 15 km	18%
160>Level>170	2 km – 6 km	41%
170>Level>180	0.5 km – 2 km	27%
180>Level>190	170 m – 500 m	10%
Above 190 dB	0 m – 170 m	<3%

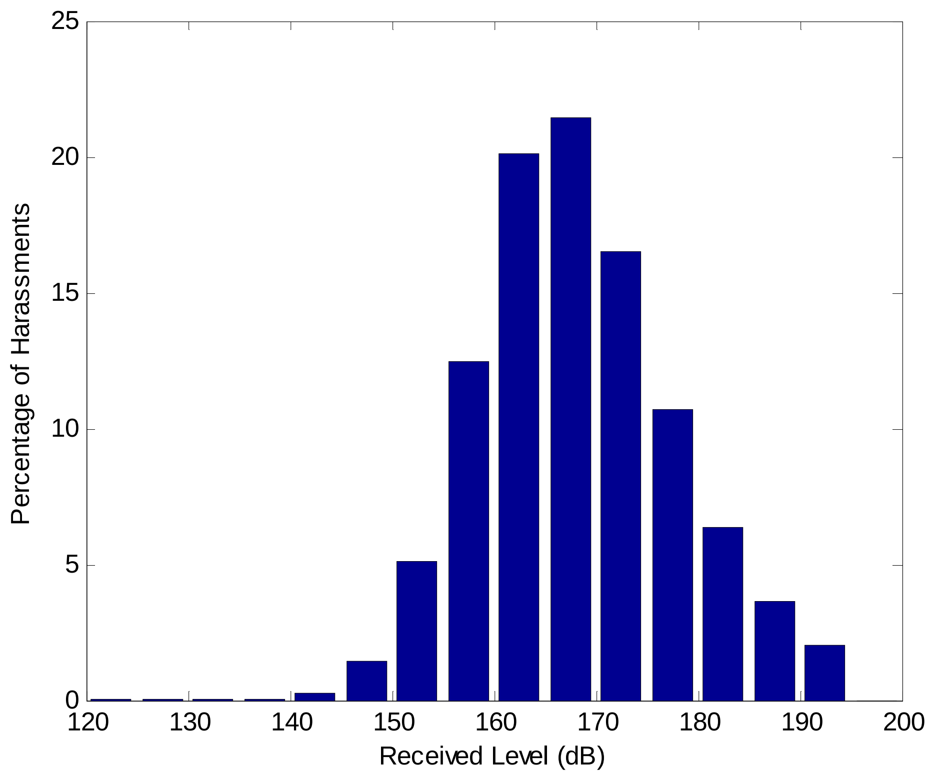


Figure F-26: The approximate percentage of behavioral harassments for every 5 degree band of received level from the 53C

With the data used to produce the previous figure, the average effect reduction across season for a sound path blocked by land can be calculated. For the 53C, since approximately 94 percent of harassments occur within 10 kilometers of the source, a sound path blocked by land at 10 kilometers will, on average, cause approximately 94 percent the effect of an unblocked path, as shown in Figure F-27.

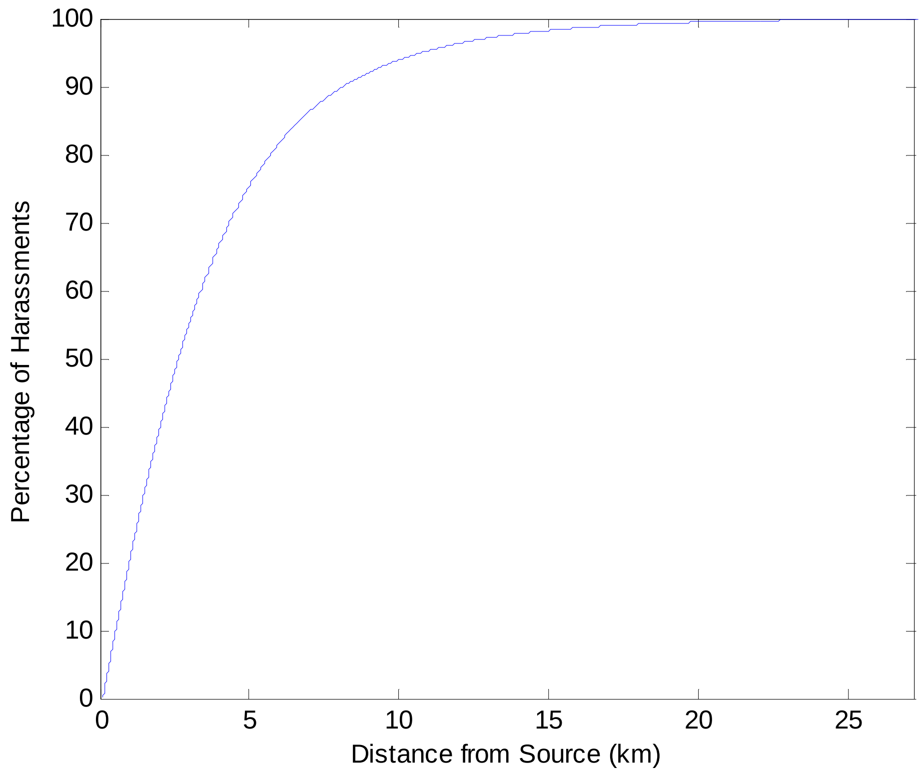


Figure F-27: Average Percentage of Harassments Occurring Within a Given Distance

As described above, the mapping process determines the angular profile of and distance to the coastline(s) from each grid point. The distance, then, determines the reduction due to land shadow when the sonar is pointed in that direction. The angular profile, then, determines the probability that the sonar is pointed at the coast.

Define θ_n = angular profile of coastline at point n in radians

Define r_n = mean distance to shoreline

Define A(r) = average effect adjustment factor for sound blocked at distance r

The land shadow at point n can be approximated by $A(r_n)\theta_n/(2\pi)$. For illustration, the following plots give the land shadow reduction factor at each point in each range area for the 53C. The white portions of the plot indicate the areas outside the range and the blue lines indicate the coastline. The color plots inside the ranges give the land shadow factor at each point. The average land shadow factor for the 53C in the MIRC is 0.9997, or the reduction in effect is 0.03 percent. For the other, lower-power sources, this reduction is lower. The effect of land shadow in the MIRC is also negligible.

F.6.3.3 The Effect of Multiple Ships

Behavioral harassment, under risk function, uses maximum SPL over a 24-hour period as the metric for determining the probability of harassment. An animal that receives sound from two sonars, operating simultaneously, receives its maximum SPL from one of the ships. Thus, the effects of the louder, or closer, sonar determine the probability of harassment, and the more distant sonar does not. If the distant sonar operated by itself, it would create a lesser effect on the animal, but in the presence of a more dominating sound, its effects are cancelled. When two sources are sufficiently close together, their sound fields within the cutoff range will partially overlap and the larger of the two sound fields at each point in that overlap cancel the weaker. If the distance between sources is twice as large as the range to cutoff, there will be no overlap.

Computation of the overlap between sound fields requires the precise locations and number of the source ships. The general modeling scenarios of the MIRC do not have these parameters, so the effect was modeled using an average ship distance, 20 km, and an average number of ships per exercise. The number of ships per exercise varied based on the type of exercise, as given in Table F-14.

Table F-14: Average Number of 53C-Transmitting Ships in the MIRC Exercise Types

Action	Average Number of SQS-53C-Transmitting Ships
Multi-Strike Group	4
TRACKEX-TORPEX	1.5

The formation of ships in any of the above exercise has been determined by Navy planners. The ships are located in a straight line, perpendicular to the direction traveled. Figures F-28 and F-29 show examples with four ships, and their ship tracks.

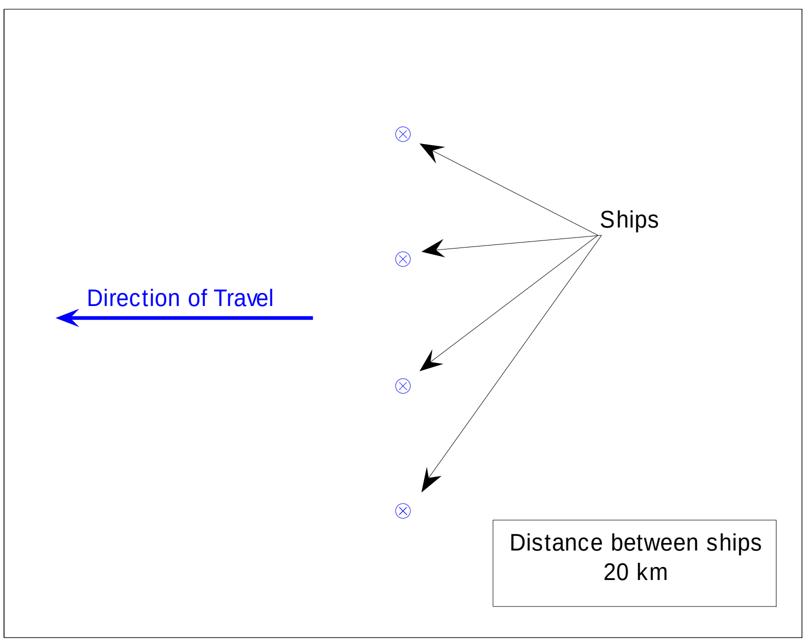


Figure F-28: Formation and Bearing of Ships in Four-Ship Example

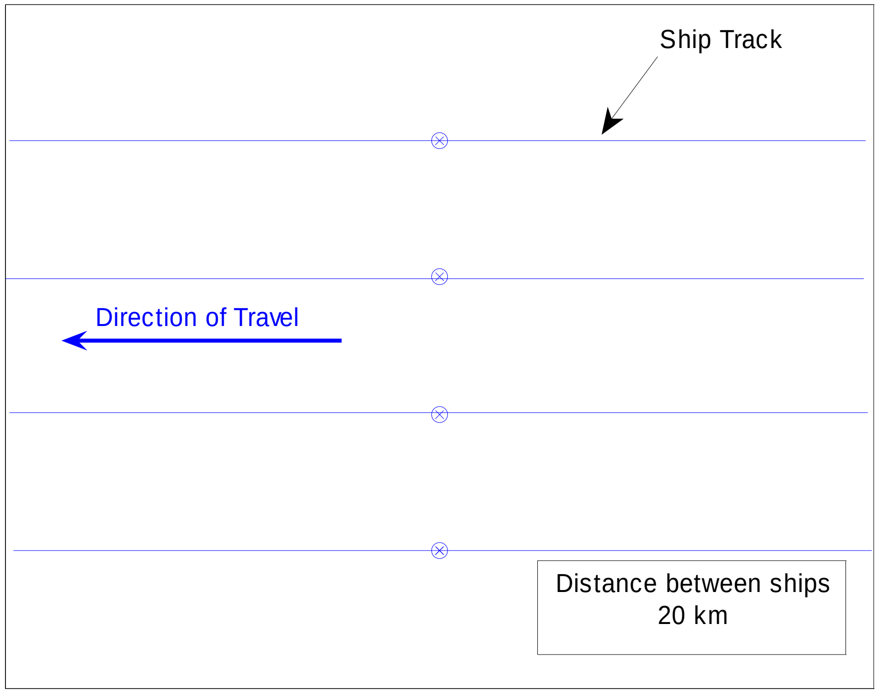


Figure F-29: Ship Tracks of Ships in 4-Ship Example

The sound field created by these ships, which transmit sonar continually as they travel will be uniform in the direction of travel (or the "x" direction), and vary by distance from the ship track in the direction perpendicular to the direction of travel (or the "y" direction) (Figure F-30).

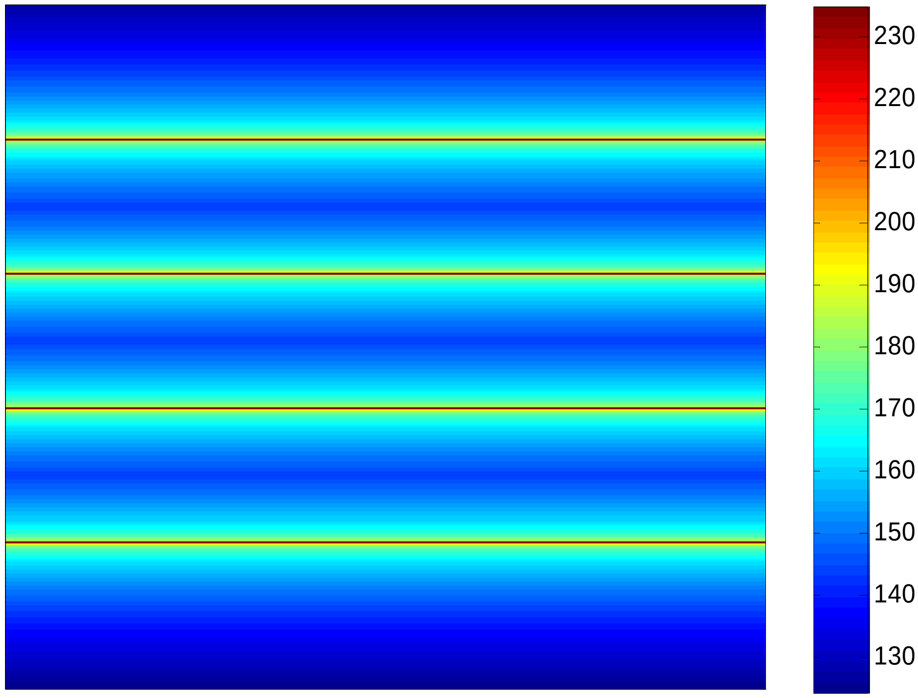


Figure F-30: Sound Field Produced by Multiple Ships

This sound field of the four ships operating together ensonifies less area than four ships operating individually. At the time of modeling, even the average number of ships and mean distances between them were unknown, so a post-calculation correction should be applied.

Referring to the above picture of the sound field around the ship tracks, the portion above the upper-most ship track, and the portion below the lower-most ship track sum to produce exactly the sound field as an individual ship.

Therefore, the remaining portion of the sound field, between the uppermost ship track and the lowermost ship track, is the contribution of the three additional ships (Figure F-31).

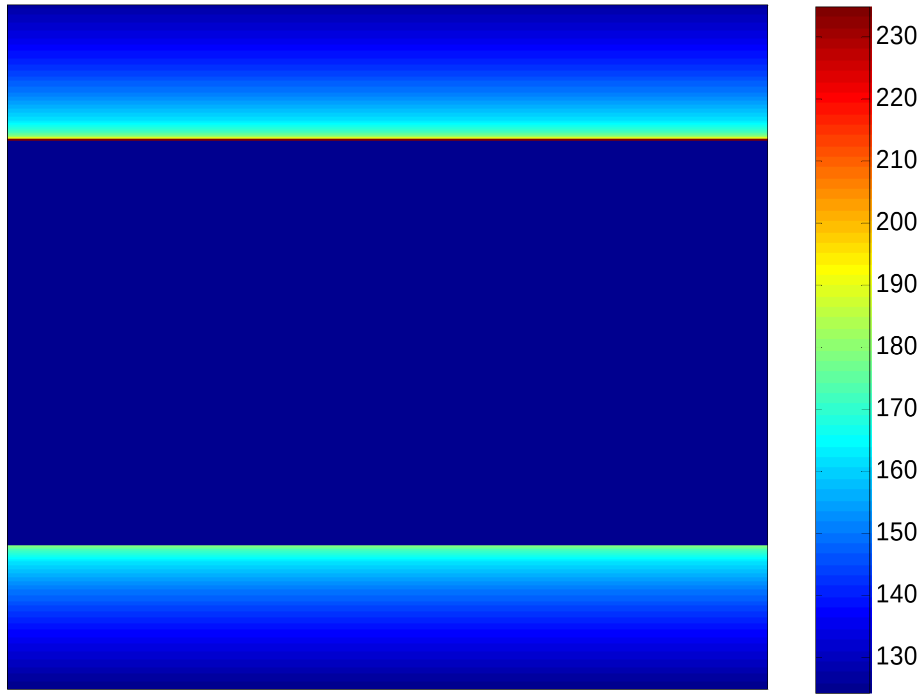


Figure F-31: Upper and Lower Portion of Sound Field

This remaining sound field is made up of three bands (Figure F-32). Each of the three additional ships contributes one band to the sound field. Each band is somewhat less than the contribution of the individual ship because its sound is overcome by the nearer source at the center of the band. Since each ship maintains 20 kilometer distance between it and the next, the height of these bands is 20 km, and the sound from each side projects 10 kilometers before it is overcome by the source on the other side of the band. Thus, the contribution to a sound field for an additional ship is identical to that produced by an individual ship whose sound path is obstructed at 10 kilometers. The work in the previous discussion on land shadow provides a calculation of effect reduction for obstructed sound at each range. An AQS-53C-transmitting ship with obstructed signal at 10 kilometers causes 94 percent of the number of harassments as a ship with an unobstructed signal. Therefore, each additional ship causes 0.94 times the harassments of the individual ship. Applying this factor to the exercise types, an adjustment from the results for a single ship can be applied to predict the effects of multiple ships (Table F-15).

Table F-15: Adjustment Factors for Multiple Ships in MIRC Exercise Types

Action	Average Number of SQS-53C-Transmitting Ships	Adjustment Factor from Individual Ship for Formation and Distance
Multi-Strike Group	4	3.82
TRACKEX-TORPEX	2	1.94

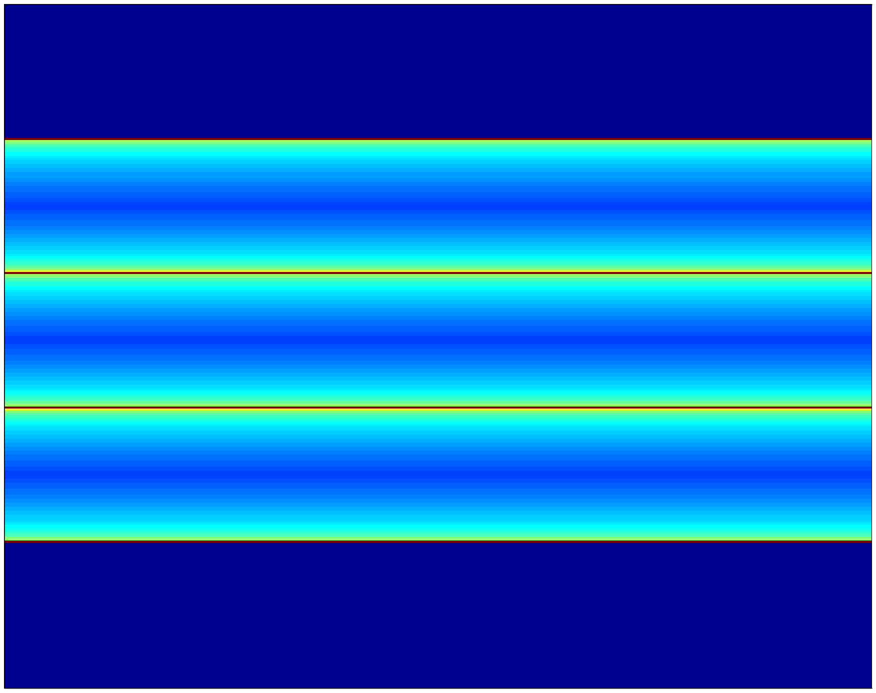


Figure F-32: Central Portion of Sound Field

F.7 References

Arons, A.B. (1954). “Underwater Explosion Shock Wave Parameters at Large Distances from the Charge,” J. Acoust. Soc. Am. 26, 343.

Bartberger, C.L. (1965). “Lecture Notes on Underwater Acoustics,” NADC Report NADC=WR-6509, Naval Air Development Center Technical Report, Johnsville, PA, 17 May (AD 468 869) (UNCLASSIFIED).

Christian, E.A. and J.B. Gaspin, (1974). Swimmer Safe Standoffs from Underwater Explosions,” NSAP Project PHP-11-73, Naval Ordnance Laboratory, Report NOLX-89, 1 July (UNCLASSIFIED).

Department of the Navy (1998), “Final Environmental Impact Statement, Shock Testing the SEAWOLF Submarine,” U.S. Department of the Navy, Southern Division, Naval Facilities Engineering Command, North Charleston, SC, 637 p.

Department of the Navy (2001), “Final Environmental Impact Statement, Shock Trial of the WINSTON S. CHURCHILL (DDG 81),” U.S. Department of the Navy, NAVSEA, 597 p.

Department of the Navy (DoN). (2008a). Department of the Navy, Commander, U.S. Navy Pacific Fleet, Final Environmental Impact Statement/Overseas Environmental Impact Statement, Hawaii Range Complex. May 2008.

Department of the Navy (DoN). (2008a). Department of the Navy, Commander, U.S. Navy Pacific Fleet, Final Environmental Impact Statement/Overseas Environmental Impact Statement, Southern California Range Complex. December 2008.

Goertner, J.F. (1982). “Prediction of Underwater Explosion Save Ranges for Sea Mammals,” Naval Surface Warfare Center (NSWC) Report NSCW TR 82-188, NSWC, Dahlgren, VA (UNCLASSIFIED).

Goertner, J.F. (1982), “Prediction of Underwater Explosion Safe Ranges for Sea Mammals,” NSWC TR 82-188, Naval Surface Weapons Center, Dahlgren, VA.

Keenan, R.E., Denise Brown, Emily McCarthy, Henry Weinberg, and Frank Aidala (2000). “Software Design Description for the Comprehensive Acoustic System Simulation (CASS Version 3.0) with the Gaussian Ray Bundle Model (GRAB Version 2.0)”, NUWC-NPT Technical Document 11,231, Naval Undersea Warfare Center Division, Newport, RI, 1 June (UNCLASSIFIED).

McGrath, J.R. (1971). “Scaling Laws for Underwater Exploding Wires,” J. Acoust. Soc. Am. 50, 1030-1033 (UNCLASSIFIED).

NMFS. 2005. Incidental Harassment Authorization for taking and importing marine mammals; taking marine mammals Incidental to conducting the Precision Strike Weapon (PSW) testing and training by Eglin Air Force Base in the Gulf of Mexico. Federal Register. Vol. 70, No. 160: 48675-48691.

Urick, R.J. (1983). Principles of Underwater Sound for Engineers, McGraw-Hill, NY (first edition: 1967, second edition: 1975) (UNCLASSIFIED).

Weston, D.E. (1960). “Underwater Explosions as Acoustic Sources,” Proc. Phys. Soc. 76, 233 (UNCLASSIFIED).

APPENDIX G

MARINE MAMMAL DENSITY

This page intentionally left blank.

APPENDIX H

CETACEAN STRANDING REPORT

Description of marine mammal strandings and causes

This page intentionally left blank.

TABLE OF CONTENTS

CETACEAN STRANDING REPORT

H.1 WHAT IS A STRANDED MARINE MAMMAL?

When a live or dead marine mammal swims or floats onto shore and becomes “beached” or incapable of returning to sea, the event is termed a “stranding” (Geraci *et al.* 1999; Perrin and Geraci 2002; Geraci and Lounsbury 2005; NMFS 2007). The legal definition for a stranding within the United States is that “ (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance.” (16 United States Code [U.S.C.] 1421h).

The majority of animals that strand are dead or moribund (NMFS 2007). For those that are alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival.

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (NMFS 2007).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado 1991; Frantzis 1998; Walsh *et al.* 2001; Freitas 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell 1987, Walsh *et al.* 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci *et al.* 1999). All of these normally pelagic off-shore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier’s dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier’s beaked whales, California sea lions, and harbor seals (Mazzuca *et al.* 1999; Norman *et al.* 2004; Geraci and Lounsbury 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland 2001; Harwood 2002; Gulland 2006; NMFS 2007). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include (Hohn *et al.* 2006b):

(1) A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.

(2) A temporal change in morbidity, mortality, or strandings is occurring.

(3) A spatial change in morbidity, mortality, or strandings is occurring.

(4) The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.

(5) Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).

(6) Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.

(7) Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

Unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso 1996; Geraci *et al.* 1999; Walsh *et al.* 2001; Gulland and Hall 2005). Table H-1 provides an overview of documented UMEs attributable to natural causes over the past four decades worldwide.

Table H-1. Marine mammal unusual mortality events attributed to or suspected from natural causes 1978-2005.

Year	Species and number	Location	Cause
1978	Hawaiian monk seals (50)	NW Hawaiian Islands	Ciguatoxin and maitotoxin
1979-80	Harbor seals (400)	Massachusetts	Influenza A
1982	Harbor seals	Massachusetts	Influenza A
1983	Multiple pinniped species	West coast of US, Galapagos	El Nino
1984	California sea lions (226)	California	Leptospirosis
1987	Sea otters (34)	Alaska	Saxitoxin
1987	Humpback whales (14)	Massachusetts	Saxitoxin
1987-88	Bottlenose dolphins (645)	Eastern seaboard (New Jersey to Florida)	Morbillivirus; Brevetoxin
1987-88	Baikal seals (80-100,000)	Lake Baikal, Russia	Canine distemper virus
1988	Harbor seals (approx 18,000)	Northern Europe	Phocine distemper virus
1990	Striped dolphins (550)	Mediterranean Sea	Dolphin morbillivirus
1990	Bottlenose dolphins (146)	Gulf Coast, US	Unknown; unusual skin lesions observed

Year	Species and number	Location	Cause
1994	Bottlenose dolphins (72)	Texas	Morbillivirus
1995	California sea lions (222)	California	Leptospirosis
1996	Florida manatees (149)	West Coast Florida	Brevetoxin
1996	Bottlenose dolphins (30)	Mississippi	Unknown; Coincident with algal bloom
1997	Mediterranean monk seals (150)	Western Sahara, Africa	Harmful algal bloom; Morbillivirus
1997-98	California sea lions (100s)	California	El Nino
1998	California sea lions (70)	California	Domoic acid
1998	Hooker's sea lions (60% of pups)	New Zealand	Unknown, bacteria likely
1999	Harbor porpoises	Maine to North Carolina	Oceanographic factors suggested
2000	Caspian seals (10,000)	Caspian Sea	Canine distemper virus
1999-2000	Bottlenose dolphins (115)	Panhandle of Florida	Brevetoxin
1999-2001	Gray whales (651)	Canada, US West Coast, Mexico	Unknown; starvation involved
2000	California sea lions (178)	California	Leptospirosis
2000	California sea lions (184)	California	Domoic acid
2000	Harbor seals (26)	California	Unknown; Viral pneumonia suspected
2001	Bottlenose dolphins (35)	Florida	Unknown
2001	Harp seals (453)	Maine to Massachusetts	Unknown
2001	Hawaiian monk seals (11)	NW Hawaiian Islands	Malnutrition
2002	Harbor seals (approx. 25,000)	Northern Europe	Phocine distemper virus
2002	Multispecies (common dolphins, California sea lions, sea otters) (approx. 500)	California	Domoic acid
2002	Hooker's sea lions	New Zealand	Pneumonia
2002	Florida manatee	West Coast of Florida	Brevetoxin
2003	Multispecies (common dolphins, California sea lions, sea otters) (approx. 500)	California	Domoic acid
2003	Beluga whales (20)	Alaska	Ecological factors
2003	Sea otters	California	Ecological factors
2003	Large whales (16 humpback, 1 fine, 1 minke, 1 pilot, 2 unknown)	Maine	Unknown; Saxitoxin and domoic acid detected in 2 of 3 humpbacks
2003-2004	Harbor seals, minke whales	Gulf of Maine	Unknown
2003	Florida manatees (96)	West Coast of Florida	Brevetoxin
2004	Bottlenose dolphins (107)	Florida Panhandle	Brevetoxin
2004	Small cetaceans (67)	Virginia	Unknown
2004	Small cetaceans	North Carolina	Unknown
2004	California sea lions (405)	Canada, US West Coast	Leptospirosis

Year	Species and number	Location	Cause
2005	Florida manatees, bottlenose dolphins (ongoing Dec 2005)	West Coast of Florida	Brevetoxin
2005	Harbor porpoises	North Carolina	Unknown
2005	California sea lions; Northern fur seals	California	Domoic acid
2005	Large whales	Eastern North Atlantic	Domoic acid suspected
2005-2006	Bottlenose dolphins	Florida	Brevetoxin suspected

Note: Data from Gulland and Hall (2007): citations for each event contained in Gulland and Hall (2007).

H.2 UNITED STATES STRANDING RESPONSE ORGANIZATION

Stranding events provide scientists and resource manager's information not available from limited at-sea surveys, and may be the only way to learn key biological information about certain species such as distribution, seasonal occurrence, and health (Rankin 1953; Moore *et al.* 2004; Geraci and Lounsbury 2005). Necropsies are useful in attempting to determine a reason for the stranding, and are performed on stranded animals when the situation and resources allow.

In 1992, Congress passed the Marine Mammal Health and Stranding Response Act (MMHSRA) which authorized the Marine Mammal Health and Stranding Response Program (MMHSRP) under authority of the Department of Commerce, National Marine Fisheries Service. The MMHSRP was created because of public concern over marine mammal mortalities. Its objectives are twofold: to formalize the response process and to focus efforts being initiated by numerous local stranding organizations.

Major elements of the MMHSRP include the following (NMFS 2007):

- National Marine Mammal Stranding Network
- Marine Mammal UME Program
- National Marine Mammal Tissue Bank (NMMTB) and Quality Assurance Program
- Marine Mammal Health Biomonitoring, Research, and Development
- Marine Mammal Disentanglement Network
- John H. Prescott Marine Mammal Rescue Assistance Grant Program (a.k.a. the Prescott Grant Program)
- Information Management and Dissemination.

The United States has a well-organized network in coastal states to respond to marine mammal strandings. Overseen by the NMFS, the National Marine Mammal Stranding Network is comprised of smaller organizations manned by professionals and volunteers from nonprofit organizations, aquaria, universities, and state and local governments trained in stranding response. Currently, more than 400 organizations are authorized by NMFS to respond to marine mammal strandings (NMFS 2007).

The following is a list of NMFS Regions and Associated States and Territories:

- NMFS Northeast Region- ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA
- NMFS Southeast Region- NC, SC, GA, FL, AL, MS, LA, TX, PR, VI
- NMFS Southwest Region- CA
- NMFS Northwest Region- OR, WA
- NMFS Alaska Region- AK
- NMFS Pacific Islands Region- HI, Guam, American Samoa, Commonwealth of the Northern Mariana Islands (CNMI)

Stranding reporting and response efforts over time have been inconsistent, although effort and data quality within the United States have been improving within the last 20 years (NMFS 2007). Given the historical inconsistency in response and reporting, however, interpretation of long-term trends in marine mammal stranding is difficult (NMFS 2007). During the past decade (1995 to 2004), approximately 40,000 stranded marine mammals (about 12,400 were cetaceans) have been reported by the regional stranding networks, averaging 3,600 reported strandings per year (Figure H-1; NMFS 2007). The highest number of strandings was reported between the years 1998 and 2003. Detailed regional stranding information including most commonly stranded species can be found in Zimmerman (1991), Geraci and Lounsbury (2005), and NMFS (2007).

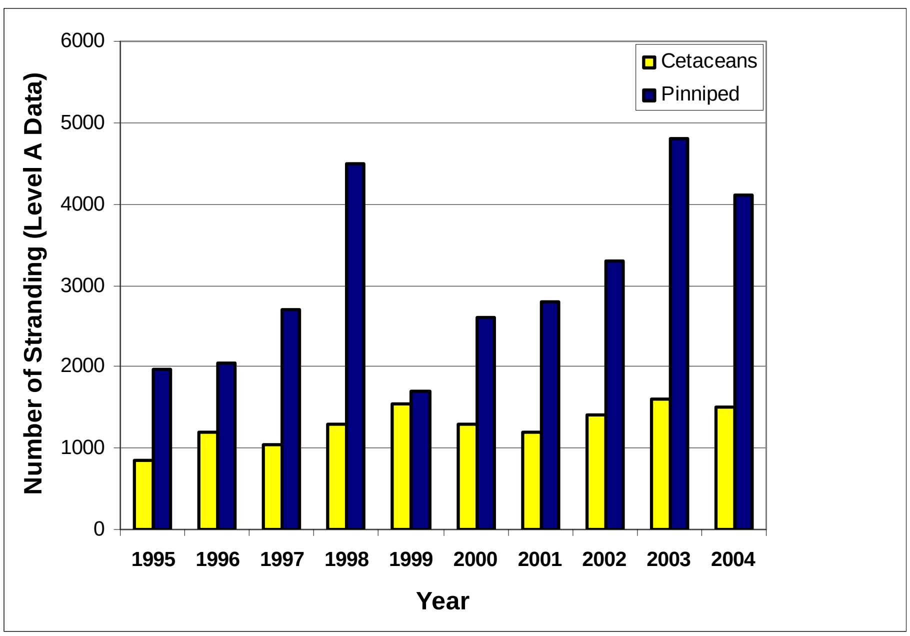


Figure H-1. United States annual cetacean and pinniped stranding events from 1995-2004.
(Source: NMFS 2007)

H.3 THREATS TO MARINE MAMMALS AND POTENTIAL CAUSES FOR STRANDING

Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci *et al.* 1999; Carretta *et al.* 2007). Strandings may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci *et al.* 1999; Culik 2002; Perrin and Geraci 2002; Hoelzel 2003; Geraci and Lounsbury 2005; NRC 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that is responsible for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding. Specific threats and potential stranding causes may include the following:

- Natural causes
    - Disease
    - Natural toxins
    - Weather and climatic influences
    - Navigation errors
    - Social cohesion
    - Predation
- Anthropogenic (human influenced) causes
    - Fisheries interaction
    - Vessel strike
    - Pollution and ingestion
    - Noise

H.4 NATURAL THREATS/STRANDING CAUSES

H.4.1 Overview

Significant natural causes of mortality, die-offs, and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Other natural mortality not discussed in detail includes predation by other species such as sharks (Cockcroft *et al.* 1989; Heithaus 2001), killer whales (Constantine *et al.* 1998; Guinet *et al.* 2000; Pitman *et al.* 2001), and some species of pinniped (Hiruki *et al.* 1999; Robinson *et al.* 1999).

H.4.2 Disease

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, and fungal origin (Visser *et al.* 1991; Dunn *et al.* 2001; Harwood, 2002). Gulland and Hall (2005, 2007) provide a more detailed summary of individual and population effects of marine mammal diseases.

Microparasites such as bacteria, viruses, and other microorganisms are commonly found in marine mammal habitats and usually pose little threat to a healthy animal (Geraci *et al.* 1999).

For example, long-finned pilot whales that inhabit the waters off of the northeastern coast of the United States are carriers of the morbillivirus, yet have grown resistant to its usually lethal effects (Geraci *et al.* 1999). Since the 1980s, however, virus infections have been strongly associated with marine mammal die-offs (Domingo *et al.* 1992; Geraci and Lounsbury 2005). Morbillivirus is the most significant identified marine mammal virus and suppresses a host's immune system and increases risk of secondary infection (Harwood 2002). The largest bottlenose dolphin die-off associated with morbillivirus occurred in 1987, when hundreds of coastal dolphins succumbed to the virus (Lipscomb *et al.* 1994). A bottlenose dolphin UME in 1993 and 1994 was caused by morbillivirus. Die-offs ranged from northwestern Florida to Texas, with an increased number of deaths as it spread (NMFS 2007). A 2004 UME in Florida was also associated with dolphin morbillivirus (NMFS 2004). Influenza A was responsible for the first reported mass mortality in the U.S., occurring along the coast of New England in 1979-1980 (Geraci *et al.* 1999; Harwood, 2002). Canine distemper virus has been responsible for large scale pinniped mortalities and die-offs (Grachev *et al.* 1989; Kennedy *et al.* 2000; Gulland and Hall 2005), while a bacteria, *Leptospira pomona*, is responsible for periodic die-offs in California sea lions about every four years (Gulland *et al.* 1996; Gulland and Hall 2005). It is difficult to determine whether microparasites commonly act as a primary pathogen, or whether they show up as a secondary infection in an already weakened animal (Geraci *et al.* 1999). Most marine mammal die-offs from infectious disease in the last 25 years, however, have had viruses associated with them (Simmonds and Mayer 1997; Geraci *et al.* 1999; Harwood 2002).

Macroparasites are usually large parasitic organisms and include lungworms, trematodes (parasitic flatworms), and protozoans (Geraci and St.Aubin 1987; Geraci *et al.* 1999). Marine mammals can carry many different types, and have shown a robust tolerance for sizeable infestation unless compromised by illness, injury, or starvation (Morimitsu *et al.* 1987; Dailey *et al.* 1991; Geraci *et al.* 1999). *Nasitrema spp.*, a usually benign trematode found in the head sinuses of cetaceans (Geraci *et al.* 1999), can cause brain damage if it migrates (Ridgway and Dailey 1972). As a result, this worm is one of the few directly linked to stranding in the cetaceans (Dailey and Walker 1978; Geraci *et al.* 1999).

Non-infectious disease, such as congenital bone pathology of the vertebral column (osteomyelitis, spondylosis deformans, and ankylosing spondylitis), has been described in several species of cetacean (Paterson 1984; Alexander *et al.* 1989; Kompanje 1995; Sweeny *et al.* 2005). In humans, bone pathology such as ankylosing spondylitis, can impair mobility and increase vulnerability to further spinal trauma (Resnick and Niwayama 2002). Bone pathology has been found in cases of single strandings (Paterson 1984; Kompanje 1995), and also in cetaceans prone to mass stranding (Sweeny *et al.* 2005), possibly acting as a contributing or causal influence in both types of events.

H.4.3 Naturally Occurring Marine Neurotoxins

Some single cell marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can accumulate (termed bioaccumulation) in the flesh and organs of fish and invertebrates (Geraci *et al.* 1999; Harwood 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins (Van Dolah 2005). Figure H-2 shows U.S. animal mortalities from 1997-2006 resulting from toxins produced during harmful algal blooms.

In the Gulf of Mexico and mid- to southern Atlantic states, "red tides," a form of harmful algal bloom, are created by a dinoflagellate (*Karenia brevis*). *K. brevis* is found throughout the Gulf of Mexico and sometimes along the Atlantic coast (Van Dolah 2005; NMFS 2007). It produces a neurotoxin known as brevetoxin. Brevetoxin has been associated with several marine mammal UMEs within this area (Geraci 1989; Van Dolah *et al.* 2003; NMFS 2004; Flewelling *et al.*, 2005; Van Dolah, 2005; NMFS, 2007). On the U.S. West Coast and in the northeast Atlantic, several species of diatoms produce a toxin called domoic acid which has also been linked to marine mammal strandings (Geraci *et al.* 1999; Van Dolah *et al.* 2003; Greig *et al.* 2005; Van Dolah 2005; Brodie *et al.* 2006; NMF 2007). Other algal toxins associated with marine mammal strandings include saxitoxins and ciguatoxins and are summarized by Van Dolah (2005).

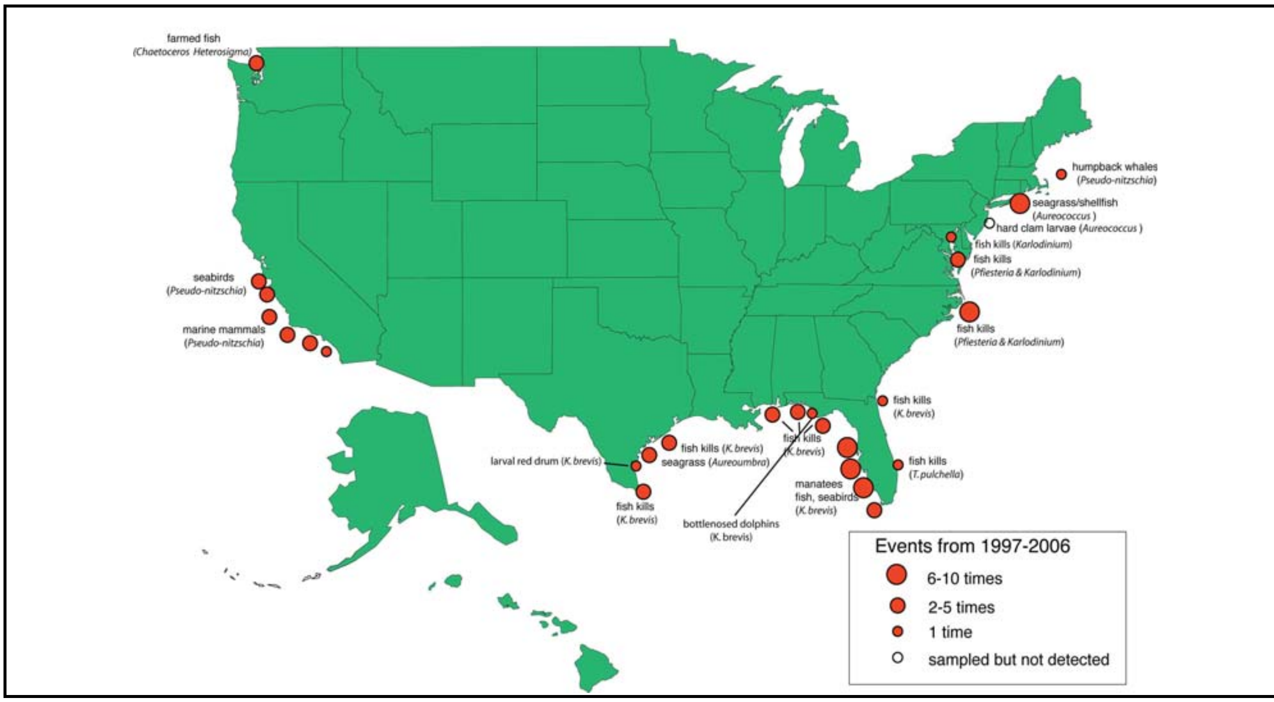


Figure H-2. Animal Mortalities from harmful algal blooms within the United States from 1997-2006.
(Source: Woods Hole Oceanographic Institute (WHO) http://www.whoi.edu/redtide/HABdistribution/HABmap.html)

H.4.4 Weather events and climate influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to localized marine mammal strandings (Geraci *et al.* 1999; Walsh *et al.* 2001). Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni *et al.* 2000; Norman and Mead 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter 1991). Ice movement along southern Newfoundland has forced groups of blue whales and white-beaked dolphins ashore (Sergeant 1982). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker *et al.* 2005).

The effect of large scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings is difficult to quantify given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth *et al.* 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker *et al.* 2006) and potential starvation if foraging is not successful. Stranding may follow either as a direct result of starvation or as an indirect result of a weakened and stressed state (e.g., succumbing to disease) (Selzer and Payne 1988; Geraci *et al.* 1999; Moore 2005; Learmonth *et al.* 2006; Weise *et al.* 2006).

Two recent papers examined potential influences of climate fluctuation on stranding events in southern Australia, including Tasmania, an area with a history of more than 20 mass strandings since the 1920s (Evans *et al.* 2005; Bradshaw *et al.* 2006). These authors note that patterns in animal migration, survival, fecundity, population size, and strandings will revolve around the availability and distribution of food resources. In southern Australia, movement of nutrient-rich waters pushed closer to shore by periodic meridional winds (occurring about every 12 to 14 years) may be responsible for bringing marine mammals closer to land, thus increasing the probability of stranding (Bradshaw *et al.* 2006). The papers conclude, however, that while an overarching model can be helpful for providing insight into the prediction of strandings, the particular reasons for each one are likely to be quite varied.

H.4.5 Navigational Error

Geomagnetism- It has been hypothesized that, like some land animals, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and that areas of local magnetic anomalies may influence strandings (Bauer *et al.* 1985; Klinowska 1985; Kirschvink *et al.* 1986; Klinowska 1986; Walker *et al.* 1992; Wartzok and Ketten 1999). In a plot of live stranding positions in Great Britain with magnetic field maps, Klinowska (1985, 1986) observed an association between live stranding positions and magnetic field levels. In all cases, live strandings occurred at locations where magnetic minima, or lows in the magnetic fields, intersect the coastline. Kirschvink *et al.* (1986) plotted stranding locations on a map of magnetic data for the East Coast, and were able to develop associations between stranding sites and locations where magnetic minima intersected the coast. The authors concluded that there were highly significant tendencies for cetaceans to beach themselves near these magnetic minima and coastal intersections. The results supported the hypothesis that cetaceans may have a magnetic sensory system similar to other migratory animals, and that marine magnetic topography and patterns may influence long-distance movements (Kirschvink *et al.* 1986). Walker *et al.* (1992) examined fin whale swim patterns off the northeastern U.S. continental shelf, and reported that migrating animals aligned with lows in the gradient of magnetic intensity. While a similar pattern between magnetic features and marine mammal strandings at New Zealand stranding sites was not seen (Brabyn and Frew 1994), mass strandings in Hawaii typically were found to occur within a narrow range of magnetic anomalies (Mazzuca *et al.* 1999).

Echolocation Disruption in Shallow Water- Some researchers believe stranding may result from reductions in the effectiveness of echolocation within shallow water, especially with the pelagic species of odontocetes who may be less familiar with coastline (Dudok van Heel 1966; Chambers and James 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since it is common for live strandings to occur along beaches with shallow, sandy gradients (Brabyn and McLean 1992; Mazzuca *et al.* 1999; Maldini *et al.* 2005; Walker *et al.* 2005). A contributing factor to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter, etc.) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy within echolocation signals and reduce the perceptibility of returning echoes of interest.

H.4.6 Social cohesion

Many pelagic species such as sperm whales, pilot whales, melon-head whales, and false killer whales, and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci *et al.* 1999; Conner 2000; Perrin and Geraci 2002; NMFS 2007).

H.5 ANTHROPOGENIC THREATS/STRANDING CAUSES

H.5.1 Overview

With the exception of historic whaling in the 19th and early part of the 20th century, during the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci *et al.* 1999; NMFS 2007). These include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), vessel strikes (Laist *et al.* 2001), and gunshots. Figure H-3 shows potential worldwide risk to small-toothed cetaceans by source.

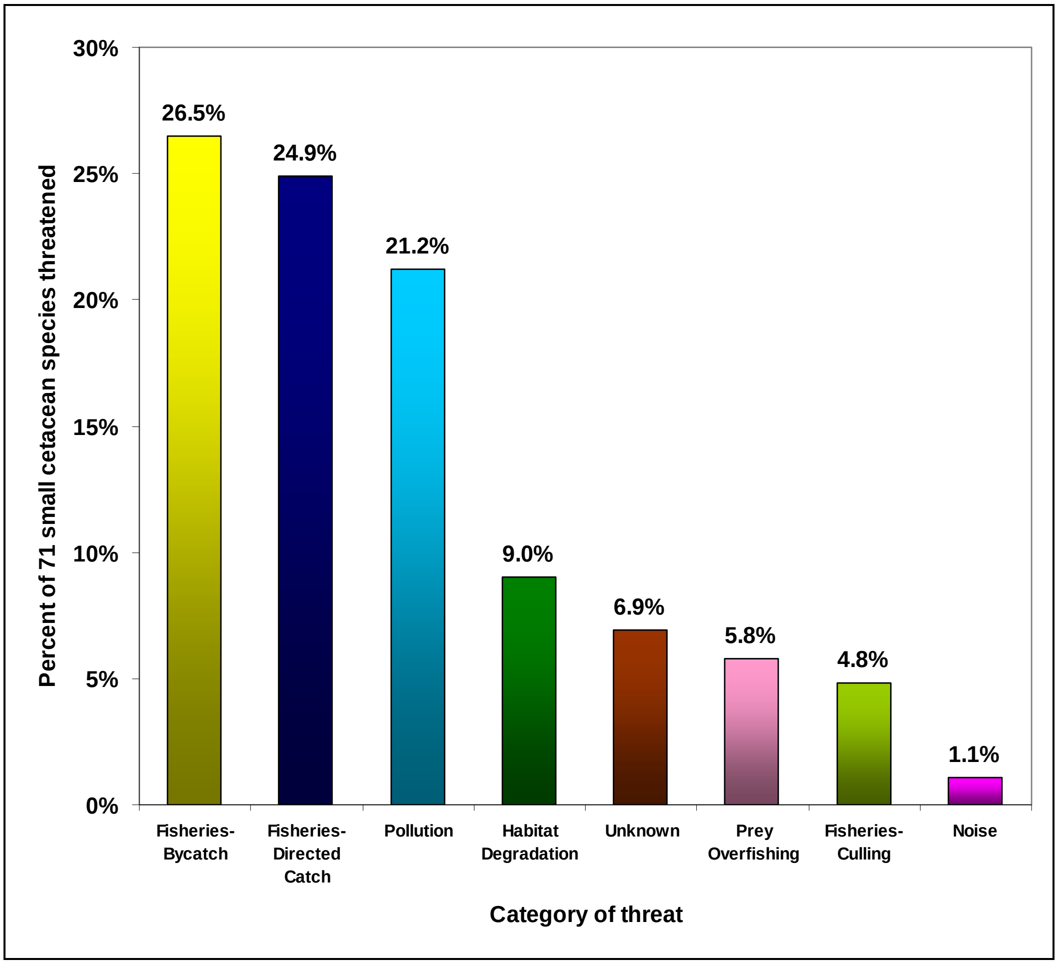


Figure H-3. Human threats to world wide small cetacean populations.
(Source: Culik 2002)

H.5.2 Fisheries Interaction: By-Catch and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci *et al.* 1999; Baird 2002; Culik 2002; Carretta *et al.* 2004; Geraci and Lounsbury 2005; NMFS 2007). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in their deaths worldwide (Geraci *et al.* 1999; Nieri *et al.* 1999; Geraci and Lounsbury 2005; Read *et al.* 2006; Zeeber *et al.* 2006).

By-catch- By-catch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (NRC 2006). Read *et al.* (2006) estimated the magnitude of marine mammal by-catch in U.S. and global fisheries. Data for the United States was obtained from fisheries observer programs, reports of entangled stranded animals, and fishery logbooks. In U.S. fisheries, the mean annual by-catch of marine mammals between 1990 and 1999 was 6,215 animals (SE = +/- 448). Eighty-four percent of cetacean by-catch occurred in gill-net fisheries, with dolphins and porpoises constituting the majority of these. The authors noted a 40 percent decline in marine mammal by-catching the years 1995 through 1999 compared to 1990 through 1994, and suggested that effective conservation measures implemented during the later time period played a significant role.

To estimate annual global by-catch, Read *et al.* (2006) used U.S. vessel by-catch data from 1990-1994 and extrapolated to the world's vessels for the same time period. They calculated an estimate of 653,365 of marine mammals caught annually around the world, again with most occurring in gill-net fisheries. The authors concluded that with global marine mammal by-catch likely to be in the hundreds of thousands every year, by-catch in fisheries will be the single greatest threat to many marine mammal populations around the world.

Entanglement- Active and discarded fishing gear pose a major threat to marine mammals. Entanglement can lead to drowning and/or impairment in activities such as diving, swimming, feeding and breeding. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear still attached to their bodies, and the cause of death for many stranded marine mammals is often attributed to such interactions (Baird and Gorgone 2005; Geraci *et al.* 1999; Campagna *et al.* 2007). Because marine mammals that die or are injured in fisheries may not wash ashore and not all animals that do wash ashore exhibit clear signs of interactions, stranding data probably underestimate fishery-related mortality and serious injury (NMFS 2005a).

Various accounts of fishery-related stranding deaths have been reported over the last several decades along the U.S. coast. From 1993 through 2003, 1,105 harbor porpoises were reported stranded from Maine to North Carolina, many of which had cuts and body damage suggestive of net entanglement (NMFS 2005d). In 1999, it was possible to determine that the cause of death for 38 of the stranded porpoises was from fishery interactions (NMFS 2005d). An estimated 78 baleen whales were killed annually in the offshore southern California/Oregon drift gillnet fishery during the 1980s (Heyning and Lewis 1990). From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the mainland U.S. West Coast (California Marine Mammal Stranding Network Database 2006).

H.5.3 Ship Strike

Marine mammals sometimes come into physical contact with oceangoing vessels, which can lead to injury or death and cause subsequent stranding (Laist *et al.* 2001; Geraci and Lounsbury 2005; de Stephanis and Urquiola 2006). These events, termed "ship strikes," occur when an animal at the surface is struck directly by a vessel, when a surfacing animal hits the bottom of a vessel, or when an animal just below the surface is cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus 2001; Laist *et al.* 2001; Vanderlaan and Taggart 2007).

The growth in civilian commercial ports has been accompanied by a large increase in commercial vessel traffic. This has, in turn, expanded the threat of ship strikes to marine mammals in recent decades. The Final Report of the NOAA International Symposium on “Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology” stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to over 85,000 vessels in 1998 (NRC 2003; Southall 2005). From 1985 to 1999, world seaborne trade doubled to 5 billion tons and currently includes 90 percent of the total world trade, with container shipping movements representing the largest volume of seaborne trade. Current statistics support the prediction that the international shipping fleet will continue to grow at current or greater rates. Vessel densities along existing coastal routes are expected to increase both domestically and internationally. New routes are expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall 2005). Given the expected increase in vessel density and operational capability, a concomitant increase in marine mammal ship strikes can be expected.

H.5.4 Ingestion of Marine Debris and Exposure to Toxins

Debris in the marine environment poses a health hazard for marine mammals. Not only can they become entangled, but animals may ingest plastics and other debris that are indigestible, and which can contribute to illness or death through irritation or blockage of the stomach and intestines (Tarpley and Marwitz 1993, Whitaker *et al.* 1994; Gorzelany 1998; Secchi and Zarzur 1999; Baird and Hooker 2000). There are certain species of cetaceans (e.g. sperm whales) that are more likely to eat trash, especially plastics (Geraci *et al.* 1999; Evans *et al.* 2003; Whitehead 2003).

For example, between 1990 and October 1998, 215 pygmy sperm whales stranded along the U.S. Atlantic coast from New York through the Florida Keys (NMFS 2005a). Remains of plastic bags and other debris were found in the stomachs of 13 of these animals. In 1987, a pair of latex examination gloves was retrieved from the stomach of a stranded dwarf sperm whale (NMFS 2005c). In one pygmy sperm whale found stranded in 2002, red plastic debris was found in the stomach along with squid beaks (NMFS 2005a). Oliveira de Meirelles and Barros (2007) documented mortality to a rough-toothed dolphin in Brazil from plastic debris ingestion.

Chemical contaminants like organochlorines (PCBs, DDT) and heavy metals may pose potential health risks to marine mammals (Das *et al.* 2003; De Guise *et al.* 2003).Despite having been banned for decades, levels of organochlorines are still high in marine mammal tissue samples taken along U.S. coasts (Hickie *et al.* 2007; Krahn *et al.* 2007; NMFS 2007a). These compounds are long-lasting, reside in marine mammal adipose tissues (especially in the blubber), and can be toxic. Contaminant levels in odontocetes (piscivorous animals) have been reported to be one to two orders of magnitude higher compared to mysticetes (planktivorous animals) (Borell 1993; O’Shea and Brownell 1994; O’Hara and Rice 1996; O’Hara *et al.* 1999).

Chronic exposure to PCBs and/or DDT is immunosuppressive, as has been seen in bottlenose dolphins (Lahvis *et al.* 1995) and seals (p. vitulina) (Ross *et al.* 1996). Chronic exposure has been linked to infectious disease mortality in harbor porpoises stranded in the UK (Jepson *et al.* 1999; Jepson *et al.* 2005), carcinoma in California in sea lions (Ylitalo *et al.* 2005), and population reductions of Baltic seals (Bergman *et al.* 2001). High levels of PCBs in immature, pelagic dolphins has been observed (Struntz *et al.* 2004), raising concern about contaminant loads further offshore. Moderate levels of PCBs and chlorinated pesticides (such as DDT, DDE, and dieldrin) have been found in pilot whale blubber with bioaccumulation levels more similar in whales from the same stranding event than from animals of the same age or sex (NMFS 2005b). Accumulation of heavy metals has also been documented in many cetaceans (Frodello and Marchand 2001; Das *et al.* 2003; Wittnich *et al.* 2004), sometimes exceeding levels known to cause neurologic and immune system impairment in other mammals (Nielsen *et al.* 2000; Das *et al.* 2003; De Guise *et al.* 2003).

Other forms of habitat contamination and degradation may also play a role in marine mammal mortality and strandings. Some events caused by humans have direct and obvious effects on marine mammals, such as oil spills (Geraci *et al.* 1999). Oil spills can cause both short- and long-term medical problems for many marine mammal species through ingestion of tainted prey, coating of skin/fur, and adherence to oral and nasal cavities (Moeller 2003). In most cases, the effects of contamination are likely to be indirect in nature; e.g. effects on prey species availability or an increase in disease susceptibility (Geraci *et al.* 1999).

H.5.5 Anthropogenic Sound

There is evidence that underwater man-made sounds, such as explosions, drilling, construction, and certain types of sonar (Southall *et al.* 2006), may be a contributing factor in some stranding events. Marine mammals may respond both behaviorally and physiologically to anthropogenic sound exposure, (e.g., Richardson *et al.* 1995; Finneran *et al.* 2000; Finneran *et al.* 2003; Finneran *et al.* 2005); however, the range and magnitude of the behavioral response of marine mammals to various sound sources is highly variable (Richardson *et al.* 1995) and appears to depend on the species involved, the experience of the animal with the sound source, the motivation of the animal (e.g., feeding, mating), and the context of the exposure.

Exposure to sonar signals has been postulated as being a specific cause of several stranding events. Given that it is likely that the frequency of certain sonar systems is within the range of hearing of many marine mammals, the consideration of sonar as a causative mechanism of stranding is warranted. In the following sections, specific stranding events that have been putatively linked to sonar operations are discussed.

H.6 STRANDING EVENT CASE STUDIES

Over the past two decades, several mass stranding events involving beaked whales have been documented. A review of historical data (mostly anecdotal) maintained by the Marine Mammal Program in the National Museum of Natural History, Smithsonian Institution reports 49 beaked whale mass stranding events between 1838 and 1999. The largest beaked whale mass stranding occurred in the 1870s in New Zealand when 28 Gray’s beaked whales (*Mesoplodon grayi*) stranded. Blainsville’s beaked whale (*Mesoplodon densirostris*) strandings are rare, and records show that they were involved in one mass stranding in 1989 in the Canary Islands. Cuvier's beaked whales (*Ziphius cavirostris*) are the most frequently reported beaked whale to strand, with at least 19 stranding events from 1804 through 2000 (DoC and DoN 2001; Smithsonian Institution 2000). While beaked whale strandings have occurred since the 1800s (Geraci and Lounsbury 1993; Cox *et al.* 2006; Podesta *et al.* 2006), several mass strandings have been temporally and spatially associated with naval operations utilizing mid-frequency active (MFA) sonar (Simmonds and Lopez-Jurado 1991; Frantzis 1998; Jepson *et al.* 2003; Cox *et al.* 2006).

H.6.1 Beaked Whale Case Studies

In the following sections, specific stranding events that have been putatively linked to potential sonar operations are discussed. These events represent a small overall number of animals over an 11 year period (40 animals) and not all worldwide beaked whale strandings can be linked to naval activity (ICES 2005a,b; Podesta *et al.* 2006). Four of the five events occurred during NATO exercises or events where DON presence was limited (Greece, Portugal, and Spain). One of the five events involved only DON ships (Bahamas). These events are given specific consideration in the case studies that follow.

Beaked whale stranding events associated with naval operations.

1996	May	Greece (NATO/US)
2000	March	Bahamas (US)
2000	May	Portugal, Madeira Islands (NATO/US)
2002	September	Spain, Canary Islands (NATO/US)
2006	January	Spain, Mediterranean Sea coast (NATO/US)

1996 Greece Beaked Whale Mass Stranding (May 12 – 13, 1996)

Description: Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along a 38.2-km (20.6-NM) strand of the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1 µPa, respectively (D'Amico and Verboom 1998; D'Spain *et al.* 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis 1998).

Findings: Partial necropsies of eight of the animals were performed, including external assessments and the sampling of stomach contents. No abnormalities attributable to acoustic exposure were observed, but the stomach contents indicated that the whales were feeding on cephalods soon before the stranding event. No unusual environmental events before or during the stranding event could be identified (Frantzis 1998).

Conclusions: The timing and spatial characteristics of this stranding event were atypical of stranding in Cuvier's beaked whale, particularly in this region of the world. No natural phenomenon that might contribute to the stranding event coincided in time with the mass stranding. Because of the rarity of mass strandings in the Greek Ionian Sea, the probability that the sonar tests and stranding coincided in time and location, while being independent of each other, was estimated as being extremely low (Frantzis 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.

2000 Bahamas Marine Mammal Mass Stranding (March 15-16, 2000)

Description: Seventeen marine mammals comprised of nine Cuvier's beaked whales, three Blainville's beaked whales (*Mesoplodon densirostris*), two unidentified beaked whales, two minke whales (*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*), stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15-16, 2000 (Evans and England 2001). The strandings occurred over a 36-hour period and coincided with DON use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively.

Seven of the animals that stranded died, while ten animals were returned to the water alive. The animals known to have died included five Cuvier's beaked whales, one Blainville's beaked whale, and the single spotted dolphin. Six necropsies were performed and three of the six necropsied whales (one Cuvier's beaked whale, one Blainville's beaked whale, and the spotted dolphin) were fresh enough to permit identification of pathologies by computerized tomography (CT). Tissues from the remaining three animals were in a state of advanced decomposition at the time of inspection.

Findings: All five necropsied beaked whales were in good body condition and did not show any signs of external trauma or disease. In the two best preserved whale specimens, hemorrhage was associated with the brain and hearing structures. Specifically, subarachnoid hemorrhage within the temporal region of the brain and intracochlear hemorrhages were noted. Similar findings of bloody effusions around the ears of two other moderately decomposed whales were consistent with the same observations in the freshest animals. In addition, three of the whales had small hemorrhages in their acoustic fats, which are fat bodies used in sound production and reception (i.e., fats of the lower jaw and the melon). The best-preserved whale demonstrated acute hemorrhage within the kidney, inflammation of the lung and lymph nodes, and congestion and mild hemorrhage in multiple other organs.

Other findings were consistent with stresses and injuries associated with the stranding process. These consisted of external scrapes, pulmonary edema and congestion. The spotted dolphin demonstrated poor body condition and evidence of a systemic debilitating disease. In addition, since the dolphin stranding site was isolated from the acoustic activities of Navy ships, it was determined that the dolphin stranding was unrelated to the presence of Navy active sonar.

Conclusions: The post-mortem analyses of stranded beaked whales led to the conclusion that the immediate cause of death resulted from overheating, cardiovascular collapse and stresses associated with being stranded on land. However, the presence of subarachnoid and intracochlear hemorrhages were believed to have occurred prior to stranding and were hypothesized as being related to an acoustic event. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined. The spotted dolphin was in overall poor condition for examination, but showed indications of long-term disease. No analysis of baleen whales (minke whale) was conducted.

2000 Madeira Island, Portugal Beaked Whale Strandings (May 10 – 14, 2000)

Description: Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10–14, 2000 (Cox *et al.* 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2–15, 2000. The timing and location of the exercises overlapped with that of the stranding incident.

Findings: Two of the three whales were necropsied. Two heads were taken to be examined. One head was intact and examined grossly and by CT; the other was only grossly examined because it was partially flensed and had been seared from an attempt to dispose of the whale by fire (Ketten 2005). No blunt trauma was observed in any of the whales. Consistent with prior CT scans of beaked whales stranded in the Bahamas 2000 incident, one whale demonstrated subarachnoid and peribullar hemorrhage and blood within one of the brain ventricles. Post-cranially, the freshest whale demonstrated renal congestion and hemorrhage, which was also consistent with findings in the freshest specimens in the Bahamas incident.

Conclusions: The pattern of injury to the brain and auditory system were similar to those observed in the Bahamas strandings, as were the kidney lesions and hemorrhage and congestion in the lungs (Ketten 2005). The similarities in pathology and stranding patterns between these two events suggested a similar causative mechanism. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.

2002 Canary Islands Beaked Whale Mass Stranding (24 September 2002)

Description: On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (Jepson *et al.* 2003). Seven of the 14 whales died on the beach and the 7 were returned to the ocean. Four beaked whales were found stranded dead over the next three days either on the coast or floating offshore (Fernández *et al.* 2005). At the time of the strandings, an international naval exercise called Neo-Tapon, involving numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández *et al.* 2005).

Findings: Eight Cuvier's beaked whales, one Blainville's beaked whale, and one Gervais' beaked whale were necropsied; six of them within 12 hours of stranding (Fernández *et al.* 2005). The stomachs of the whales contained fresh and undigested prey contents. No pathogenic bacteria were isolated from the whales, although parasites were found in the kidneys of all of the animals. The head and neck lymph nodes were congested and hemorrhages were noted in multiple tissues and organs, including the kidney, brain, ears, and jaws. Widespread fat emboli were found throughout the carcasses, but no evidence of blunt trauma was observed in the whales. In addition, the parenchyma of several organs contained macroscopic intravascular bubbles and lesions, putatively associated with nitrogen off-gassing.

Conclusions: The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages, and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson *et al.* 2003; Fernández *et al.* 2005). Whereas gas emboli would develop from the nitrogen gas, fat emboli would enter the blood stream from ruptured fat cells (presumably where nitrogen bubble formation occurs) or through the coalescence of lipid bodies within the blood stream.

The possibility that the gas and fat emboli found by Fernández *et al.* (2005) was due to nitrogen bubble formation has been hypothesized to be related to either direct activation of the bubble by sonar signals or to a behavioral response in which the beaked whales flee to the surface following sonar exposure. The first hypothesis is related to rectified diffusion (Crum and Mao 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard 1979). Deeper and longer dives of some marine mammals, such as those conducted by beaked whales, are theoretically predicted to induce greater levels of supersaturation (Houser *et al.* 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size. The second hypothesis speculates that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson *et al.* 2003; Fernández *et al.* 2005). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation.

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann 2004). Sound exposure levels predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated and are suspected as needing to be very high (Evans 2002; Crum *et al.* 2005). Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.* 2003), there is no conclusive evidence supporting this hypothesis and there is concern that at least some of the pathological findings (e.g., bubble emboli) are artifacts of the necropsy. Currently, stranding networks in the United States have created a set of necropsy guidelines to determine, in part, the possibility and frequency with which bubble emboli can be introduced into marine mammals during necropsy procedures (Arruda *et al.* 2007).

2006 Spain, Gulf of Vera Beaked Whale Mass Stranding (26-27 January 2006)

Description: The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered during the day on January 27, but had already died. A following report stated that the first three animals were located near the town of Mojacar and were examined by a team from the University of Las Palmas de Gran Canarias, with the help of the stranding network of Ecologistas en Acción Almería-PROMAR and others from the Spanish Cetacean Society. The fourth animal was found dead on the afternoon of May 27, a few kilometers north of the first three animals.

From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 93 km (50 NM) of the stranding site.

Findings: Veterinary pathologists necropsied the two male and two female beaked whales (*Z. cavirostris*).

Conclusions: According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas 2004):

- Operations were conducted in areas of at least 1,000 m (3,281 ft) in depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000 to 6,000 m (3,281 to 19,685 ft) occurring a cross a relatively short horizontal distance (Freitas 2004).

- Multiple ships, in this instance, five MFA sonar equipped vessels, were operating in the same area over extended periods of time (20 hours) in close proximity.

- Exercises took place in an area surrounded by landmasses, or in an embayment. Operations involving multiple ships employing mid-frequency active sonar near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas 2004).

H.7 OTHER GLOBAL STRANDING DISCUSSIONS

In the following sections, stranding events that have been putatively linked to DON activity in popular press are presented. As detailed in the individual case study conclusions, the DON believes that there is enough to evidence available to refute allegations of impacts from mid-frequency sonar.

Stranding Events Case Studies

2003 Washington State Harbor Porpoise Strandings (May 2 – June 2, 2003)

Description: At 10:40 a.m. on May 5, 2003, the USS Shoup began the use of mid-frequency tactical active sonar as part of a naval exercise. At 2:20 p.m., the USS Shoup entered the Haro Strait and terminated active sonar use at 2:38 p.m., thus limiting active sonar use within the strait to less than 20 minutes. Between May 2 and June 2, 2003, approximately 16 strandings involving 15 harbor porpoises (*Phocoena phocoena*) and one Dall's porpoise (*Phocoenoides dalli*) were reported to the Northwest Marine Mammal Stranding Network. A comprehensive review of all strandings and the events involving USS Shoup on May 5, 2003, were presented in DON (2004). Given that the USS Shoup was known to have operated sonar in the strait on May 5, and that supposed behavioral reactions of killer whales (*Orcinus orca*) had been putatively linked to these sonar operations (NMFS Office of Protected Resources 2005), NMFS undertook an analysis of whether sonar caused the strandings of the harbor porpoises.

Whole carcasses of ten of harbor porpoises and the head of an additional porpoise were collected for analysis. Necropsies were performed on ten of the harbor porpoises and six whole carcasses and two heads were selected for CT imaging. Gross examination, histopathology, age determination, blubber analysis, and various other analyses were conducted on each of the carcasses (Norman *et al.* 2004).

Findings: Post-mortem findings and analysis details are found in Norman *et al.* (2004). All of the carcasses suffered from some degree of freeze-thaw artifact that hampered gross and histological evaluations. At the time of necropsy, three of the porpoises were moderately fresh, whereas the remainder of the carcasses was considered to have moderate to advanced decomposition. None of the 11 harbor porpoises demonstrated signs of acoustic trauma. In contrast, a putative cause of death was determined for five of the porpoises; two animals had blunt trauma injuries and three animals had indication of disease processes (fibrous peritonitis, salmonellosis, and necrotizing pneumonia). A cause of death could not be determined in the remaining animals, which is consistent with expected percentage of marine mammal necropsies conducted within the northwest region.

Conclusions: NMFS concluded from a retrospective analysis of stranding events that the number of harbor porpoise stranding events in the approximate month surrounding the USS Shoup use of sonar was higher than expected based on annual strandings of harbor porpoises (Norman *et al.* 2004). It is important to note that the number of strandings in the May-June timeframe in 2003 was also higher for the outer coast, indicating a much wider phenemona than use of sonar by USS Shoup in Puget Sound for one day in May. The conclusion by NMFS that the number of strandings in 2003 was higher is also different from that of The Whale Museum, which has documented and responded to harbor porpoise strandings since 1980 (Osborne 2003). According to The Whale Museum, the number of strandings as of May 15, 2003, was consistent with what was expected based on historical stranding records and was less than that occurring in certain years. For example, since 1992 the San Juan Stranding Network has documented an average of 5.8 porpoise strandings per year. In 1997, there were 12 strandings in the San Juan Islands with more than 30 strandings throughout the general Puget Sound area. Disregarding the discrepancy in the historical rate of porpoise strandings and its relation to the USS Shoup, NMFS acknowledged that the intense level of media attention focused on the strandings likely resulted in an increased reporting effort by the public over that which is normally observed (Norman *et al.* 2004). NMFS also noted in its report that the "sample size is too small and biased to infer a specific relationship with respect to sonar usage and subsequent strandings."

Seven of the porpoises collected and analyzed died prior to Shoup departing to sea on May 5, 2003. Of these seven, one, discovered on May 5, 2003, was in a state of moderate decomposition, indicating it died before May 5; the cause of death was determined to be due, most likely, to salmonella septicemia. Another porpoise, discovered at Port Angeles on May 6, 2003, was in a state of moderate decomposition, indicating that this porpoise also died prior to May 5. One stranded harbor porpoise discovered fresh on May 6 is the only animal that could potentially be linked in time to the USS Shoup's May 5 active sonar use. Necropsy results for this porpoise found no evidence of acoustic trauma. The remaining eight strandings were discovered one to three weeks after the USS Shoup's May 5 transit of the Haro Strait, making it difficult to causally link the sonar activities of the USS Shoup to the timing of the strandings. Two of the eight porpoises died from blunt trauma injury and a third suffered from parasitic infestation, which possibly contributed to its death (Norman *et al.* 2004). For the remaining five porpoises, NMFS was unable to identify the causes of death.

The speculative association of the harbor porpoise strandings to the use of sonar by the USS Shoup is inconsistent with prior stranding events linked to the use of mid-frequency sonar. Specifically, in prior events, the stranding of whales occurred over a short period of time (less than 36 hours), stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Although mid-frequency active sonar was used by the USS Shoup, the distribution of harbor porpoise strandings by location and with respect to time surrounding the event do not support the suggestion that mid-frequency active sonar was a cause of harbor porpoise strandings. Rather, a complete lack of evidence of any acoustic trauma within the harbor porpoises, and the identification of probable causes of stranding or death in several animals, further supports the conclusion that harbor porpoise strandings were unrelated to the sonar activities of the USS Shoup (DON 2004).

2004 Hawai'i Melon-Headed Whale Mass Stranding (July 3-4, 2004)

Description: The majority of the following information is taken from the NMFS report on the stranding event (Southall *et al.* 2006). On the morning of July 3, 2004, 150 to 200 melon-headed whales (*Peponocephala electra*) entered Hanalei Bay, Kauai. Individuals attending a canoe blessing ceremony observed the animals entering the bay at approximately 7 a.m. The whales were reported entering the bay in a "wave as if they were chasing fish" (Braun 2005). At 6:45 a.m. on July 3, 2004, approximately 46.3 km (25 NM) north of Hanalei Bay, active sonar was tested briefly prior to the start of an anti-submarine warfare exercise.

The whales stopped in the southwest portion of the bay, grouping tightly, and displayed spy-hopping and tail-slapping behavior. As people went into the water among the whales, the pod separated into as many as four groups, with individual animals moving among the clusters. This continued through most of the day, with the animals slowly moving south and then southeast within the bay. By about 3 p.m., police arrived and kept people from interacting with the animals. At 4:45 p.m. on July 3, 2004, the RIMPAC Battle Watch Captain received a call from a National Marine Fisheries representative in Honolulu, Hawaii, reporting the sighting of as many as 200 melon-headed whales in Hanalei Bay. At 4:47 p.m. the Battle Watch Captain directed all ships in the area to cease active sonar transmissions.

At 7:20 p.m. on July 3, 2004, the whales were observed in a tight single pod 68.6 m (75 yards) from the southeast side of the bay. The pod was circling in a group and displayed frequent tail slapping and whistle vocalizations and some spy hopping. No predators were observed in the bay and no animals were reported as having fresh injuries. The pod stayed in the bay through the night of July 3, 2004.

On the morning of July 4, 2004, the whales were observed to still be in the bay and collected in a tight group. A decision was made at that time to attempt to herd the animals out of the bay. A 213 to 244-m (700- to 800-ft) rope was constructed by weaving together beach morning glory vines. This vine rope was tied between two canoes and with the assistance of 30 to 40 kayaks, was used to herd the animals out of the bay. By approximately 11:30 a.m. on July 4, 2004, the pod was coaxed out of the bay.

A single neonate melon-headed whale was observed in the bay on the afternoon of July 4, after the whale pod had left the bay. The following morning on July 5, 2004, the neonate was found stranded on Lumahai Beach. It was pushed back into the water but was found stranded dead between 9 and 10 a.m. near the Hanalei pier. NMFS collected the carcass and had it shipped to California for necropsy, tissue collection, and diagnostic imaging.

Following the stranding event, NMFS undertook an investigation of possible causative factors of the stranding. This analysis included available information on environmental factors, biological factors, and an analysis of the potential for sonar involvement. The latter analysis included vessels that utilized mid-frequency active sonar on the afternoon and evening of July 2. These vessels were to the southeast of Kauai, on the opposite side of the island from Hanalei Bay.

<u>Findings</u>: NMFS concluded from the acoustic analysis that the melon-headed whales would have had to have been on the southeast side of Kauai on July 2 to have been exposed to sonar from naval vessels on that day (Southall *et al.* 2006). There was no indication whether the animals were in that region or whether they were elsewhere on July 2. NMFS concluded that the animals would have had to swim from 1.4 to 4.0 m/s (3 to 9 mi/hr) for 6.5 to 17.5 hours after sonar transmissions ceased to reach Hanalei Bay by 7 a.m. on July 3. Sound transmissions by ships to the north of Hanalei Bay on July 3 were produced as part of exercises between 6:45 a.m. and 4:47 p.m. Propagation analysis conducted by the 3rd Fleet estimated that the level of sound from these transmissions at the mouth of Hanalei Bay could have ranged from 138 to 149 dB re: 1 µPa.

NMFS was unable to determine any environmental factors (e.g., harmful algal blooms, weather conditions) that may have contributed to the stranding. However, additional analysis by Navy investigators found that a full moon occurred the evening before the stranding and was coupled with a squid run (Mobley *et al.* 2007). In addition, a group of 500 to 700 melon-headed whales were observed to come close to shore and interact with humans in Sasanhaya Bay, Rota, on the same morning as the whales entered Hanalei Bay (Jefferson *et al.* 2006). Previous records further indicated that, though the entrance of melon-headed whales into the shallows is rare, it is not unprecedented. A pod of melon-headed whales entered Hilo Bay in the 1870s in a manner similar to that which occurred at Hanalei Bay in 2004.

The necropsy of the melon-headed whale calf suggested that the animal died from a lack of nutrition, likely following separation from its mother. The calf was estimated to be approximately one week old. Although the calf appeared not to have eaten for some time, it was not possible to determine whether the calf had ever nursed after it was born. The calf showed no signs of blunt trauma or viral disease and had no indications of acoustic injury.

<u>Conclusions</u>: Although it is not impossible, it is unlikely that the sound level from the sonar caused the melon-headed whales to enter Hanalei Bay. This conclusion is based on a number of factors:

1. The speculation that the whales may have been exposed to sonar the day before and then fled to the Hanalei Bay is not supported by reasonable expectation of animal behavior and swim speeds. The flight response of the animals would have had to persist for many hours following the cessation of sonar transmissions. Such responses have not been observed in marine mammals and no documentation of such persistent flight response after the cessation of a frightening stimulus has been observed in other mammals. The swim speeds, though feasible for the species, are highly unlikely to be maintained for the durations proposed, particularly since the pod was a mixed group containing both adults and neonates. Whereas Southall *et al.* (2006) suggest that the animals would have had to swim from 1.4 to 4.0 m/s (3 to 9 mi/hr) for 6.5 to 17.5 hours, it is improbable that a neonate could achieve the same for a period of many hours.

2. The area between the islands of Oahu and Kauai and the Pacific Missile Range Facility (PMRF) training range have been used in RIMPAC exercises for more than 20 years, and are used year-round for ASW training using mid frequency active sonar. Melon-headed whales inhabiting the waters around Kauai are likely not naive to the sound of sonar and there has never been another stranding event associated in time with ASW training at Kauai or in the Hawaiian Islands. Similarly, the waters surrounding Hawaii contain an abundance of marine mammals, many of which would have been exposed to the same sonar operations that were speculated to have affected the melon-headed whales. No other strandings were reported coincident with the RIMPAC exercises. This leaves it uncertain as to why melon-headed whales, and no other species of marine mammal, would respond to the sonar exposure by stranding.

3. At the nominal swim speed for melon-headed whales, the whales had to be within 2.8 and 3.7 km (1.5 and 2 NM) of Hanalei Bay before sonar was activated on July 3. The whales were not in their open ocean habitat but had to be close to shore at 6:45 a.m. when the sonar was activated to have been observed inside Hanalei Bay from the beach by 7 a.m. (Hanalei Bay is very large area). This observation suggests that other potential factors could be causative of the stranding event (see below).

4. The simultaneous movement of 500 to 700 melon-headed whales and Risso's dolphins into Sasanhaya Bay, Rota, in the Northern Marianas Islands on the same morning as the

2004 Hanalei stranding (Jefferson *et al.* 2006) suggests that there may be a common factor which prompted the melon-headed whales to approach the shoreline. A full moon occurred the evening before the stranding and a run of squid was reported concomitant with the lunar activity (Mobley *et al.* 2007). Thus, it is possible that the melon-headed whales were capitalizing on a lunar event that provided an opportunity for relatively easy prey capture. A report of a pod entering Hilo Bay in the 1870s indicates that on at least one other occasion, melon-headed whales entered a bay in a manner similar to the occurrence at Hanalei Bay in July 2004. Thus, although melon-headed whales entering shallow embayments may be an infrequent event, and every such event might be considered anomalous, there is precedent for the occurrence.

5. The received noise sound levels at the bay were estimated to range from roughly 95 to 149 dB re: 1 µPa. Received levels as a function of time of day have not been reported, so it is not possible to determine when the presumed highest levels would have occurred and for how long. However, received levels in the upper range would have been audible by human participants in the bay. The statement by one interviewee that he heard "pings" that lasted an hour and that they were loud enough to hurt his ears is unreliable. Received levels necessary to cause pain over the duration stated would have been observed by most individuals in the water with the animals. No other such reports were obtained from people interacting with the animals in the water.

Although NMFS concluded that sonar use was a "plausible, if not likely, contributing factor in what may have been a confluence of events (Southall *et al.* 2006)," this conclusion was based primarily on the basis that there was an absence of any other compelling explanation. The authors of the NMFS report on the incident were unaware, at the time of publication, of the simultaneous event in Rota. In light of the simultaneous Rota event, the Hanalei stranding does not appear as anomalous as initially presented and the speculation that sonar was a causative factor is weakened. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.). In addition, the inability to conclusively link or exclude the impact of other environmental factors makes a causal link between sonar and the melon-headed whale strandings highly speculative at best.

1980- 2004 Beaked Whale Strandings in Japan (Brownell *et al.* 2004)

Description: Brownell *et al.* (2004) compared the historical occurrence of beaked whale strandings in Japan (where there are U.S. naval bases) with strandings in New Zealand (which lacks a U.S. naval base) and concluded the higher number of strandings in Japan may be related to the presence of U.S. Navy vessels using mid-frequency sonar. While the dates for the strandings were well documented, the authors of the study did not attempt to correlate the dates of any Navy activities or exercises with the dates of the strandings.

To fully investigate the allegation made by Brownell *et al.* (2004), the Center for Naval Analysis (CNA) looked at the past U.S. Naval exercise schedules from 1980 to 2004 for the water around Japan in comparison to the dates for the strandings provided by Brownell *et al.* (2004). None of the strandings occurred during or within weeks after any DON exercises. While the CNA analysis began by investigating the probabilistic nature of any co-occurrences, the results were a 100 percent probability that the strandings and sonar use were not correlated by time. Given there was no instance of co-occurrence in over 20 years of stranding data, it can be reasonably postulated that sonar use in Japanese waters by DON vessels did not lead to any of the strandings documented by Brownell *et al.* (2004).

2004 Alaska Beaked Whale Strandings (June 17 to July 19, 2004)

Description: Between June 17 and July 19, 2004, five beaked whales were discovered at various locations along 2,575 km (1,389.4 NM) of the Alaskan coastline, and one was found floating (dead) at sea. Because the DON exercise Alaska Shield/Northern Edge 2004 occurred within the approximate timeframe of these strandings, it has been alleged that sonar may have been the probable cause of these strandings.

The Alaska Shield/Northern Edge 2004 exercise consisted of a vessel-tracking event followed by a vessel-boarding search-and-seizure event. There was no ASW component to the exercise, no use of mid-frequency sonar, and no use of explosives in the water. There were no events in the Alaska Shield/Northern Edge exercise that could have caused any of the strandings over this 33 day period.

2005 North Carolina Marine Mammal Mass Stranding Event (January 15-16, 2005)

Description: On January 15 and 16, 2005, 36 marine mammals consisting of 33 short-finned pilot whales, one minke whale, and two dwarf sperm whales stranded alive on the beaches of North Carolina (Hohn *et al.* 2006a). The animals were scattered across a 111-km (59.9-NM) area from Cape Hatteras northward. Because of the live stranding of multiple species, the event was classified as a UME (Unusual Mortality Event). It is the only stranding on record for the region in which multiple offshore species were observed to strand within a two- to three-day period.

The DON indicated that from January 12 to 14, some unit level training with mid-frequency active sonar was conducted by vessels that were 93 to 185 km (50.2 to 99.8 NM) from Oregon Inlet. An expeditionary strike group was also conducting exercises to the southeast, but the closest point of active sonar transmission to the inlet was 650 km (350.7 NM) away. The unit level operations were not unusual for the area or time of year and the vessels were not involved in antisubmarine warfare exercises. Marine mammal observers on board the vessels did not detect any marine mammals during the period of unit level training. No sonar transmissions were made on January 15-16.

The National Weather Service reported that a severe weather event moved through North Carolina on January 13 and 14 (Figure H-4). The event was caused by an intense cold front that moved into an unusually warm and moist air mass that had been persisting across the eastern United States for about a week. The weather caused flooding in the western part of the state, considerable wind damage in central regions of the state, and at least three tornadoes that were reported in the north central part of the state. Severe, sustained (one to four days) winter storms are common for this region.

Over a two-day period (January 16-17), two dwarf sperm whales, 27 pilot whales, and one minke whale were necropsied and tissue samples collected. Twenty-five of the stranded cetacean heads were examined; two pilot whale heads and the heads of the dwarf sperm whales were analyzed by CT.

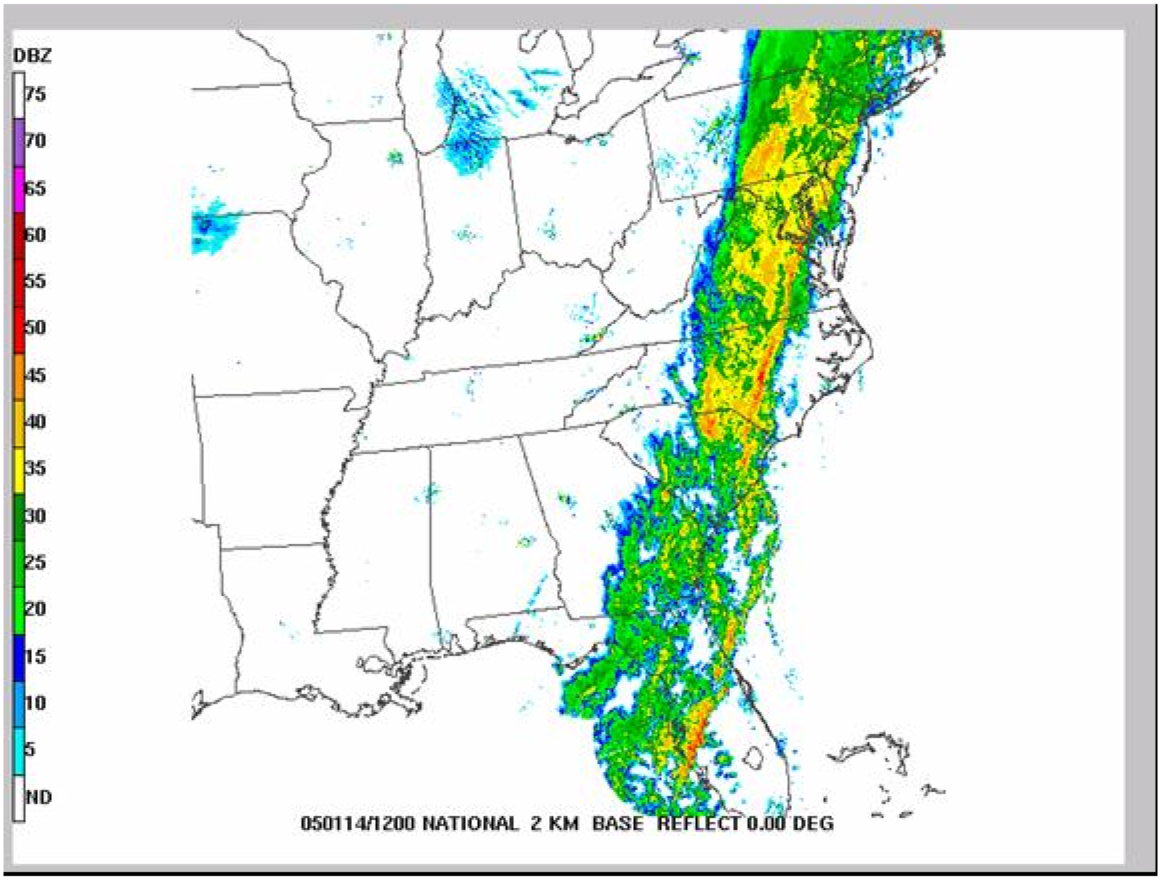


Figure H-4. Regional radar imagery for the East Coast (including North Carolina) on July 14. The time of the image is approximately 7 a.m.

Findings: The pilot whales and dwarf sperm whale were not emaciated, but the minke whale, which was believed to be a dependent calf, was emaciated. Many of the animals were on the beach for an extended period of time prior to necropsy and sampling, and many of the biochemical abnormalities noted in the animals were suspected of being related to the stranding and prolonged time on land. Lesions were observed in all of the organs, but there was no consistency across species. Musculoskeletal disease was observed in two pilot whales and cardiovascular disease was observed in one dwarf sperm whale and one pilot whale. Parasites were a common finding in the pilot whales and dwarf sperm whales but were considered consistent with the expected parasite load for wild odontocetes. None of the animals exhibited traumas similar to those observed in prior stranding events associated with mid-frequency sonar activity. Specifically, there was an absence of auditory system trauma and no evidence of distributed and widespread bubble lesions or fat emboli, as was previously observed (Fernández *et al.* 2005).

Sonar transmissions prior to the strandings were limited in nature and did not share the concentration identified in previous events associated with mid-frequency active sonar use (Evans and England 2001). The operational/environmental conditions were also dissimilar (e.g., no constrictive channel and a limited number of ships and sonar transmissions). NMFS noted that environmental conditions were favorable for a shift from up-welling to down-welling conditions, which could have contributed to the event. However, other severe storm conditions existed in the days surrounding the strandings and the impact of these weather conditions on at-sea conditions is unknown. No harmful algal blooms were noted along the coastline.

Conclusions: All of the species involved in this stranding event are known to strand in this region. Although the cause of the stranding could not be determined, several whales had preexisting conditions that could have contributed to the stranding. Cause of death for many of the whales was likely due to the physiological stresses associated with being stranded. A consistent suite of injuries across species, which was consistent with prior strandings where sonar exposure is expected to be a causative mechanism, was not observed.

NMFS was unable to determine any causative role that sonar may have played in the stranding event. The acoustic modeling performed, as in the Hanalei Bay incident, was hampered by uncertainty regarding the location of the animals at the time of sonar transmissions. However, as in the Hanalei Bay incident, the response of the animals following the cessation of transmissions would imply a flight response that persisted for many hours after the sound source was no longer operational. In contrast, the presence of a severe weather event passing through North Carolina during January 13 and 14 is a possible contributing factor to the North Carolina UME of January 15.

H.8 STRANDING SECTION CONCLUSIONS

Marine mammal strandings have been a historic and ongoing occurrence attributed to a variety of causes. Over the last fifty years, increased awareness and reporting has lead to more information about species effected and raised concerns about anthropogenic sources of stranding. While there has been some marine mammal mortalities potentially associated with mid-frequency sonar effects to a small number of species (primarily limited numbers of certain species of beaked whales), the significance and actual causative reason for any impacts is still subject to continued investigation. ICES (2005a) noted, that taken in context of marine mammal populations in general, sonar is not a major threat, nor a significant contributor to the overall ocean noise budget. However, continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid-frequency sonar (Bradshaw *et al.* 2006; ICES 2005b; Barlow and Gisiner 2006; Cox *et al.* 2006).

REFERENCES

Alexander, J. W., Solangi, M. A., and L. S. Riegel, 1989. "Vertebral osteomyelitis and suspected diskospondylitis in an Atlantic bottlenose dolphin (*Tursiops truncatus*)," Journal of Wildlife Diseases 25, 118-121.

Andrew, R.K., B. M., Howe, and J. A. Mercer, 2002. Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. Journal of the Acoustic Society of America 3(2):65-70.

Arruda, J., A. Costidis, S. Cramer, D. R. Ketten, W. McLellan, E. W. Montie, M. Moore, and S. Rommel, 2007. "Odontocete Salvage, Necropsy, Ear Extraction, and Imaging Protocols," edited by N. M. Young (Ocean Research, Conservation and Solutions [ORCAS] and ONR), pp. 1-171.

Arveson, P.T. and D. J. Vendittis, 2006. Radiated noise characteristics of a modern cargo ship. Journal of the Acoustic Society of America 107(1):118-129.

Baird, R. W. and S. K. Hooker, 2000. "Ingestion of plastic and unusual prey by a juvenile harbour porpoise," Marine Pollution Bulletin 40, 719-720.

Baird, R.W., P. J. Stacey, D. A. Duffus, and K. M. Langelier, 2002. An evaluation of gray whale (*Eschrichtius robustus*) mortality incidental to fishing operations in British Columbia, Canada. Journal of Cetacean Research and Management 4(3):289-296.

Baird, R.W. and A. M. Gorgone, 2005. False killer whale dorsal fin disfigurements as a possible indicator of long-line fishery interactions in Hawaiian waters. Pacific Science 59(4):593-601.

Barlow, J. and R. Gisiner, 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management 7(3):239-249.

Bauer, G., Fuller, M., Perry, A., Dunn, J. R., and J. Zoeger, 1985. "Magnetoreception and biomineralization of magnetite in cetaceans," in Magnetite Biomineralization and Magnetoreception in Organisms: A New Biomagnetism edited by J. L. Kirschvink, D. S. Jones, and B. J. MacFadden (Plenum Press, New York), pp. 489-507.

Bergman, A., A. Bergstrand, and A. Bignert, 2001. "Renal lesions in Baltic grey seals (*Halichoerus grypus*) and ringed seals (*Phoca hispida botnica*)," Ambio 30, 397-409.

Borell, A., 1993. PCB and DDTs in blubber of cetaceans from the northeastern North Atlantic. Marine Pollution Bulletin 26:146-151.

Brabyn, M., and R. V. C. Frew, 1994. "New Zealand herd stranding sites do not relate to geomagnetic topography," Mar. Mammal Sci. 10, 195-207.

Brabyn, M. W., and I. G. McLean, 1992. "Oceanography and coastal topography of herd-stranding sites for whales in New Zealand," J. Mamm. 73, 469-476.

Bradshaw, C. J., K. Evans, and M. A. Hindell, 2006. "Mass cetacean strandings: A plea for empiricism," Conservation Biology 20, 584-586.

Braun, R. C., 2005. Personal communication via email between Dr. Robert Braun, National Marine Fisheries Service, Pacific Island Fisheries Science Center, Honolulu, Hawaii, and Mr. Conrad Erkelens, U.S. Pacific Fleet, Fleet Environmental Office, Pearl Harbor Hawaii, 1 September.

Brodie, E. C., F. M. D. Gulland, D. J. Greig, M. Hunter, J. Jaakola, J. S. Leger, T. A. Leighfield, and F. M. V. Dolah, 2006. "Domoic acid causes reproductive failure in California sea lions (*Zalophus californianus*)," Marine Mammal Science 22:700–707.

Brownell, R. L., Jr., T. Yamada, J. G. Mead, and A. van Helden, 2004. Mass strandings of Cuvier's beaked whales in Japan: U.S. naval acoustic link? Unpublished paper SC/56/E37 presented to IWC Scientific Committee, July 2004. 100 pp.

Campagna, C., V. Falabella, M. Lewis., 2007. Entanglement of southern elephant seals in squid fishing gear. Marine Mammal Science 23(2):414-418.

Carretta, J. V., J. Barlow, K. A. Forney, M. M. Muto, and J. Baker, 2001. U.S. Pacific marine mammal stock assessments: 2001. NOAA Technical Memorandum NOAA-TM-NMFS-SWFWC-317.

Carretta, T. Price, D. Petersen, and R. Read, 2004. Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. Marine Fisheries Review 66(2):21-30.

Carretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. S. Lowry, 2007. "U.S. Pacific Marine Mammal Stock Assessments: 2006," (NOAA-TM-NMFS-SWFSC-398, National Marine Fisheries Service, Southwest Fisheries Science Center), p. 321.

Chambers, S., and R. N. James, 2005. "Sonar termination as a cause of mass cetacean strandings in Geographe Bay, south-western Australia," in Acoustics 2005, Acoustics in a Changing Environment (Busselton, Western Australia).

Clyne, H., 1999. Computer simulations of interactions between the North Atlantic right whale (*Eubalaena glacialis*) and shipping.

Cockcroft, V. G., Cliff, G., and Ross, G. J. B., 1989. "Shark predation on Indian Ocean bottlenose dolphins *Tursiops truncatus* off Natal, South Africa," South African Journal of Zoology 24, 305-310.

Conner, R. C., 2000. "Group living in whales and dolphins," in Cetacean Societies: Field Studies of Dolphins and Whales, edited by J. Mann, R. C. Conner, P. L. Tyack, and H. Whitehead (University of Chicago Press, Chicago), pp. 199-218.

Constantine, R., I. Visser, D. Buurman, R. Buurman, B. McFadden, 1998. "Killer whale (*Orcinus orca*) predation on dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura, New Zealand," Mar. Mammal Sci. 14, 324-330.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Meads, and L. Benner, 2006. "Understanding the impacts of anthropogenic sound on beaked whales," J. Cetacean Res. Manage. 7, 177-187.

Crocker, D. E., D. P. Costa, B. J. Le Boeuf, P. M. Webb, and D. S. Houser, 2006. "Impacts of El Niño on the foraging behavior of female northern elephant seals," Mar. Ecol. Prog. Ser. 309.

Crum, L. A., M. R. Bailey, G. Jingfeng, P. R. Hilmo, S. G. Kargl, and T. J. Matula, 2005. "Monitoring bubble growth in supersaturated blood and tissue ex vivo and the relevance to marine mammal bioeffects," Acoustic Research Letters Online 6, 214-220.

Crum, L. A., and Y. Mao, 1996. "Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety," J. Acoust. Soc. Am. 99, 2898-2907.

Culik, B. M., 2002. "Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats," in United Nations Environment Programme, Convention on Migratory Species (Marine Mammal Action Plan/Regional Seas Reports and Studies No. 177), p. 343.

D'Amico, A., and W. Verboom, 1998. "Report of the Bioacoustics Panel, NATO/SACLANT," pp. 2-1-2-60.

D'Spain, G.L., A. D'Amico, and D. M. Fromm., 2006. Properties of the underwater sound fields during some well documented beaked whale mass stranding events. Journal of Cetacean Research and Management 7(3):223-238.

Dailey, M., and W. A. Walker, 1978. "Parasitism as a factor (?) in single strandings of southern California cetaceans," Journal of Parasitology 64, 593-596.

Dailey, M., M. Walsh, D. Odell, and T. Campbell, 1991. "Evidence of prenatal infection in the bottlenose dolphin (*Tursiops truncatus*) with the lungworm *Halocercus lagenorhynchi* (*Nematoda Pseudaliidae*)," Journal of Wildlife Diseases 27, 164-165.

Das, K., V. Debacker, S. Pillet, and J. M. Bouquegneau, 2003. "Heavy metals in marine mammals," in Toxicology of Marine Mammals, edited by J. G. Vos, G. D. Bossart, M. Fournier, and T. J. O'Shea (Taylor & Francis, London), pp. 135-167.

De Guise, S., K. B. Beckmen, and S. D. Holladay, 2003. "Contaminants and marine mammal immunotoxicology and pathology," in Toxicology of Marine Mammals, edited by J. G. Vos, G. D. Bossart, M. Fournier, and T. J. O'Shea (Taylor & Francis, London), pp. 38-54.

De Stephasis, R. and E. Urquiola, 2006. Collisions between ships and cetaceans in Spain. Report to the Scientific Committee, International Whaling Commission SC/58/BC5.

DeMaster, D., C. W. Fwler, S. L. Perry, and M. F. Richlen, 2001. "Predation and competition: The impact of fisheries on marine-mammal populations over the next one hundred years," J. Mamm. 82, 641-651.

Dierauf, L. A., and F. M. D. Gulland, 2001. "Marine Mammal Unusual Mortality Events," in Marine Mammal Medicine, edited by L. A. Dierauf, and F. M. D. Gulland (CRC Press, Boca Raton), pp. 69-81.

Domingo, M., J. Visa, M. Pumarola, A. J. Marco, L. Ferrer, R. Rabanal, and S. Kennedy, 1992. "Pathologic and immunocytochemical studies of morbillibirus infection in striped dolphins (*Stenella coeruleoalba*)," Veterinary Pathology 29, 1-10.

Dudok van Heel, W. H., 1966. "Navigation in cetacea," in Whales, Dolphins, and Porpoises, edited by K. S. Norris (University of California Press, Berkeley), pp. 597-606.

Dunn, J. L., J. D. Buck, and T. R. Robeck, 2001. "Bacterial diseases of cetaceans and pinnipeds," in Marine Mammal Medicine, edited by L. A. Dierauf, and F. M. D. Gulland (CRC Press, Boca Raton, FL), pp. 309-335.

Evans, D. L., 2002. "Report of the Workshop on Acoustic Resonance as a Source of Tissue Trauma in Cetaceans," (Silver Spring, MD).

Evans, D. L., and G. R. England, 2001. "Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000," (Department of Commerce), pp. 1-66.

Evans, K., and M. A. Hindell, 2004. The diet of sperm whales (*Physeter macrocephalus*) in southern Australian waters. ICES Journal of Marine Science, Vol 61, No 8, pp. 1313 - 1329.

Evans, K., R. Thresher, R. M. Warneke, C. J. A. Bradshaw, M. Pook, D. Thiele, and M. A. Hindell, 2005. "Periodic variability in cetacean strandings: links to large-scale climate events," Biology Letters 1, 147-150.

Fernández, A., J. Edwards, V. Martín, F. Rodríguez, A. Espinosa de los Monteros, P. Herráez, P. Castro, J. R. Jaber, and M. Arbelo, 2005. "Gas and fat embolic syndrome" involving a mass stranding of beaked whales exposed to anthropogenic sonar signals," Journal of Veterinary Pathology 42, 446-457.

Finneran, J. J., D. A. Carder, C. E. Schlundt, and S. H. Ridgway, 2005. "Temporary threshold shift (TTS) in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones," J. Acoust. Soc. Am. 118, 2696-2705.

Finneran, J. J., R. Dear, D. A. Carder, and S. H. Ridgway, 2003. "Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer," J. Acoust. Soc. Am. 114, 1667-1677.

Finneran, J. J., C. E. Schlundt, D. A. Carder, J. A. Clark, J. A. Young, J. B. Gaspin, and S. H. Ridgway, 2000. "Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions," J. Acoust. Soc. Am. 108, 417-431.

Flewelling, L. J., J. P. Naar, J. P. Abbott, D. G. Baden, N. B. Barros, G. D. Bossart, M. Y. D. Bottein, D. G. Hammond, E. M. Haubold, C. A. Heil, M. S. Henry, H. M. Jacocks, T. A. Leighfield, R. H. Pierce, T. D. Pitchford, S. A. Rommel, P. S. Scott, K. A. Steidinger, E. W. Truby, F. M. V. Dolah, and J. H. Landsberg, 2005. "Brevetoxicosis: Red tides and marine mammal mortalities," Nature 435, 755-756.

Frantzis, A., 1998. "Does acoustic testing strand whales?" Nature, p. 29.

Freitas, L., 2004. "The stranding of three Cuvier's beaked whales *Ziphius cavirostris* in Madeira Archipelago - May 2000," in European Cetacean Society 17th Annual Conference (Las Palmas, Gran Canaria).

Frodello, J. P., and B. Marchand, 2001. "Cadmium, copper, lead, and zinc in five toothed whale species of the Mediterranean Sea," International Journal of Toxicology 20, 339-343.

Geraci, J. R., 1989. "Clinical investigation of the 1987-88 mass mortality of bottlenose dolphins along the U.S. central and south Atlantic coast," (Final report to the National Marine Fisheries Service, U. S. Navy, Office of Naval Research, and Marine Mammal Commission), pp. 1-63.

Geraci, J. R., and V. J. Lounsbury, 1993. Marine Mammals Ashore: A Field Guide for Strandings. Texas A&M University Sea Grant College Program, Galveston, TX.

Geraci, J. R., J. Harwood, and V. J. Lounsbury, 1999. "Marine mammal die-offs: Causes, investigations, and issues," in Conservation and management of marine mammals, edited by J. R. Twiss, and R. R. Reeves (Smithsonian Institution Press, Washington, DC), pp. 367-395.

Geraci, J. R., and V. J. Lounsbury, 2005. Marine Mammals Ashore: A Field Guide for Strandings (Second Edition) (National Aquarium in Baltimore, Baltimore, MD).

Geraci, J. R., and D. J. St.Aubin, 1987. "Effects of parasites on marine mammals," International Journal of Parasitology 17, 407-414.

Goodson, A.D., 1997. Developing deterrent devices designed to reduce the mortality of small cetaceans in commercial fishing nets. Marine and Freshwater Behaviour and Physiology 29:211-236.

Gorzelany, J. F., 1998. "Unusual deaths of two free-ranging Atlantic bottlenose dolphins (*Tursiops truncatus*) related to ingestion of recreational fishing gear," Mar. Mammal Sci. 14, 614-617.

Grachev, M. A., V. P. Kumarev, L. V. Mamaev, V. L. Zorin, L. V. Baranova, N. N. Denikina, S. I. Belkov, E. A. Petrov, and V. S. Kolesnik, 1989. "Distemper virus in Baikal seals," Nature 338, 209-210.

Greig, D. J., F. M. D. Gulland, C. Kreuder, 2005. "A decade of live California sea lion (*Zalophus californianus*) strandings along the central California coast: Causes and trends, 1991-2000," Aquat. Mammals 31, 11-22.

Guinet, C., L. G. Barrett-Lennard, B. Loyer, B, 2000. "Coordinated attack behavior and prey sharing by killer whales at Crozet Archipelago: strategies for feeding on negatively-buoyant prey," Mar. Mammal Sci. 16, 829-834.

Gulland, F. M. D., 2006. "Review of the Marine Mammal Unusual Mortality Event Response Program of the National Marine Fisheries Service," (Report to the Office of Protected Resources, NOAA/National Marine Fisheries Service, Silver Springs, MD), p. 32.

Gulland, F. M. D., and A. J. Hall, 2005. "The Role of Infectious Disease in Influencing Status and Trends," in Marine Mammal Research, edited by J. E. Reynolds, W. F. Perrin, R. R. Reeves, S. Montgomery, and T. J. Ragen (John Hopkins University Press, Baltimore), pp. 47-61.

Gulland, F.M.D. and A.J. Hall, 2007. Is marine mammal health deteriorating? Trends in global reporting of marine mammal disease. EcoHealth 4:135-150.

Gulland, F. M. D., M. Koski, L. J. Lowenstine, A. Colagross, L. Morgan, and T. Spraker, 1996. "Leptospirosis in California sea lions (*Zalophus califorianus*) stranded along the central California coast, 1981-1994," Journal of Wildife Diseases 32, 572-580.

Harwood, J., 2002. "Mass Die-offs," in Encyclopedia of Marine Mammals, edited by W. F. Perrin, B. Würsig, and J. G. M. Thewissen (Academic Press, San Diego), pp. 724-726.

Heithaus, M. R., 2001. "Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: Attack rate, bite scar frequencies and attack seasonality," Mar. Mammal Sci. 17, 526-539.

Heyning, J. E., and T. D. Lewis, 1990. Entanglements of baleen whales in fishing gear of southern California. Report International Whaling Commission 40:427-431.

Hickie, B. E., P. S. Ross, R. W. MacDonald, and J. K. B. Ford, 2007. Killer whales (*Orcinus orcas*) faced protracted health risks associated with lifetime exposure to PCBs. *Environmental Science and Technology,* 41:6613-6619.

Hiruki, L. M., M. K. Schwartz, and P. L. Boveng, 1999. "Hunting and social behaviour of leopard seals (*Hydrurga leptonyx*) at Seal Island, South Shetland Islands, Antarctica," Journal of Zoology 249, 97-109.

Hoelzel, A. R., 2003. Marine Mammal Biology: An Evolutionary Approach (Blackwell Publishing, Malden MA).

Hohn, A. A., D. S. Rotstein, C. A. Harms, and B. L. Southall, 2006a. "Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (Balaenoptera acutorostrata), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005," (Department of Commerce), p. 222.

Hohn, A. A., D. S. Rotstein, C. A. Harms, and B. L. Southall, 2006b. "Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005," p. 222.

Houser, D. S., R. Howard, and S. Ridgway, 2001. "Can diving-induced tissue nitrogen supersaturation increase the chance of acoustically driven bubble growth in marine mammals?" J. theor. Biol. 213, 183-195.

International Council for the Exploration of the Sea (ICES), 2005a. Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish- 2nd edition. International Council for the Exploration of the Sea. ICES AGISC CM 2005/ACE:06. 25 pp.

International Council for the Exploration of the Sea (ICES), 2005b. Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations. International Council for the Exploration of the Sea. 5 pp.

Jasny, M., J. Reynolds, C. Horowitz, and A. Wetzler, 2005. "Sounding the Depths II: The rising toll of sonar, shipping, and industrial ocean noise on marine life. Natural Resources Defense Council. 84 pp.

Jefferson, T. A., D. Fertl, M. Michael, and T. D. Fagin, 2006. "An unusual encounter with a mixed school of melon-headed whales (*Peponocephala electra*) and rough-toothed dolphins (*Steno bredanesis*) at Rota, Northern Mariana Islands," Micronesica 38, 239-244.

Jefferson, T. A., P. J. Stacey, and R. W. Baird, 1991. A review of killer whale interactions with other marine mammals: Predation to co-existence. Mammal Review 21(4):151-180.

Jensen, A. S. and G. K. Silber, 2004. Large whale ship strike database. NOAA Technical Memorandum NMFS-OPR-25, January 2004.

Jepson, P. D., M. Arbelo, R. Deaville, I. A. R. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Herráez, A. M. Pocknell, E. Rodriguez, F. E. Howie, A. Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. Cunningham, and A. Fernandez, 2003. "Gas-bubble lesions in stranded cetaceans," Nature 425, 575-576.

Jepson, P. D., P. M. Bennett, C. R. Allchin, R. J. Lae, T. Kuiken, J. R. Baker, E. Rogan, and J. K. Kirkwood, 1999. "Investigating potential associations between chronic exposure to polychlorinated biphenyls and infectious disease mortality in harbour porpoises from England and Wales," The Science of the Total Environment 243/244, 339-348.

Jepson, P. D., P. M. Bennett, R. Deaville, C. R. Allchin, J. R. Baker, and R. Law, 2005. "Relationships between polychlorinated biphenyls and health status in harbor porpoises (*Phocoena phocoena*) stranded in the United Kingdom," Environ. Toxicol. Chem. 24 238-248.

Johnson, J.H. and T. H. Woodley, 1998. A survey of acoustic harassment device (AHD) use in the Bay of Fundy, NB, Canada. Aquatic Mammals 24:51-61.

Kennedy, S., T. Kuiken, P. D. Jepson, R. Deaville, M. Forsyth, T. Barrett, M. W. G. van de Bildt, A. D. M. E. Osterhaus, T. Eybatov, C. Duck, A. Kydyrmanov, I. Mitrofanov, and S. Wilson, 2000. "Mass die-off of Caspian seals caused by canine distemper virus," Emerging Infectious Diseases 6, 637-639.Ketten, D., 2005. "Beaked whale necropsy findings for strandings in the Bahamas, Puerto Rico, and Madeira, 1999-2002," (Woods Hole Oceanographic Institution, Woods Hole, MA), p. 36.

Kirschvink, J. L., A. E. Dizon, and J. A. Westphal, 1986. "Evidence from strandings for geomagnetic sensitivity in cetaceans," J. Exp. Biol. 120, 1-24.

Klinowska, M., 1985. "Cetacean live stranding sites relate to geomagnetic topography," Aquat. Mammals 11, 27-32.

Klinowska, M., 1986. "Cetacean live stranding dates relate to geomagnetic disturbances," Aquat. Mammals 11, 109-119.

Knowlton, A. R., F. T. Korsmeyer, J. E. Kerwin, H. Y. Wu, and B. Hynes, 1995. The hydrodynamic effects of large vessels on right whales. Final Report to NOAA Fisheries. NMFS Contract No. 40EANFF400534. 81 p.

Knowlton, A. R., and S. D. Kraus, 2001. Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean. Journal of Cetacean Research and Management (Special Issue) 2:193-208.

Kompanje, E. J. O., 1995. "On the occurrence of spondylosis deformans in white-beaked dolphins *Lagenorhynchus albirostris* (Gray, 1846) stranded on the Dutch coast," Zooligische Mededekingen Leiden 69, 231-250.

Krahn, M. M., M. B. Hanson, R. W. Baird, R. H. Boyer, D. G. Burrows, C. E. Emmons, J. K. B. Ford, L. L. Jones, D. P. Noren, P. S. Ross, G. S. Schorr, and T. K. Collier, 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. *Marine Pollution Bulletin* (2007), doi:10.1016/j.marpolbul.2007.08.015.

Lahvis, G. P., R. S. Wells, D. W. Kuehl, J. L. Stewart, H. L. Rhinehart, and C. S. Via, 1995. "Decreased lymphocyte responses in free-ranging bottlenose dolphins (*Tursiops truncatus*) are associated with increased concentrations of PCBs and DDT in peripheral blood," Environmental Health Perspectives 103, 67-72.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Posesta, 2001. "Collisions between ships and whales," Mar. Mammal Sci. 17, 35-75.

Le Boeuf, B. J., and J. Reiter, 1991. "Biological effects associated with El Nino Southern Oscillation, 1982-83m on northern elephant seals breeding at Ano Nuevo, California," in Pinnipeds and El Nino: Responses to Environmental Stress, edited by F. Trillmich, and K. A. Ono (Springer-Verlag, Berlin), pp. 206-218.

Learmonth, J. A., C. D. Macleod, M. B. Santos, G. J. Pierce, H. Q. P. Crick, and R. A. Robinson, 2006. "Potential effects of climate change on marine mammals," Oceanography and Marine Biology: an Annual Review 44, 431-464.

Lipscomb, T. P., F. Y. Schulman, D. Moffett, and S. Kennedy, 1994. Morbilliviral disease in Atlantic bottlenose dolphins (*Tursiops truncatus*) from the 1987-88 epizootic. *Journal of Wildlife Diseases*, 30 (4), pp 567-571.

Madsen, P. T., M. A. Johnson, P. J. Miller, A. N. Soto, J. Lynch, and P. L. Tyack, 2006. Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. Journal of the Acoustic Society of America 120(4):2366-2379.

Maldini, D., L. Mazzuca, and S. Atkinson, 2005. "Odontocete stranding patterns in the main Hawaiian islands (1937-2002): How do they compare with live animal surveys?" Pacific Science 59, 55-67.

Maybaum, H. L., 1989. Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera noveangliaea*, in Hawaiian waters. Thesis, Masters of Science, University of Hawaii Manoa, August 1989. 112 p.

Maybaum, H. L., 1993. Responses of humpback whales to sonar sounds. Journal of the Acoustical Society of America 109:2455.

Mazzuca, L., S. Atkinson, B. Keating, and E. Nitta, 1999. "Cetacean mass strandings in the Hawaiian Archipelago, 1957-1998," Aquat. Mammals 25, 105-114.

McDonald, M. A., J. A. Hildebrand, and S. M. Wiggins, 2006. "Increases in deep ocean ambient noise in the northeast pacific west of San Nicolas Island, California" Journal of the Acoustical Society of America. 120(2):711-718.

Michel, J, R. Nairn, J. A. Johnson, and D. Hardin, 2001. Development and design of biological and physical monitoring protocols to evaluate the long-term impacts of offshore dredging operations on the marine environment. Final Report to the U.S. Department of Interior, Minerals Management Service, International Activities and Marine Minerals Divisions (INTERMAR), Herndon, CA. Contract No. 14-35-0001-31051. 116 p.

Mignucci-Giannoni, A. A., G. M. Toyos-Gonzalez, J. Perez-Padilla, M. A. Rodriguez-Lopez, and J. Overing, 2000. "Mass stranding of pygmy killer whales (*Feresa attenuata*) in the British Virgin Islands," J. Mar. Biol. Ass. U. K. 80, 759-760.

Marine Mammal Commission (MMC), 1999. Marine Mammals and Persistent Ocean Contaminants: Proceedings of the Marine Mammal Commission Workshop Keystone, Colorado, 12-15 October 1998.Mobley, J. R. Jr., S. W. Martin, D. Fromm, and P. E. Nachtigall, , 2007. Lunar influences as possible cause for simultaneous aggregations of melon-headed whales in Hanalei Bay, Kauai and Sasanhaya Bay, Rota. 17th Biennial Conference on the Biology of Marine Mammals. Cape Town, South Aftica. November 29 through December 3, 2007.

Moeller, R. B., 2003. "Pathology of marine mammals with special reference to infectious diseases," in Toxicology of Marine Mammals, edited by J. G. Vos, G. D. Bossart, M. Fournier, and T. J. O'Shea (Taylor & Francis, London), pp. 3-37.

Moore, M. J. and G. A. Early, 2004. Cumulative sperm whale bone damage and the bends. Science 306:2215.

Moore, M. J., B. Rubinstein, S. A. Norman, and T. Lipscomb, 2004. "A note on the most northerly record of Gervais' beaked whale from the western North Atlantic Ocean," J. Cetacean Res. Manage. 6, 279-281.

Moore, S. E., 2005. "Long-term Environmental Change and Marine Mammals," in Marine Mammal Research: Conservation Beyond Crisis, edited by J. E. Reynolds, W. F. Perrin, R. R. Reeves, S. Montgomery, and T. J. Ragen (John Hopkins University Press, Baltimore), pp. 137-147.

Morimitsu, T., T. Nagai,M. Ide, H. Kawano, A. Naichuu, M. Koono, and A. Ishii, 1987. "Mass stranding of *odontoceti* caused by parasitogenic eighth cranial neuropathy," Journal of Wildife Diseases 23, 586-590.

Morisaka, T. and R. C. Connor, 2007. Predation by killer whales (*Orcinus orca*) and the evolution of whistle loss and narrow-band high frequency clicks in odontocetes. Journal of Evolutionary Biology 20(4):1439-1458.

National Marine Fisheries Service (NMFS), 1997. Investigation of scientific information on the impacts of California sea lions and Pacific harbor seals on salmonids and on the coastal ecosystems of Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-28. 172 pp.

National Marine Fisheries Service (NMFS), 2004. "Interim Report on the Bottlenose Dolphin (*Tursiops truncatus*) Unusual Mortality Event Along the Panhandle of Florida, March-April 2004," (National Marine Fisheries Service), pp. 1-36.

National Marine Fisheries Service (Office of Protected Resources), 2005. "Assessment of Acoustic Exposures on Marine Mammals in Conjunction with USS Shoup Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington, 5 May 2003."

National Marine Fisheries Service (NMFS), 2005a. Pygmy Sperm Whale (*Kogia breviceps*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

National Marine Fisheries Service (NMFS), 2005b. Long-Finned Pilot Whale (*Globicephala melas*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

National Marine Fisheries Service (NMFS), 2005c. Dwarf Sperm Whale (*Kogia sima*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

National Marine Fisheries Service (NMFS), 2005d. Harbor Porpoise (*Phocoena phocoena*): Gulf of Maine/Bay of Fundy Stock. Stock Assessment Report. December, 2005.

National Marine Fisheries Service (NMFS), 2007. "Draft Programmatic Environmental Impact Statement for the Marine Mammal Health and Stranding Response Program," (National Marine Fisheries Service, Office of Protected Resources), p. 1006.

National Marine Fisheries Service (NMFS), 2007a. FAQs about Marine Mammal Strandings. Retrieved from http://www.nmfs.noaa.gov/pr/health/faq.htm, 30 January 2007.

National Marine Fisheries Service (NMFS), 2007b. National Marine Fisheries Service, Office of Protected Resources. Hawaii Viewing Guidelines. Accessed 2/14/07. http://www.nmfs.noaa.gov/pr/education/hawaii/guidelines.htm

National Research Council (NRC), 1994. "Low-frequency Sound and Marine Mammals: Current Knowledge and Research Needs". (National Research Council of the National Academes, National Academes Press, Washington, DC).

National Research Council (NRC), 1996. "Natural Climate Variability on Decade-to-Century Time Scales". (National Research Council of the National Academes, National Academes Press, Washington, DC).

National Research Council (NRC), 2000. "Marine Mammals and Low-Frequency Sound-Progress Since 1994". (National Research Council of the National Academes, National Academes Press, Washington, DC).

National Research Council (NRC), 2003. "Ocean Noise and Marine Mammals". (National Research Council of the National Academes, National Academes Press, Washington, DC).

National Research Council (NRC), 2005. "Marine Mammal Populations and Ocean Noise". (National Research Council of the National Academes, National Academes Press, Washington, DC).

National Research Council (NRC), 2006. "Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options, Committee on Ecosystem Effects of Fishing: Phase II - Assessments of the Extent of Change and the Implications for Policy," (National Research Council, of the National Academes, National Academes Press, Washington, DC).

Nielsen, J. B., F. Nielsen, P. Jorgensen, and P. Grandjean, 2000. "Toxic metals and selenium in blood from pilot whales (*Globicephala melas*) and sperm whales (*Physeter catodon*)," Marine Pollution Bulletin 40, 348-351.

Nieri, M., E. Grau, B. Lamarch, and A. Aguilar, 1999. Mass mortality of Atlantic spotted dolphin (*Stenella frontalis*) caused by a fishing interaction in Mauritania. (Marine Mammal Science 15(3):847-854).

Norman, S. A., and J. G. Mead, 2001. "*Mesoplodon europaeus*," Mammalian Species 688, 1-5.

Norman, S. A., S. Raverty, B. McClellan, A. Pabst, D. Ketten, M. Fleetwood, J. K. Gaydos, B. Norberg, L. Barre, T. Cox, B. Hanson, and S. Jeffries, 2004. "Multidisciplinary investigation of stranded harbor porpoises (*Phocoena phocoena*) in Washington State with an assessment of acoustic trauma as a contributory factor (2 May – 2 June 2003)," (United States Department of Commerce), p. 120.

Nowacek, D., M. P. Johnson, and P. L. Tyack, 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships by respond to alerting stimuli. Proceedings of the Royal Society of London, Series B. Biological Sciences 271:227-231.

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack, 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2):81-115.

Odell, D. K., 1987. The mystery of marine mammal strandings. Cetus 7:2.

O'Hara, T. M. and C. Rice, 1996. Polychlorinated biphenyls. In: A. Fairbrother, L. Locke, and G Hoff (eds). Noninfectious diseases of wildlife, 2nd edition. Iowa State University Press, Ames, Iowa.

O'Hara, T. M., M. M. Krahn, D. Boyd, P. R. Becker, and L. M. Philo, 1999. Organochlorine contaminant levels in Eskimo harvested bowhead whales of arctic Alaska. Journal of Wildlife Diseases 35(4):741-752.

Oliveira de Meirelles, A. C., and H. M. D. R. Barros, 2007. Plastic debris ingested by a rough-toothed dolphin, *Steno bredanensis*, stranded alive in northeastern Brazil. *Biotemas*, 20(1):127-131. March 2007.

O'Shea, T. J., and R. L. Brownell, Jr., 1994. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. Science of the Total Environment 154:179-200.

Osborne, R., 2003. "Historical Information on Porpoise Strandings in San Juan County Relative to the May 5th Navy Sonar Incident," (The Whale Museum News and Events).

Pace, R. M, and G. K. Silber, 2005. Abstract- Simple analyses of ship and large whale collisions: Does speed kill? Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, December 2005.

Palka, D. and M. Johnson (eds), 2007. Cooperative Research to Study Dive Patterns of Sperm Whales in the Atlantic Ocean. Minerals Management Service, New Orleans, LA. OCS Study MMS2007-033. 49 pp.

Parente, C. L., J. P. Araujo, and M. E. Araujo, 2007. Diversity of cetaceans as tool in monitoring environmental impacts of seismic surveys. Biota Neotrop 7(1):1-7.

Paterson, R. A., 1984. "Spondylitis deformans in a Bryde's whale (*Balaenoptera edeni* Anderson) stranded on the southern coast of Queensland," Journal of Wildife Diseases 20, 250-252.

Perrin, W. F., and J. R. Geraci, 2002. "Stranding," in Encyclopedia of Marine Mammals, edited by W. F. Perrin, B. Wursig, and J. G. M. Thewissen (Academic Press, San Diego), pp. 1192-1197.

Piantadosi, C. A., and E. D. Thalmann, 2004. "Whales, sonar and decompression sickness," Nature 15 April 1-2.

Pitman, R. L., L. T. Ballance, S. L. Mesnick, and S. J. Chivers, 2001. "Killer whale predation on sperm whales: Observations and implications," Mar. Mammal Sci. 17, 494-507.

Podesta, M., A. D'Amico, G. Pavan, A. Drouga, A. Komnenou,and N. Portunato, 2006. A review of *Ziphius cavirostris* strandings in the Mediterranean Sea. Journal of Cetacean Research and Mangagement 7(3):251-261.

Polefka, S., 2004. Anthropogenic Noise and the Channel Islands National Marine Sanctuary. Report by Environmental Defense Center, Santa Barbara, CA. 51 pp.

Rankin, J. J., 1953. "First record of the rare beaked whale, *Mesoplodon europaeus*, *Gervais*, from the West Indies," Nature 172, 873-874.

Read, A. J., P. Drinker, and S. Northridge, 2006. "Bycatch of marine mammals in U.S. and global fisheries," Conservation Biology 20, 163-169.

Resnick, D., and G. Niwayama, 2002. "Ankylosing spondylitis," in Diagnosis of bone and joint disorders, edited by D. Resnick (W.B. Saunders Co., Philadelphia), pp. 1023-1081.

Ross, D., 1976. Mechanics of underwater noise. Pergamon, New York. 375 pp.

Richardson, W. J., C. R. Greene Jr., C. I. Malme, and D. H. Thomson, 1995. Marine Mammals and Noise (Academic Press, New York).

Ridgway, S. H. and M. D. Dailey, 1972. "Cerebral and cerebellar involvement of trematode parasites in dolphins and their possible role in stranding," J. Wildlife Dis. 8, 33-43.

Ridgway, S. H. and R. Howard, 1979. "Dolphin lung collapse and intramuscular circulation during free diving: evidence from nitrogen washout," Science 206, 1182-1183.

Robinson, S., L. Wynen, and S. Goldsworthy, 1999. "Predation by a Hooker's sea lion (*Phocarctos hookeri*) on a small population of fur seals (*Arctocephalus spp*.) at Macquarie Island," Mar. Mammal Sci. 15, 888-893.

Ross, P. E., R. L. DeSwart, R. F. Addison, H. VanLoveren, J. G. Vos, and A. Osterhaus, 1996. "Contaminant-induced immunotoxicity in harbour seals: wildlife at risk?" Toxicology 112, 157-169.

Simmonds, M. P. and L. F. Lopez-Jurado, 1991. Whales and the military. Nature 351:448.

Secchi, E. R., and S. Zarzur, 1999. "Plastic debris ingested by a Blainville's beaked whale, *Mesoplodon densirostris*, washed ashore in Brazil," Aquat. Mammals 25, 21-24.

Selzer, L. A. and P. M. Payne, 1988. "The distribution of white-sided dolphins (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States," Mar. Mammal Sci. 4, 141-153.

Sergeant, D. E., 1982. "Some biological correlates of environmental conditions around Newfoundland during 1970-1979: harp seals, blue whales and fulmar petrels," (North Atlantic Fisheries Organization. NAFO. Scientific Council Studies), pp. 107-110.

Simmonds, M. P. and J. D. Hutchinson, 1996. "The Conservation of Whales and Dolphins: Science and Practice". John Wiley & Sons, Chichester, UK.

Simmonds, M. P. and L. F. Lopez-Jurado, 1991. "Whales and the military," Nature 351, 448.

Simmonds, M. P. and S. J. Mayer, 1997. "An evaluation of environmental and other factors in some recent marine mammal mortalities in Europe: implications for conservation and management," Environmental Review 5, 89-98.

Smithsonian Institution, 2000. Cetacean Distributional Database. Marine Mammal Program, Smithsonian Institution, Washington, DC.

Soto, N. A., M. Johnson, P. T. Madsen, P. L. Tyack, A. Bocconcelli, J. F. Borsani, 2006. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (*Ziphius cavirostris*). Marine Mammal Science 22(3): 690-699.

Southall, B. L., R. Braun, F. M. D. Gulland, A. D. Heard, R. W. Baird, S. M. Wilkin, and T. K. Rowles, 2006. "Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004," 73 pp.

Stone, C. J. and M. J. Tasker, 2006. The effects of seismic airguns on cetaceans in U.K. waters. Journal of Cetacean Research and Management 8(3):255-263.

Struntz, W. D. J., J. R. Kucklick, M. M. Schantz, P. R. Becker, W. E. McFee, and M. K. Stolen, 2004. "Persistent organic pollutants in rough-toothed dolphins (*Steno bredanensis*) sampled during an unusual mass stranding event," Marine Pollution Bulletin 48, 164-192.Sweeny, M. M., J. M. Price, G. S. Jones, T. W. French, G. A. Early, and M. J. Moore, 2005. "Spondylitic changes in long-finned pilot whales (*Globicephala melas*) stranded on Cape Cod, Massachusetts, USA, between 1982 and 2000," J. Wildlife Dis. 41, 717-727.

Tarpley, R. J. and S. Marwitz, 1993. "Plastic debris ingestion by cetaceans along the Texas coast: two case reports," Aquat. Mammals 19, 93-98.

Trites, A. W., V. Christensen, and D. Pauly, 1997. "Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean," Journal of Northwest Atlantic Fishery Science 22, 173-187.

Urick, R. J., 1983. Principles of Underwater Sound for Engineers, McGraw-Hill, NY.

U.S. Department of Navy, 2001. Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar- Volume 1.

U.S. Department of Navy, 2004. Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by USS Shoup (DDG 86) in the Haro Strait on or about 5 May 2003. February 2004.

Van Dolah, F. M., 2005. "Effects of Harmful Algal Blooms," in Marine Mammal Research, edited by J. E. Reynolds, W. F. Perrin, R. R. Reeves, S. Montgomery, and T. J. Ragen (John Hopkins University Press, Baltimore), pp. 85-99.

Van Dolah, F. M., G. J. Doucette, F. M. D. Gulland, T. L. Rowles, and G. Bossart, 2003. "Impacts of algal toxins on marine mammals," in Toxicology of Marine Mammals, edited by J. G. Vos, G. D. Bossart, M. Fournier, and T. J. O'Shea (Taylor & Francis, London), pp. 247-269.

Vanderlaan, A. S. M. and C. T. Taggart, 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science 23(1):144-156.

Vidal, O. and J. P. Gallo-Reynoso, 1996. "Die-offs of marine mammals and sea birds in the Gulf of California, Mexico," Mar. Mammal Sci. 12, 627-635.

Visser, I. K. G., J. S. Teppema, and A. D. M. E. Ostrhaus, 1991. "Virus infections of seals and other pinnipeds," Reviews in Medical Microbiology 2, 105-114.

Walker, M. M., J. L. Kirschvink, G. Ahmed, and A. E. Dizon, 1992. "Evidence that fin whales respond to the geomagnetic field during migration," J. Exp. Biol. 171, 67-78.

Walker, R. J., E. O. Keith, A. E. Yankovsky, and D. K. Odell, 2005. "Environmental correlates of cetacean mass stranding sites in Florida," Mar. Mammal Sci. 21, 327-335.

Walsh, M. T., R. Y. Ewing, D. K. Odell, and G. D. Bossart, 2001. "Mass Strandings of Cetaceans," in Marine Mammal Medicine, edited by L. A. Dierauf, and F. M. D. Gulland (CRC Press, Boca Raton), pp. 83-96.

Wartzok, D. and D. Ketten, 1999. "Marine mammal sensory systems," in The Biology of Marine Mammals, edited by J. E. Reynolds, and S. A. Rommel (Smithsonian Institution Press, Washington, DC).

Weise, M. J., D. P. Costa, and R. M. Kudela, 2006. "Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005," Geophysical Research Letters 33, L22S10.

Whitaker, B. R., J. R. Geraci, and A. Stamper, 1994. "The near-fatal ingestion of plastic by a pygmy sperm whale, *Kogia* breviceps," in IAAAM Proceedings, edited by B. Fenwick (Vallejo, CA), p. 108.

Whitehead, H., 2003. Sperm whales. University of Chicago Press, Chicago, Illinois.

Wilkinson, D. M., 1991. "Report to the Assistant Administrator for Fisheries, in Program Review of the Marine Mammal Stranding Networks," (U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Silver Springs, MD), pp. 1-171.

Wilson, J., L. Rotterman, and D. Epperson, 2006. Minerals Management Service Overview of Seismic Survey Mitigation and Monitoring on the U.S. Outer Continental Shelf. Presented to the Scientific Committee of the International Whaling Commission, SC/58/E8. 13 pp.

Wittnich, C., M. Belanger, N. Askin, K. Bandali, and W. J. Wallen, 2004. "Awash in a sea of heavy metals: mercury pollution and marine animals," (Oceanographic Environmental Research Society and Canadian Marine Animal Rescue Network), pp. 1-70.

Ylitalo, G. M., J. E. Stein, T. Hom, L. L. Johnson, K. L. Tilbury, A. J. Hall, T. Rowles, D. Greig, L. J. Lowenstine, and F. M. D. Gulland, 2005. "The role of organochlorines in cancer-associated mortality in California sea lions (*Zalophus californianus*)," Marine Pollution Bulletin 50, 30-39.

Zeeberg, J., A. Corten, and E. de Graaf, 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa.. Fisheries Research 78:186-195.

Zimmerman, S. T. 1991. A history of marine mammal stranding networks in Alaska, with notes on the distribution of the most commonly stranded cetacean species, 1975-1987 In: J.E. Reynolds, and D.K. Odell 9ed). Marine Mammal Strandings in the United States: Proceedings of the Second Marine Mammal Stranding Workshop. NOAA Technical Report NMFS 98.

APPENDIX I

BAIN COMMENT RESPONSES

This page intentionally left blank.

Appendix I – Responses to Bain Letter

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

1

In reviewing whether the parameters employed were based upon the best available science, the implications in the uncertainty in the values, and biases and limitations in the risk function criteria, The commenter asserted that data were incorrectly interpreted by NMFS when calculating parameter values, resulting in a model that underestimates takes. NMFS, in its regulatory capacity for the MMPA, chose the data sets, interpreted the data, and set parameters for the risk function analysis to quantify exposures to mid-frequency sound sources NMFS may classify as Level B takes for military readiness activities. Of primary importance to the commenter was that the risk function curves specified by NMFS do not account for a wide range of frequencies from a variety of sources (e.g., motor boats, seismic survey activities, "banging on pipes"). In fact, all of the commenter's comments concerning "data sets not considered" by NMFS relate to sound sources that are either higher or lower in frequency than MFA sonar, are contextually different (such those presented in whale watch vessel disturbances or oil industry activities), or are relatively continuous in nature as compared to intermittent sonar pings. These sounds from data sets not considered have no relation to the frequency or duration of a typical Navy MFA sonar as described in the Draft EIS/OEIS.

As discussed above and in the Draft EIS/OEIS, NMFS selected data sets that were relevant to MFA sonar sources and selected parameters accordingly. In order to satisfy The commenter's concern that a risk function must be inherently precautionary, NMFS could have selected data sets and developed parameters derived from a wide variety of sources across the entire spectrum of sound frequencies in addition to or as substitutes for those that best represent the Navy's MFA sonar. The net result, however, would have been a risk function that captures a host of behavioral responses beyond those that are biologically significant as contemplated by the definition of Level B harassment under the MMPA applicable to military readiness activities. The commenter's specific comments and the Navy's responses are provided below.

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

This page a duplicate of above

2 Given the results of the modeling for MIRC, having a lower basement value would not result in any significant number of additional takes. This was demonstrated in the Final EIS/OEIS (Table 3.7-6 and Figure 3.7-10) showing that less than 1% of the predicted number of takes resulted from exposures below 140 dB. The commenter further suggests that the criteria used to establish the risk function parameters should reflect the biological basement where any reaction is detectable. The MMPA was not intended to regulate any and all marine mammal behavioral reactions. Congress amended the MMPA to make clear its intention with the amendment to the MMPA for military readiness activities as enumerated in the following National Defense Authorization Act clarification - (i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered. NMFS, in its regulatory capacity for the MMPA, chose the data sets and parameters for use in the risk function analysis to regulate military readiness activities. Congress, by amending the MMPA, specifically is not regulating any and all behavioral reactions.

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

This page a duplicate of above

3 NMFS, as a cooperating agency and in its role as the MMPA regulator, reviewed all available applicable data and determined that there were specific data from three data sets that should be used to develop the criteria. NMFS then applied the risk function to predict exposures that resulted in exposures that NMFS may classify as harassment. (This is described in the Final EIS/OEIS at Section 3.7.3.1.14). NMFS developed two risk curves based on the Feller adaptive risk function, one for odontocetes and one for mysticetes, with input parameters of B=120 dB, K=45, 99% point = 195 dB, 50% point = 165 dB.

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

This page a duplicate of above

4 The risk function methodology assumes variations in responses within the species and was chosen specifically to account for uncertainties and the limitations in available data. NMFS considered all available data sets and determined it to be the best data currently available. While the data sets have limitations, they constitute the best available science.

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

This page a duplicate of above

5

The commenter was concerned that if one animal is "taken" and leaves an area then the whole pod would likely follow. As explained in Appendix F of the Draft EIS/OEIS, the model does not operate on the basis of an individual animal but quantifies exposures NMFS may classify as takes based on the summation of fractional marine mammal densities. Because the model does not consider the many mitigation measures that the Navy utilizes when it is using MFA sonar, to include MFA sonar power down and power off requirements should mammals be spotted within certain distances of the ship, if anything, it over estimates the amount of takes given that large pods of animals should be easier to detect than individual animals.

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

This page a duplicate of above

6

Modeling accounts for exposures NMFS may classify as takes at distances up to 125 km as described in the Final EIS/OEIS (Table 3.7-6). As discussed in Appendix F of both the Final and Draft EIS/OEIS, the MIRC contains a total of 9 distinct environmental provinces with specific sound propagation characteristics. These represent the various combinations of five bathymetry provinces, ten Sound Velocity Profile province, and six high frequency bottom loss classes. Based on these different provinces, the Navy identified different representative sonar modeling areas to fully encompass sound attenuation within the MIRC. Within these provinces, sound attenuated down to 140 dB at distances out to about 125 km (Table 3.7-6). Using these sound propagation characteristics, the risk function modeling for the MIRC resulted in less than 1% of the exposures that NMFS may classify as a take occurring between 120 dB and 140 dB (Table 3.7-6). The area encompassed by this sound propagation, as determined by NMFS for exposures that may constitute harassment, avoids a bias towards underestimation because the risk function parameters were designed with this in mind.

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

This page a duplicate of above

Section 5.2 of the Draft EIS/OEIS evaluated alternative and/or additional mitigations, specifically, as it relates to potential mitigation approaches. The examples of the fundamentally different approaches noted in the comment were addressed in this section of the Draft EIS/OEIS. In addition, NMFS has identified general goals of mitigation measures. These goals include avoidance or minimization of injury or death, a reduction in the number of marine mammals exposed to received levels when these are expected to result in takes, a reduction in the number of times marine mammals are exposed when these are expected to result in takes, a reduction in the intensity of exposures that are expected to result in takes, and reduction in adverse effects to marine mammal habitat.

7 In this regard, NMFS and Navy have identified mitigation measures that are practicable and reasonably effective. For example, the safety zones reduce the likelihood of physiological harm, the number of marine mammals exposed, and the intensity of those exposures.

NMFS and Navy have determined that mitigation measures in conjunction with our understanding of decades of sonar use has resulted in only negligible impacts in the MIRC Section 3.7.3). Mitigation measures that are practicable involve those that reduce direct physiological effects within the TTS and PTS thresholds.

Introduction

The Navy distinguishes two types of takes: Level A, in which there is immediate injury or death; and Level B, in which there is no immediate injury, but cumulative exposure may lead to harm at the population level. However, in certain contexts, Level B harassment may lead to Level A takes through indirect mechanisms.

8 The population effects of Level A takes on populations are relatively easy to assess, as individuals that are killed are obviously removed from the population, and those that are injured are more likely to die whenever the population is next exposed to stress.

Calculating the population effects of Level B takes is a topic of contemporary research (Trites and Bain 2000). For example, Bain (2002a) explored using energetic consequences of behavior change in conjunction with population dynamics models to estimate population effects of Level B takes. Stress concurrent with Level B harassment would have additional population consequences. Stress may occur in the absence of behavioral change, or the absence of change in significant behavioral patterns such as foraging or nursing, or exclusion from optimal habitat. Lusseau et al. (2006) concluded disturbance caused a decline in and posed a significant threat to the survival of the bottlenose dolphin population in Doubtful Sound, New Zealand. While they noted vessel strikes were occurring (Level A takes), cumulative behavioral effects (Level B takes) were believed to be the primary threat to the population.

Models relating acoustic exposure to takes thus are not sufficient by themselves to interpret the effects of noise on populations. It is likely that different magnitudes of effect, whether physical harm, behavioral change that leads to physical harm, disruption of significant behavioral activities, or behavioral changes that pose negligible risk to populations when they occur only rarely but can become significant when exposure is prolonged or repeated, will have different relationships to noise. The different magnitudes of takes will have different population consequences. Thus it will be challenging to synthesize results of multiple studies, as different measured endpoints may belong on different curves relating them to noise, and different endpoints will have different population consequences. Further, the population consequences can depend on the health of the population (Bain 2002a). All these factors need to be considered when evaluating the environmental consequences of exposing marine mammals to noise.

Unconditional effects

9 Temporary Threshold Shifts in captive marine mammals are commonly used as an index of physical harm (e.g., Nachtigall et al. 2003, Finneran et al. 2002 and 2005, Kastak et al. 2005). Limiting experimental noise exposure to levels that cause temporary effects alleviates ethical concerns about deliberately causing permanent injury. However, repeated exposure to noise that causes temporary threshold shifts can lead to permanent hearing loss. In fact, chronic exposure to levels of noise too low to cause temporary threshold shifts can cause permanent hearing loss. Animal models (e.g., rats, cats,

2

Response 8: Navy agrees with the comment and notes that there is no documented decrease in many populations of endangered and non-endangered species in MIRC, where decades of sonar use, training, and RDT&E have occurred, would suggest that there is an absence of Level A effects from those activities.

Response 9: This issue was recognized and discussed as presented in the Draft EIS/OEIS (Section 3.7.2.4.4, page 3.7-44). Based on prior National Oceanic and Atmospheric Administration rulings, NMFS established that exposures resulting in Level A and B harassment cannot be considered to overlap in an analysis of impacts, otherwise the regulatory distinction between the two criteria would be lost and the take quantification required would be ambiguous. To facilitate the regulatory process, a clear and distinct division between Level A and Level B harassments was maintained as required by NMFS in its role as the regulator and a cooperating agency in the Draft EIS/OEIS.

monkeys, chinchillas) have been used for tests of noise causing permanent physical harm (Henderson et al. 1991, Gao et al. 1992, Blakeslee et al. 1978, Clark 1991). Damage to hearing from noise exposure is an example of unconditional injury from noise. OSHA (2007) requires limiting human exposure to noise at 115 dB above threshold (equivalent to 145 dB re 1 μPa for killer whales, Szymanski et al. 1999) to 15 minutes.

Stress reactions are another available index (e.g., Romano et al. 2004). Ayres (personal communication) found evidence suggesting that whale watching results in increased levels of stress hormones in wild killer whales.

Conditional effects

Changes in behavior resulting from noise exposure could result in indirect injury in the wild. A variety of mechanisms for Level B harassment to potentially lead to Level A takes have been identified.

Gas bubble lesions have been observed in beaked whales (Jepson et al. 2003, Fernandez et al. 2005, Cox et al. 2006). A variety of mechanisms have been proposed for this. While some have proposed these may be due to acoustically mediated bubble growth, and hence are an unconditional consequence of noise exposure (Crum and Mao 1996), it is more likely that these result from decompression sickness. That is, changes in dive behavior may prevent clearance of nitrogen gas from the body, resulting in larger bubbles than would occur in undisturbed dive patterns. One possible change is that beaked whales may remain submerged for an unusually long period of time, and then rapidly ascend. The rapid ascent is a change in behavior that prevents nitrogen from remaining in solution in the blood. Zimmer and Tyack (2007) questioned whether the rapid ascent mechanism would actually result in lesions, and proposed another behavior change that might occur is interruption of deep dives. Deep dives allow the lungs to collapse, preventing nitrogen from reaching the body. Further, a series of rapid breaths at the surface can be used to clear nitrogen absorbed under pressure. Interruption of the normal surface interval can allow nitrogen to build up over time. Changes in depths of dives are of more concern than rapid ascents as this mechanism would be applicable to a wide range of species, while if the rapid ascent mechanism is involved, it would be primarily a concern for deep diving species (Zimmer and Tyack 2007).

While failure to flee may lead to injury in beaked whales, flight may lead to injury in other species. Minke whales have been found stranded after sonar exercises (NOAA and Navy 2001). A minke whale was observed traveling at high speed during exposure to mid-frequency sonar in Haro Strait in 2003. It is easy to see how such behavior would lead to stranding when a beach is located in front of the whale, as minke whales lack echolocation and visibility is limited underwater. Exhaustion from rapid flight leading to heart or other muscle damage (Williams and Thorne 1996) could also account for increased mortality such as was observed in harbor porpoises following sonar exercises in Juan de Fuca and Haro Straits in April and May of 2003. Harbor porpoises, in contrast to

3

9 This issue was recognized and discussed as presented in the Draft EIS/OIES (Section 3.7.3.1.10, page 3.7-67). Based on prior National Oceanic and Atmospheric Administration rulings, NMFS established that exposures resulting in Level A and B harassment cannot be considered to overlap in an analysis of impacts, otherwise the regulatory distinction between the two criteria would be lost and the take quantification required would be ambiguous. To facilitate the regulatory process, a clear and distinct division between Level A and Level B harassments was maintained as required by NMFS in its role as the regulator and a cooperating agency in the Draft EIS/OEIS.

Dall's porpoises, rarely engage in sustained high energy activities such as rapid swimming or bow riding, and hence are less adapted to long distance flight responses.

Even successful flight may have negative survival consequences. In the absence of disturbance, individuals will tend to occupy optimal habitat. Displacement from optimal habitat will have consequences that will depend on the duration of the displacement, the quality of the alternate habitat, and the condition of the individuals at the time of displacement.

Separation of individuals from social units is another consequence of noise exposure that may lead to mortality. In 2003 in Haro Strait, some killer whales responded to mid-frequency sonar by seeking shelter behind a reef. Others chose to flee, resulting in splitting of a pod that historically spent all of its time together as a single unit. While no deaths resulted from this particular incident, other killer whales have been observed separated from their social units resulting in death prior to reunion or requiring human intervention to restore the individual to its social unit (Schroeder et al. 2007).

Temporary threshold shifts may conditionally lead to harm. Impaired hearing ability increases vulnerability to ship strike. In 2003, blunt force trauma was identified as a cause of death in the investigation of harbor porpoise mortalities following exposure to mid-frequency sonar in Washington State. A minke whale was nearly struck by a research vessel in the area where one had been observed fleeing mid-frequency sonar exposure. These species are familiar with boats in that area, and normally avoid them by a wide margin when they can hear them coming.

Impaired auditory ability may also increase predation risk. For example, Dahlheim and Towell (1994) reported an attack by killer whales on white-sided dolphins. The approach by the whales went undetected due to the noise of the research vessel. Further, impaired hearing may impair foraging ability and communication (Bain and Dahlheim 1994).

The Risk Function Model

The risk function uses three parameters. B is the received level at which the most sensitive individuals start to respond with changes in significant behaviors such as foraging. K is the difference in received level between the level at which half of individuals respond and the level at which the most sensitive individuals respond. That is, B+K is the level at which 50% of individuals respond. A is a shape parameter that attempts to capture the variability in responsiveness of the population. That is, are essentially all the individuals the same and the bulk of them become responsive when the received level is near B+K, in which case a simple threshold model would provide a good approximation, or is there a lot of variation in the population, in which case many individuals become responsive when received levels are near B?

The model is based on the hypothesis that some individuals start to respond at lower levels than others. It anticipates that some individuals will hold out until very high levels before responding. The model includes parameters that allow it to be applied appropriately to species with differing noise tolerance. However, the Navy used one set of parameter values to predict the responses of all species. This paper reviews the accuracy of the choice of parameter values, the implications of using the wrong parameter values, and whether the model makes unbiased predictions when uncertainty in the parameter values exists.

Limitations

Like many models, the risk model has limitations. It fails to take into account social interactions. For example, the model anticipates that individuals may move away from a source at different exposure levels, but fails to recognize that this would result in individuals becoming separated from the group. This is likely to lead to the curve becoming asymmetrical, with the "holdouts" responding to the behavior of their schoolmates rather than the sound. As the area exposed to lower levels of noise is larger than the area exposed to higher levels of noise, this would result in more individuals being affected than the model predicts for social species.

The model does not account for multiple sources. Kruse (1991), Williams and Ashe (2007) and Bain et al. (2006) noted that killer whale responses to vessels varied with the number of vessels present. The magnitude of certain responses increased on the order of 10% per source, although Williams and Ashe (2007) noted that large numbers of sources could result in changes in the opposite direction of small numbers of sources, potentially canceling out the effect. That is, rather than a risk function that simply identifies how likely a response is to occur, one that takes into account the magnitude of the response would be ideal.

Pingers have been used to reduce entanglement in gillnets. Kraus et al. (1997) were able to reduce entanglement of harbor porpoises by 90%. Gearin et al. (1996, 2000) used more pingers, and were able to reduce entanglement by 95%. While this could be accounted for by the fact that more pingers increase the minimum sound level at the net (Bain 2002b), Laake et al. (1997, 1998, 1999) found porpoises typically remained much farther from the net than the spacing between pingers, even after the avoidance response declined due to habituation. Thus, the effect of multiple sources seems larger than the effect of fewer sources. Pingers have also been successful in protecting other species from nets (Barlow and Cameron, 1999; Cameron 1999, Stone et al. 1997).

In addition to quantitative changes in response to multiple sources, there may be a qualitative change in the response. For example, noise is used in drive fisheries of many odontocete species to cause stranding or near strandings. That is, multiple sources were used to displace individuals in a particular direction, and the consequences (stranding) were more serious than displacement from the source alone as would result from exposure to a single source.

5

The risk to the population of qualitatively different responses varies not only with the type of response, but the circumstances. If the response is going ashore, fatalities are highly likely to result. If the response is slowly moving away for a short period of time, no fatalities are likely to result. However, if the response is to slowly move away from a prime feeding area for an extended period of time, and the population is food limited, fatalities may result, and the number is likely to be related directly to the duration of exclusion from the feeding area, and only indirectly to the cumulative sound energy received.

Finally, the model assumes that marine mammals behave independently from each other. This is not likely to be the case. Even species that are normally solitary, like harbor seals, have been observed to school in response to high energy noise (personal observation). To remain a member of a group, individuals must remain in geographic proximity to each other. As more sensitive individuals move away, others who are not sufficiently disturbed by the sound itself would need to move as well to remain members of the group. The result is likely to be a step function at moderate exposure levels rather than the gradual increase in risk predicted by the model. The result would be that risk is underestimated. The proportion of individuals necessary to lead all individuals to respond in a similar manner to noise is likely to vary among species, and propensity to mass strand may be a good predictor of the importance of this effect.

Datasets

The Navy chose to rely upon three datasets.

Captive cetaceans

Studies of captive marine mammals provide an excellent setting for identifying direct effects of sound. E.g., one of the datasets employed by the Navy consists of studies relating short-term exposure of bottlenose dolphins and belugas to high levels of noise to Temporary Threshold Shifts. The Navy (Dept. Navy 2008b, p 3-7) noted aggressive behavior toward the test apparatus, suggesting stress was another consequence of the test (see also Romano et al. 2004). Such effects would be unconditional results of noise exposure.

However, extrapolation of the level at which aggression was observed to the level at which behaviorally mediated effects might occur in the wild is problematic, as this depends on how well trained the subjects were. For example, the Navy has been a leader in training dolphins and other marine mammals to cooperate with husbandry procedures. Tasks like taking blood, stomach lavage, endoscopic examination, collection of feces, urine, milk, semen and skin samples, etc. once required removing individuals from the water and using several people to restrain them. With training, painful and uncomfortable procedures can be accomplished without restraint and with a reduction in stress that has significantly extended lifespans of captive marine mammals (Bain1988).

6

This was specifically addressed in the Draft EIS/OEIS (Section 3.7.3.1.14) and considered as part of this decision making process. Additional data sets from wild animals were incorporated into development of the risk function parameters specifically to address this concern and these were presented in Section 3.7.3.1.14of the Draft EIS/OEIS. Additionally, as discussed in Domjan 1998, and as cited in the Draft EIS/OEIS, animals in captivity can be more or less sensitive than those found in the wild. It does not follow, therefore, that the risk function modeling underestimates takes.

That is, the absence of avoidance or aggressive behavior does not imply an absence of physical harm, much less the absence of potential for behavior changes that may lead to indirect harm.

Physical harm may occur in the wild without avoidance responses as well. Yano and Dahlheim (1995) found killer whales continued to predate on longlines despite being physically injured by deterrents such as gunshots. Reeves et al. (1996) reviewed other examples from fishery interactions of injurious approaches to deterrence failing.

If belugas and bottlenose dolphins are like killer whales, and the 50% risk level is about 15 dB below the 50% risk level for behavioral change in trained animals (see below), this would put their value around 170 dB re 1 μPa. Even this is likely to be an overestimate, as boat motors with a source level of 165 dB re 1 μPa can cause behavioral changes in bottlenose dolphins (Nowacek et al. 2001.) This new value, 170 dB re 1 μPa, averaged with the other Navy datasets, would drop the average 50% risk level to 160 dB re 1 μPa.

Killer whales

The second dataset is killer whales exposed to mid-frequency sonar from the USS Shoup in Haro Strait, Washington, in May, 2003. The level quoted in the HRC SDEIS (Dept. Navy 2008b) is an estimate of the received levels experienced when mid-frequency sonar was transmitted from about 3 km away. This level caused major behavioral changes in 100% of exposed whales (Risk=1 for Level B takes of a magnitude that in other contexts or species could lead indirectly to physical harm), but was not to believed to have caused Level A takes (the whales did not strand, and received levels were estimated to be too low to have caused threshold shifts, NMFS OPR 2005) in any individuals (Risk = 0). However, much more data are available from the May, 2003 Shoup incident. Behavioral changes were first observed at 47 km (where the received level was estimated to be 121 dB). The behavioral response was tail slapping by about 25% of the individuals observed, which is consistent with observed responses to vessel noise at a similar level. At a distance greater than 22 km, the direction of travel changed away from a feeding area, and hence foraging behavior was disrupted. At this distance, the received level may have increased to the neighborhood of 135 dB re 1 μPa with about 6 dB of reduced spreading loss and 6 dB reduced absorption. This would be comparable to a vessel traveling at low speed approaching to within 10 m, which is very difficult to accomplish without causing whales to turn away. 100% of killer whales responded by abandoning their feeding ground and moving away from the noise source at this received level. While vessels cause diversion from straight-line paths, they have not been observed to displace killer whales from feeding areas (vessels have been observed to displace killer whales from resting areas, but this is likely mediated by presence rather than noise, as the effect is observed in the presence of silent vessels, Trites et al. 1995). Thus it is not surprising that a qualitatively different behavioral response was exhibited. The peak exposure level was estimated to be 175 dB re 1 μPa (HRC SDEIS, although NMFS noted that estimated levels tended to overestimate measured levels by 1-10 dB [NMFS OPR 2005], so the peak exposure level may have been only 165 dB). In addition to changing

7

travel patterns, the pod split, with approximately 50% of the pod continuing to shelter in an acoustic shadow zone, and the other 50% fleeing at high speed. Such behavior has not been observed in the presence of vessels alone. It should be emphasized that 100% of killer whales exhibited a disruption of a significant life process, foraging, at a level that may have been less than 135 dB re 1 μPa, in contrast to the value used in the SDEIS, 169.3 dB re 1 μPa for a 50% response.

Additional datasets are available for killer whale responses to noise. E.g., in Bain and Dahlheim's (1994) study of captive killer whales exposed to band-limited white noise in a band similar to that of mid-frequency sonar at a received level of 135 dB re 1 μPa, abnormal behavior was observed in 50% of the individuals. This is far lower than the level observed in bottlenose dolphins. In addition, Bain (1995) observed that 100% of wild killer whales appeared to avoid noise produced by banging on pipes (fundamental at 300 Hz with higher harmonics) to the 135 dB re 1 μPa contour. This indicates the difference between wild and captive killer whales (non-zero risk in captive marine mammals might correspond to 100% risk in wild individuals of the same species), as well as implying that risk of 100% may occur by 135 dB re 1 μPa for this genus in the wild.

Further, killer whales begin responding to vessel traffic at around 105-110 dB re 1 μPa with minor behavioral changes. By 135 dB re 1 μPa, disruption of foraging may approach 100%. Received level appears to be more important than proximity (Bain 2001). For risk to increase from near 0 at 105 dB re 1 μPa to near 100% by 135 dB re 1 μPa, with A=10, the 50% risk level would need to be about 120 dB re 1 μPa. Substituting 120 for 169 dB re 1 μPa reduces the average level for 50% risk by about 16 dB to 144 dB re 1 μPa. Substituting 135 dB re 1 μPa would reduce the average by 8 dB to 157 dB re 1 μPa.

Finally, the Navy's characterization of the killer whale dataset is incorrect. They indicate the effects observed in the presence of mid-frequency sonar in Haro Strait were confounded by the presence of vessels. However, the effects of vessels on killer whales have been extensively studied (e.g., Kruse 1991, Williams et al. 2002ab, Bain et al. 2006). Behavioral responses attributed to mid-frequency sonar are qualitatively different than those observed to vessels alone. While the observations are anecdotal, they were not inconsistent. The sonar signal was blocked from reaching the whales with full intensity by shallow banks or land masses during three segments of the observation period. The "inconsistencies" can be attributed to differences in behavior depending on whether there was a direct sound path from the Shoup to the whales. It should be noted there was extensive study of this population prior to exposure (see Bigg et al. 1990 and Olesiuk et al. 1990 for a description of typical research protocols), as well as extensive post-exposure monitoring (e.g., Bain et al. 2006).

Right whales

Similarly, the right whale data relied upon are of limited value. While they clearly illustrate that the value at which 50% of animals are influenced is below 135 dB re 1 μPa

8

and are therefore helpful in determining the upper limits of the B+K value, they lack sufficient low level exposures needed to fit the low end of the curve. As with killer whales, the Navy misused the data. They averaged values which resulted in 100% response. Thus the average value exceeds the level resulting in a 50% risk.

Right whales exposed to alerting devices consistently responded when received levels were above 135 dB re 1 µPa. Due to the small sample size (six individuals), it is unclear whether this is close to the 50% risk, the 100% risk level, or both. These data do not allow identification of B, as lower exposure levels were not tested. In mysticetes exposed to a variety of sounds associated with the oil industry, typically 50% exhibited responses at 120 dB re 1 µPa. Thus right whales may be similar to killer whales.

The consequences of using incorrect values can be seen by comparing the observed results of the right whale exposures to alert signals (Nowacek et al. 2004) with those predicted by the Navy model. Using the values of B=120, K=45, and A=10 in the HRC SDEIS (Dept. Navy 2008b), the probability of responses for the exposed whales are shown in column two of Table 1. The formula underestimated the number of takes by a factor of over 500. The Navy proposed using A=8 for mysticetes in recognition of this, and the results are shown in column 3. While improved, the model still underestimated takes by a factor of 183. One could try B=105 and K=15. Using A=10 provides a reasonable approximation, overestimating takes by 20% (column 4). A better approximation is provided by A=2, which predicts the number of takes within 2% (column 5). While the probability of all four right whales exposed to the highest alert signals responding is much less than one in a billion based on the Navy model and allows one to unequivocally reject the Navy's choice of parameter values as applying to that species, numerous other combinations of parameter values would fit the data as well as the values shown in the table here. Substituting 120 dB re 1 µPa for 139 dB re 1 µPa results in an average 6 dB lower at 159 dB re 1 µPa.

9

11 It is noted that an apparent factual inaccuracy with regard to the only citation provided for the repeated assertion that 50% of marine mammals will react to 120 db re 1uPa. Malme et al., (1983, 1984) indicated that for migrating whales, a 0.5 probability of response occurred at 170 dB.

Table 1. Risk for right whales (model vs. observed)

Received Level (dB re 1 μPa)	RISK B=120,K=45,A=10	RISK B=120,K=45,A=8	RISK B=105,K=15,A=10	RISK B=105,K=15,A=2
Responded				
148	0.008647	0.022021	0.999973	0.891548
143	0.001217	0.004641	0.999908	0.86521
137	5.92E-05	0.000415	0.999488	0.819864
135	1.7E-05	0.000153	0.999026	0.800039
133	4.06E-06	4.86E-05	0.998059	0.777052
No Response				
134	8.52E-06	8.79E-05	0.998633	0.788974
Error Factor	502	183	0.83	1.01

Datasets not considered

The Navy incorrectly concludes that additional datasets are unavailable. In addition to the other killer whale datasets mentioned above, data illustrating the use of acoustic harassment and acoustic deterrent devices on harbor porpoises illustrate exclusion from foraging habitat (Laake et al. 1997, 1998 and 1999, Olesiuk et al. 2002). Data are also available showing exclusion of killer whales from foraging habitat (Morton and Symonds 2002), although additional analysis would be required to assess received levels involved. The devices which excluded both killer whales and harbor porpoises had a source level of 195 dB re 1 μPa, a fundamental frequency of 10 kHz, and were pulsed repeatedly for a period of about 2.5 seconds, followed by a period of silence of similar duration, before being repeated. Devices used only with harbor porpoises had a source level of 120-145 dB re 1 μPa, fundamental frequency of10 kHz, a duration on the order of 300 msec, and were repeated every few seconds. Harbor porpoises, which the Navy treats as having a B+K value of 120 dB re 1 μPa (with A large enough to yield a step function) in the AFAST DEIS (Dept.Navy 2008a), 45 dB lower than the average value used in the HRC SDEIS, may be representative of how the majority of cetacean species, which are shy around vessels and hence poorly known, would respond to mid-frequency sonar. Even if harbor porpoises were given equal weight with the three species used to calculate B+K, including them in the average would put the average value at 154 dB re 1 μPa instead of 165 dB re 1 μPa.

Harbor porpoise responses to various acoustic devices have been documented in captivity and the wild. Pingers with a source level of 130 dB re 1 μPa displace wild harbor porpoises to a distance of at least 100-1000 m, where the received level was likely in the

10

12

The data sources the commenter presents as needing consideration involve contexts that are not applicable to the proposed actions or the sound exposures resulting from those actions. For instance, the commenter's citation to Lusseau et al. (2006) involve disturbance over a three year period to a small pod of dolphins exposed to "8,500 boat tours per year", which is nothing like the type or frequency of action that is proposed by the Navy for SOCAL. In a similar manner, the example from noise used in drive fisheries are not applicable to Navy training. Navy training involving the use of active sonar typically situations ships where the ships are located miles apart, the sound is intermittent, and the training does not involve surrounding the marine mammals at close proximity. Further, suggestions that effects from acoustic harassment devices and acoustic deterrent devices which are relatively continuous sound sources (unlike MFA sonar) and are specifically designed to exclude marine mammals from habitat, are also fundamentally different from the proposed actions and the use of MFA sonar. Finally, reactions to airguns used in seismic research or other activities associated with the oil industry are also not applicable to MFA sonar since the sound/noise sources, their frequency, source levels, and manner of use are fundamentally different.

neighborhood of 80-90 dB re 1 μPa. Studies of harbor porpoises in captivity also found responses to acoustic deterrent devices, but could not be tested at such distances due to limitations in facility size (Kastelein et al. 1997, 2001). This is another example of how studies with captive cetaceans can produce misleading results. Airmar devices with a source level of 195 dB re 1 μPa displaced an estimated 95% of harbor porpoises to a distance of 3 km. While received levels were not measured, they could have been in the neighborhood of 120-130 dB re 1 μPa. These findings are well modeled with a B value of 70 dB re 1 μPa, a K value of 25, and an A value of 4.

Many species are poorly known, due in part to difficulties approaching them from boats and in part because they do not fare well in captivity. Species that may exhibit vulnerability to noise comparable harbor porpoises include many species of Stenella (e.g., striped dolphins), beaked whales, sperm whales (which are best studied from sailboats rather than motorized vessels, and show disruption of foraging at levels below 130 dB re 1 μPa, Jochens et al. 2006), and numerous poorly known species. In contrast, Dall's porpoises are known to bow ride, and appear far less easily disturbed by noise from airguns than harbor porpoises (Calambokidis et al. 1998). They may be an example of a relatively noise tolerant species like the bottlenose dolphins included in the SDEIS.

There are also data that are based on other noise sources. E.g., effects of vessel traffic on whale and dolphin behavior could be interpreted in terms of received levels. While engine noise tends to be continuous rather than intermittent like sonar, in a reverberant environment, mid-frequency sonar may be received as a nearly continuous sound (personal observation).

Likewise, records of marine mammal responses to broadband noise sources like airguns are also likely to be informative. While it may be difficult to extrapolate levels resulting in takes due to potential differences in perception of broadband and narrowband signals, and pulses rather than continuous sounds, they can give an idea of the range of intra-specific and inter-specific variation in B and K values and be applicable to determining the A parameter.

E.g., Calambokidis et al. (1998) found harbor seal responses to airguns typically consisted of visually orienting at received levels from 143 to 158 dB re 1 μPa and moving away at received levels from 158 dB to 185 dB re 1 μPa. However, one harbor seal oriented at 163 dB re 1 μPa rather than moving away. The highest measured received levels for Dall's porpoises were about 170 dB re 1 μPa, but only about 142 dB re 1 μPa for harbor porpoises. Similarly, the highest received levels measured for California sea lions were about 180 dB re 1 μPa, but only about 160 dB re 1 μPa for Steller sea lions. The highest measured received level was also 160 dB re 1 μPa for gray whales. That is, closely related species pairs may differ in their responsiveness to noise by over 20 dB, and taxonomically diverse species pairs may exhibit similar responsiveness.

TTS data similar to those available for cetaceans have been collected from harbor and elephant seals, and California and Steller sea lions (Kastak et al. 1999, 2005). As with cetaceans, field data suggest the Navy parameter values will underestimate takes of some pinniped species, though they may provide a reasonable approximation for harbor seals and California sea lions (e.g., the data described above). Pinniped hearing in species studied to date is less sensitive than in cetaceans (e.g., California sea lions, Schusterman et al. 1972; Steller sea lions, Kastelein et al. 2005; harbor seals, Møhl 1968; northern fur seals, Moore et al. 1987; odontocetes, Au 1993), and it is commonly assumed they are less vulnerable to noise as a result. However, comparisons of Steller sea lions with Dall's porpoises and gray whales exposed to airgun noise indicates this is not always the case. A detailed consideration of pinnipeds is beyond the scope of this paper.

Using the datasets discussed above, 50% risk levels based on trained cetaceans may be 165 dB re 1 μPa, 120 dB re 1 μPa for killer and right whales, and 95 dB re 1 μPa for harbor porpoises. The average of 95, 120, 120 and 165 is 125 dB, 40 dB lower than the 50% risk value of 165 dB used in the Navy model. Even if one uses more stringent criteria for what constitutes takes (120 dB for harbor porpoises, 135 dB for killer and right whales, and 170 dB for bottlenose dolphins), the average would be 140 dB, which is 25 dB lower than the Navy model. Setting B to 100, K to 40, and A to 10 would result in roughly 40 times the number of takes than the model predicts using the Navy's parameter values.

Parameter values

The use of default values for model parameters is problematic. The available data are likely to be biased toward noise tolerant species. That is, species that are intolerant of noise are difficult to approach closely enough to study. They tend to fare poorly in captivity. E.g., spinner dolphins and harbor porpoises showed very poor survivorship in captivity, in contrast to bottlenose dolphins (Bain 1988). Thus averages based on available data are likely to underestimate effects on species for which data are not available.

While the Navy has proposed assuming noise tolerance is predictable along taxonomic lines, which correlate with hearing ability, empirical data do not support this assumption (Bain and Williams 2006). Likewise, there is interspecific variation in noise tolerance in fish (Kastelein 2008).

B Value

The basement value should be set low enough that the risk function predicts takes at the lowest of the level resulting in unconditional injuries, the level at which behaviorally mediated injuries are possible, and the level resulting in minor behavioral changes or stress that can have population level effects with sustained or repeated exposure.

An important property of the model is that the biologically observed basement value is different than the mathematical basement value. The Navy proposes using 120 dB re 1 μPa as the basement value. They indicate the selection of this value is because it was commonly found in noise exposure studies. However, 120 dB re 1 μPa has broadly been

12

13 It is noted that an apparent factual inaccuracy with regard to the only citation provided for the repeated assertion that 50% of marine mammals will react to 120 db re 1uPa. Malme et al., (1983, 1984) indicated that for migrating whales, a 0.5 probability of response occurred at 170 dB.

found as the value at which 50% of individuals responded to noise, not a small percentage. Further, a mathematical B of 120 dB corresponds to a risk of less than 2% at 150 dB (with K=45 and A=10), which would be difficult to detect in empirical studies. That is, the studies should be re-evaluated to determine the level at which a small percentage of individuals responded, and then a further correction for the difference between mathematical B and the empirically determined biological B would be needed.

However, further consideration should be given to the nature of the responses used in those studies to determine whether they represent significant behavioral changes or are only likely to have a population scale effect with sustained or repeated exposure.

For example, many looked at changes in migration routes resulting from noise exposure, and found that 50% of migrating whales changed course to remain outside the 120 dB re 1 μPa contour (Malme et al. 1983, 1984). These results might be interpreted in several ways. They could be seen as minor changes in behavior resulting in a slight increase in energy expenditure. Under this interpretation, they would not qualify as changes in a significant behavior, and are irrelevant to setting the basement value. They could be interpreted as interfering with migration, even though the whales did not stop and turn around, and hence 120 dB would make an appropriate B+K value rather than B value. Third, the change in course could have been accompanied by a stress response, in which case the received level at which the course change was initiated rather than the highest level received (120 dB re 1 μPa) could be taken as the biological basement value.

(See response to #13 above)

As discussed above, sensitive species like harbor porpoises may be significantly affected by levels below 100 dB re 1 μPa (Kastelein et al. 1997, 2000, 2001). Foraging behavior of killer whales can be disrupted by levels on the order of 105-110 dB re 1 μPa or less (Williams et al. 2002ab, data in Bain et al. 2006). These are far below the 120 dB re 1 μPa level proposed, and as mentioned above, the mathematical B value needed to predict detectable changes at 110 dB would be far lower than 110 dB. For example, B=80, K=45, and A=10 predicts a risk of less than 2% at 110 dB.

K Value

The K value reflects the difference between the mathematical B value and the level at which 50% of individuals respond. Since determining the B value has problems of its own, this critique will focus on determining the B+K value. The 50% risk level is relatively easy to determine, and has been commonly reported in the literature, as noted in the SDEIS. However, the most common value was 120 dB re 1 μPa, as noted in the SDEIS, yet these studies were not used to calculate B+K. Instead, other datasets were used, and the numbers derived were not the 50% risk levels. As mentioned above, there are problems with extrapolation of responses in trained animals to wild animals, and the right and killer whale values were based on levels that resulted in nearly 100% risk, not 50% risk. (It may not be possible to determine a level at which 50% risk occurred in killer whales, but perhaps collaboration among killer whale researchers, whale watch operators, and the Navy might identify the B+K level for that event).

13

The 50% risk level is the median level at which individuals begin to respond, not the mean as calculated in the SDEIS. While there are data suggesting risk of threshold shift is related to duration of exposure, and hence the consequences of exposure to continuous noise sources would be different than exposure to intermittent sources, there are no such data for behaviorally mediated effects. Many species strongly avoid motorized vessels, and hence are more vulnerable to noise than the average of the species considered above. Such species are likely to include those in the sperm and beaked whale families, Pacific right whales, blue whales, melon-headed and pygmy killer whales, right whale dolphins, and Clymene, striped and rough-toothed dolphins. A smaller number of species, like Dall's porpoises, are more tolerant of noise sources than the average of the species considered above. Thus it is unlikely that the average value of B+K across cetacean species would be above 120 dB re 1 μPa, although the value would vary across species.

A value

While the A value is described as relating to the sharpness of the risk function, it also influences the symmetry of the function. As A increases, risk is redistributed from low noise levels to higher noise levels. The relative risk to the population, as opposed to risk to individuals, can be described as the risk to individuals at a given received level times the relative number of individuals receiving that level. As the sound spreads to larger areas, more individuals are exposed to lower levels of noise. The shape of the risk function and the spreading loss model determine the received level that poses the most risk to the population. At high received levels, the risk to the population may be small, because although the risk to individuals is high, the number of individuals likely to be exposed is small. At low levels, the risk to the population may be again small, because although the number of individuals exposed is high, the risk to those individuals is low. At intermediate values, the population experiences the most risk. When A is low, the risk to the population peaks near B, and at high A values, the risk is concentrated near B+K.

The choice of A value appears arbitrary. The Navy indicated they wanted to allow for more response at low levels, and adjusted the A value to accomplish this. However, this would have been better accomplished by lowering the B and B+K values as suggested above.

The significance of an A value underestimating the number of individuals responding to low levels of noise and overestimating the number of individuals responding to high levels of noise is that the area exposed to low levels of noise is larger than the area exposed to high levels of noise, so the calculation would lead to an underestimate of takes.

Calambokidis et al. (1998) employed an appropriate methodology for obtaining data for calculating A values of marine mammals exposed to airguns. They used a small vessel which moved toward and away from the seismic survey vessel, and hence were able to observe behavior and measure received values at distances of over 70 km as well as close

14

to the seismic survey vessel. Thus they were able to observe normal behavior in the presence of low levels of noise, as well as identify levels above which 100% of individuals exhibited behavioral change, and note inter-specific variation in response curves.

Interaction of Terms

It appears that B+K is a stronger predictor of the number of takes than either factor separately. As a result, similar risk curves can be generated for many different pairs of B and K as long as the sum is held constant. K and A together determine the range over which risk rises from 5% to 95%. Similarly, pairs of K and A over a range of values can generate similar risk curves.

With B=120, K=45, and A=10, the risk function predicts risk is near zero at received levels near 120, and that over 99.9% of takes will occur above 138 dB re 1 µPa. Even with A = 8, 99.9% of takes occur at levels above 135 dB. With A values this large, B is better described as the level at which the risk function is undefined (it requires dividing by 0) rather than the level at which risk becomes negligible. That is, the mathematical basement value and the biological basement value are different. The level at which data from marine mammals show barely detectable risk will be far above the mathematical basement value when K is 45 and A is 8 or 10. When K or A are small, the mathematical and biological B values become similar.

Another way of looking at the difference between the mathematical and biological basement value is to ask how much risk is detectable. In field studies, it will be difficult to distinguish responses that occur in only 5% of individuals from baseline behavior. Even if a study were sensitive enough to detect this, the received level to cause 5% risk is more than 30 dB above the mathematical B value for B=120, K =45 and A=8 or 10. That is, if risk becomes biologically detectable at 120 dB, the B value used in the equation for risk should be far lower. When the model uses the biological B value as the mathematical B value, it does not accurately predict the observed pattern of takes.

Long range effects

The Navy expressed uncertainty over whether there would be long distance effects, even when sound levels were received that are known to cause effects at close range. While I am not aware of observations at 65 nautical miles, responses at over 20 miles have been observed in killer whales to mid-frequency sonar, as well as at over 15 miles to mid-frequency sonar in Dall's porpoises, and harbor porpoises appeared to respond to airguns at over 40 nm (personal observation). The porpoises were responding at distances greater than they would respond to natural predators (killer whales), which are not believed to be detectable at those ranges.

15

Further evidence of long range responses to noise can be seen in differences in detection rates of some species using acoustic means and ship-based observations. Such studies indicate that species like Pacific right whales and blue whales avoid motorized vessels at distances which place them over the horizon (Wade et al. 2006, Širović 2006).

Uncertainty and Bias

To assess the effects of uncertainty in the parameter values (B, K, and A) on bias in the estimated number of takes, the following method was used. Two spreading loss models were used. A spherical spreading loss model was used, although this was likely to underestimate received levels, particularly at long distances. The other was spherical spreading at close range followed by a cylindrical spreading loss at longer distances model. An accurate model would depend on actual conditions, which would vary from one sonar exercise to another, both as bottom topography varies from place to place and the structure of the water column varies from time to time. The two models chosen should bracket actual conditions, and will serve for purposes of illustration at this stage. In both models, absorption at 3.5 kHz was used to correct for excess attenuation (Richardson et al. 1995). A source level of 235 dB re 1 μPa was assumed for purposes of illustration.

Individuals were assumed to be distributed uniformly with distance from the source, although in practice, action areas will be large enough that density could reasonably be expected to vary. The action area was divided into concentric rings 10 meters across. As the diameter of the ring increased, the area within the ring increased:

$$A = \pi r_o^2 - \pi r_i^2$$

where r_o is the outer diameter and r_i is the inner diameter of the ring.

The risk was calculated for individuals within the ring using the Navy equation, and the relative number of individuals experiencing that risk level was based on the area of the ring. As in the equation for the individuals, the cumulative impact on the population was normalized to 1 based on the Navy default parameters. The effects of uncertainty were observed by allowing the parameters to vary above and below the default values.

Using this model, the contributions of the innermost rings were small, due to their small area, and the contribution of the outermost rings were small, due to the low risk experienced by individuals in those ring. Figures 1-20 show the shape of the risk function and the relative numbers of takes that would occur as a function of received level for a variety of parameter value combinations.

Selected values of B, K and A were used to calculate relative effects, and the results are shown in Table 2 for a spherical spreading model, and Table 3 for a model that assumes spherical spreading for the first 2 km and then cylindrical spreading after that. The default values are shown in bold. Take numbers are based on Alternative 3 in the Hawaii

16

Range Complex SDEIS (Dept. Navy 2008b), which in turn is based on the No Action Alternative, Table 3.3.1-1. Where the number of takes approaches the size of the population, the actual number of takes will be smaller than shown in the table. However, individuals will be taken multiple times and the duration of takes will be longer than if the calculated number of takes were small. Presumably, longer and more frequent takes of individuals will have more impact on the population than takes due to single exposures.

Table 2. Sensitivity Analysis based on a spherical spreading model

B	K	A	Spreading Model	Relative Effect	Humpback takes	Striped Dolphin takes	Basis
80	45	10	Inv. Square	185.29	2,826,414	867,898	Vary B
90	45	10	Inv. square	75.25	1,147,864	352,471	Vary B
100	45	10	Inv. square	23.92	364,876	112,041	Vary B
110	45	10	Inv. square	5.68	86,643	26,605	Vary B
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
130	45	10	Inv. square	0.14	2,136	656	Vary B
140	45	10	Inv. square	0.02	305	94	Vary B
120	5	10	Inv. Square	167.18	2,550,164	783,071	Vary K
120	15	10	Inv. square	62.22	949,104	291,439	Vary K
120	25	10	Inv. square	18.33	279,606	85,858	Vary K
120	35	10	Inv. square	4.47	68,185	20,937	Vary K
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	55	10	Inv. square	0.23	3508	1077	Vary K
120	65	10	Inv. square	0.06	915	281	Vary K
120	75	10	Inv. square	0.01	153	47	Vary K
120	45	1	Inv. square	42.40	646,770	198,602	Vary A
120	45	5	Inv. square	3.27	49,881	15,317	Vary A
120	45	8	Inv. square	1.40	21,356	6,558	Vary A
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	45	12	Inv. Square	0.80	12,203	3,747	Vary A
120	45	20	Inv. Square	0.52	7,932	2,436	Vary A
120	45	100	Inv. Square	0.39	5,949	1,827	Vary A
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
105	15	10	Inv. square	251.39	3,834,703	1,177,511	*Orcinus*
105	15	8	Inv. square	250.96	3,828,144	1,175,497	
70	25	10	Inv. square	1070.25	16,325,594	5,013,051	*Phocoena*
70	25	8	Inv. square	1067.49	16,283,492	5,000,123	*Phocoena*

17

14 The values suggested as parameters, the results of which are presented in the above mentioned tables, are not reasonable given the environmental conditions in MIRC have ambient noise (naturally occurring background noise) levels at or above those suggested by the commenter as behavioral harassment "B" basement values. The use of these results for examination of potential uncertainty and bias in the risk function as presented in the Draft EIS/OEIS is, therefore, not informative or applicable in the MIRC context.

Table 3. Sensitivity analysis based on a model with spherical spreading for 2 km followed by cylindrical spreading.

B	K	A	Spreading Model	Relative Effect	Humpback takes	Striped Dolphin takes	Basis
80	45	10	Hybrid	132.20	2,016,579	619,225	Vary B
90	45	10	Hybrid	65.31	996,239	305,912	Vary B
100	45	10	Hybrid	25.30	385,926	118,505	Vary B
110	45	10	Hybrid	6.67	101,744	31,242	Vary B
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
130	45	10	Hybrid	0.08	1,220	325	Vary B
140	45	10	Hybrid	.005	76	23	Vary B
120	5	10	Hybrid	127.23	1,940,771	595,947	Vary K
120	15	10	Hybrid	59.67	910,213	279,496	Vary K
120	25	10	Hybrid	21.39	326,238	100,177	Vary K
120	35	10	Hybrid	5.37	81,901	25,149	Vary K
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	55	10	Hybrid	0.18	2,724	836	Vary K
120	65	10	Hybrid	0.04	570	175	Vary K
120	75	10	Hybrid	0.01	143	44	Vary K
120	45	1	Hybrid	34.16	521,077	160,005	Vary A
120	45	5	Hybrid	3.65	55,665	17,093	Vary A
120	45	8	Hybrid	1.51	23,016	7,067	Vary A
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	45	12	Hybrid	0.73	11,103	3,409	Vary A
120	45	20	Hybrid	0.35	5,353	1,644	Vary A
120	45	100	Hybrid	0.17	2,593	796	Vary A
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
105	15	10	Hybrid	171.9	2,622,166	805,181	*Orcinus*
105	15	8	Hybrid	171.3	2,612,718	802,279	
70	25	10	Hybrid	516.41	7,877,318	2,418,864	*Phocoena*
70	25	8	Hybrid	514.46	7,847,573	2,409,731	*Phocoena*
80	45	10	Hybrid	132.20	2,016,579	619,225	"Average"species
100	40	10	Hybrid	40.88	623,525	191,464	Stringent criteria
120	45	10	Social75	1.004	15,315	4,703	75% step
120	45	10	Social50	1.06	16,169	4,965	50% step
120	45	10	Social25	1.49	22,728	6,979	25% step
120	45	10	Social10	3.02	46,067	14,146	10% step

18

15 (See response to #14 above)

An interesting characteristic of the Navy model is that uncertainty causes it to be biased to underestimate risk. The reason for this bias is that the area receiving higher than the level of sound associated with a 50% risk based on default values is smaller than the area receiving lower levels. Thus if a species is 10 dB more sensitive than predicted (the B value), the cumulative risk is underestimated by a factor of 5.68, while if it is overestimated by 10 dB the correction is 0.14. Similarly, if the error is 20 dB, the correction factors are 23.92 and 0.02, respectively. However, the values average to 6.15, not 1 as would be the case if the default values provided an unbiased estimate. Errors in K show a similar pattern.

Likewise, if the default value of A is too low, it makes little difference in the estimated number of takes. However, if the default value of A is higher than the actual value, the effect on the population can be seriously underestimated when default values are used.

It should also be noted that the bias increases with increasing uncertainty.

Another source of uncertainty is propagation. As noted above, there is uncertainty over propagation that depends on the structure of the water column. Expectations can be based on historical measurements, and actual conditions can be measured to allow re-running propagation models with actual conditions. However, when received levels as a function of distance are higher than predicted, the result is asymmetrical relative to an error of the same magnitude in the opposite direction, as is the case for errors in the receiver parameters. E.g., when a sound channel forms, the area receiving enough noise to cause takes will dramatically increase.

Finally, the magnitude of the difference between parameter values based on reanalysis of the datasets used by the Navy (with harbor porpoises added, a species included in the AFAST Draft DEIS, Dept. Navy 2008a), and the Navy analysis should be emphasized. The number of takes predicted for an average species differs by a factor of more than 100. For humpbacks, this suggests individuals would be taken an average of about 250 times. Of course, when refresh times are taken into account, the number of retakes would be below this number, but the duration of takes would go up as a result. The cumulative effect on the population is likely to be far higher with the increased number and duration of takes predicted when more realistic parameters are used than when the Navy parameters are used.

SEL vs. SPL

Studies with captive marine mammals suggest that SEL provides a good predictor of Temporary Threshold Shift. That is, there is a tight relationship among signal strength, duration, and TTS. However, for behaviorally mediated effects, this relationship is likely to be different. SPL is likely to qualitatively determine the response for signals longer than 1 ms in duration. As long as signals are produced sufficiently often, the duration from the first signal to the last is likely to be more important than the SEL. That is, for

19

low received levels, one second signals produced every 40 seconds for 120 minutes are likely to have more impact than a continuous signal that lasts 10 minutes, even though the latter contains far more sound energy (600 seconds versus 180 seconds), as a behavioral response will be sustained for hours rather than minutes.

When attempting to predict effects of takes on the population, a take table with multiple columns should be developed. One based on SEL could be used to characterize direct effects such as threshold shifts. The next two should be based on SPL. The first of these should be analyzed to evaluate the total number of individuals that would change their behavior as a result of noise exposure, with particular attention paid to exposure in high risk areas (canyons, near shore, near shipping lanes) for potential indirect injuries. The third analysis would consider duration of exposure (in hours of exercise rather than in the SEL sense) to determine whether factors such as stress, displacement from preferred habitat, changes in foraging success and predation risk, etc., would result in cumulative effects that would alter population growth in a manner equivalent to lethal removals (Bain 2002a).

Summary

In summary, development of a function that recognizes individual variation is a step in the right direction. However, the selected equation is likely to produce underestimates of takes. This is due both to social factors increasing the likelihood of a response at low exposure levels, and asymmetries in the number of individuals affected when parameters are underestimated and overestimated due to uncertainty. Thus it will be important to use the risk function in a precautionary manner.

The sensitivity analysis reveals the importance of using as many datasets as possible. First, for historical reasons, there has been an emphasis on high energy noise sources and the species tolerant enough of noise to be observed near them. Exclusion of the rarer datasets demonstrating responses to low levels of noise biases the average parameter values, and hence underestimates effects on sensitive species. In particular, exclusion of the Navy's own interpretation of harbor porpoise data resulted in an increase of B+K by 11 dB, and a reduction in estimated takes by a factor of about 5. Second, uncertainty is correlated with bias. That is, even if a representative set of noise exposure-response data are used to calculate parameter values, the statistical uncertainty resulting from small samples results in biased parameter estimates that lead to underestimation of effects. Thus when estimating takes, it will be important to correct for bias. When estimating population effects on poorly known species, it will be important to be precautionary.

An important error in the selection of parameter values was in interpretation of existing data. Extrapolating behavioral changes in beluga and killer whales and bottlenose dolphins trained to tolerate physical harm that is in their long-term best interest to the threshold for onset of any physical harm in wild individuals is problematic. A similar mistake was made with the right whale data. The level at which 100% of individuals responded was used as the value at which 50% of individuals responded (B+K).

20

Likewise, the level at which 100% of killer whales responded to mid-frequency sonar is less than the value derived for B+K in the HRC SDEIS (Dept. Navy 2008b).

The "broad overview" of studies reported responses to received levels of 120 dB re 1 µPa by 50% of individuals. That is, 120 dB re 1 µPa should be taken as a "default" value for B+K, not B. Studies which looked at the level at which statistically significant changes were observed, rather than the level at which 50% of individuals responded found lower levels for B. As a result, B is overestimated, and B+K (the level at which risk is 50%) is as well. The use of data from trained dolphins and white whales biased the average B+K value upward. The exclusion of the effects of AHD's and ADD's on harbor porpoises further biases these values, though the sensitivity analysis suggests that using average values to extrapolate takes is unlikely to be accurate due to the broad range of inter-specific variation.

It is likely that biological B values should be in the range from just detectable above ambient noise to120 dB re 1 µPa. The resulting mathematical B value could be tens of dB lower, not the 120 dB re 1 µPa proposed. For many species, risk may approach 100% in the range from 120-135 dB re 1 µPa, putting K in the 15-45 dB range. A values do not seem well supported by data, and in any case, are likely to be misleading in social species as the risk function is likely to be asymmetrical with a disproportionate number of individuals responding at low noise levels. Re-evaluating the datasets identified by the Navy and including harbor porpoises, an average B+K value of 125 dB was found, and the over-representation of species that fare well in captivity likely biases the average above what it would be for all species. Rather than one equation fitting all species well, parameters are likely to be species typical. As realistic parameter values are lower than those employed in the HRC SDEIS (Dept. Navy 2008b), AFAST DEIS (Dept. Navy 2008a) and related DEIS's, take numbers should be recalculated to reflect the larger numbers of individuals likely to be taken. The difference between the parameter values estimated here and those used in the SDEIS suggests takes were underestimated by two orders of magnitude.

The large number of takes predicted when more sensitive species are used as sources of the parameters indicates that many individuals are likely to be taken many times, and the potential for population scale effects to result from small behavioral changes becomes significant.

Assuming spherical spreading out to 2 km followed by cylindrical spreading, B=120, K=45 and A=10 (the Navy values), most takes occur where the received level is greater than 157 dB re 1 µPa and the distance is less than 13 km. With stringent criteria for what constitutes a take derived in the reanalysis (B=120, K=20, A=10), most takes would occur where the received level is below 145 db re 1 µPa and the distance is over 43 km. With the average values calculated here (B=80, K=45, and assuming A=10), most takes would occur where the received level is below 135 dB re 1 µPa and the distance is over 80 km. These values predict over 100 times more takes as the Navy values, as well as the need for very different approaches to mitigation.

21

The Navy recognizes that the occurrence of conditional effects is important to assessing the impact of noise exposure. As such effects are the result of both received levels and environmental conditions, permit conditions will be important in determining these. The potential for conditional harm suggests using mitigation to limit the potential for actual harm. E.g., the risk of causing stranding can be minimized by restricting exercises to areas far from shore. Limiting the duration of exposure can limit the consequences of long-term displacement, risk of injury from prolonged flight, and limit cumulative effects. The risk of causing gas bubble lesions can be minimized by restricting use near canyons, for extended periods of time, and limiting the number of sources. The absolute effects can be minimized by conducting exercises in areas where population density is low, or at times of year when species of concern are absent.

Finally, it will be important to assess the cumulative effects of noise combined with other factors and population status (Wade and Angliss 1997) to assess the likely effects of sonar exercises on marine mammal populations.

Literature Cited

Au, W. W. L. 1993. Sonar of dolphins. Springer-Verlag. New York.

Bain, D. E. 1988. A journey through the NMFS Marine Mammal Inventory. Proc. 1987 Int. Mar. Anim. Trainers Assoc. Conf. 103-130.

Bain, D. E. and M. E. Dahlheim. 1994. Effects of masking noise on detection thresholds of killer whales. In (T. R. Loughlin, ed.) Marine Mammals and The Exxon Valdez. Academic Press. N.Y. 243-256.

Bain, D.E. 1995. "The use of sound to guide killer whales (*Orcinus orca*) entrapped in Barnes Lake, Alaska, to open water." Poster presented to the Society for Marine Mammalogy Conference, Orlando, FL.

Bain, D. E. 2001. Noise-based guidelines for killer whale watching. Paper submitted to the Wildlife Viewing Workshop. Vancouver, BC.

Bain, D. E. 2002b. Acoustical properties of pingers and the San Juan Island commercial gillnet fishery. NMFS Contract Report No. 40ABNF701651. 14 pp.

Bain, D. E. 2002a. A model linking energetic effects of whale watching to in killer whale (*Orcinus orca*) population dynamics. Contract report submitted to Orca Relief Citizens' Alliance.

Bain, D. E., R. Williams. J. C. Smith and D. Lusseau. 2006. Effects of vessels on behavior of southern resident killer whales (*Orcinus* spp.) 2003-2005. NMFS Contract Report No. AB133F05SE3965. 65 pp.

22

Bain, D.E. and Williams, R. 2006. Long-range effects of airgun noise on marine mammals: responses as a function of received sound level and distance. IWC SC/58/E35.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. PaperIWC SC/S1/SM2. 20 pp.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. IWC Special Issue 12:383-405.

Blakeslee, E.A., K. Hynson, R. P. Hamernik and D. Henderson D. 1978. Asymptotic threshold shift in chinchillas exposed to impulse noise. J. Acoust. Soc. Amer. 63:876-882

Calambokidis, J., D. E. Bain and S. D. Osmek. 1998. Marine mammal research and mitigation in conjunction with air gun operation for the USGS "SHIPS" seismic surveys in 1998. Contract Report submitted to the Minerals Management Service.

Cameron, G. 1999. Report on the effect of acoustic warning devices (pingers) on cetacean and pinniped bycatch in the california drift gillnet fishery. NMFS Contract Report No. 40JGNF900207.

Clark, W. W. 1991. Recent studies of temporary threshold shift (TTS) and permanent threshold shift (PTS) in animals. J Acoust Soc Amer. 90:155-63.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'amico, G. D'spain, A. Fern´andez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management 7:177–187.

Crum, L. A. and Mao, Y. 1996. Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. J. Acoustical Soc. Am. 99(5):2898-2907.

Dahlheim, M. E. and R. G. Towell. 1994. Occurrence and distribution of Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) in Southeastern Alaska, with notes on an attack by killer whales (*Orcinus orca*). Marine Mammal Science. 10:458-464.

23

Department of the Navy. 2008a. Draft Atlantic Fleet Active Sonar Training Environmental Impact Statement/Overseas Environmental Impact Statement.

Department of the Navy. 2008b. Hawaii Range Complex Supplement To The Draft Environmental Impact Statement/Overseas Environmental Impact Statement.

Fernandez, A., J.F. Edwards, F. Rodriguez, A. Espinosa de los Monteros, P. Herraez, P. Castro, J.R. Jaber, V. Martin, and M. Arbelo, 2005. "Gas and fat embolic syndrome involving a mass stranding of beaked whales (Family Ziphiidae) exposed to anthropogenic sonar signals," Veterinary Pathology, 42:446-457.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and S.H. Ridgway, 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. Journal of Acoustical Society of America, 118:2696-2705.

Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder and S. H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. J. Acoust. Soc. Amer. 111:2920-2940.

Gao, W. Y., D. L. Ding, X. Y. Zheng, F. M. Ruan and Y. J. Liu. 1992. A comparison of changes in the stereocilia between temporary and permanent hearing losses in acoustic trauma. Hear. Res. 62:27-41.

Gearin, P. J., M. E. Gosho, L. Cooke, R. Delong, J. Laake and D. Greene. 1996. Acoustic alarm experiment in the 1995 Northern Washington Marine Setnet Fishery. NMML and Makah Tribal Fisheries Management Division Report.

Gearin, P. J.; Gosho, M. E.; Laake, J. L.; Cooke, L. Delong, R. L.; Hughes, K. M. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. Journal of Cetacean Research and Management. 2: 1-10.

Henderson D., M. Subramaniam, M. A. Gratton and S. S. Saunders. 1991. Impact noise: the importance of level, duration, and repetition rate. J. Acoust. Soc. Amer. 89:1350-1357.

Jepson, P. D., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Harr´ aez, A. M. Pocknell, F. Rodriguez, F. E. Howie, A. Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. A. Cunningham and A. Fern´andez. 2003. Gas-bubble lesions in stranded cetaceans. Nature 425:575–576.

24

Jochens, A., D. Biggs, D. Engelhaupt, J. Gordon, N. Jaquet, M. Johnson, R. Leben, B. Mate, P. Miller, J. Ortega-Ortiz, A. Thode, P. Tyack, J. Wormuth, and B. Würsig. 2006. Sperm whale seismic study in the Gulf of Mexico; Summary Report, 2002-2004. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2006-034. 352 pp.

Kastak, D., R.J. Schusterman, B.L. Southall, and C.J. Reichmuth, 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of the Acoustical Society of America. 106:1142-1148.

Kastak D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. Journal of the Acoustical Society of America. 118:3154–3163.

Kastelein, R.A., H. T Rippe, N. Vaughan, N. M. Schooneman, W. C. Verboom, and D. de Haan. 2000. The effects of acoustic alarms on the behavior of harbor porpoises in a floating pen. Marine Mammal Science 16, 46-64.

Kastelein, R. A., D. de Hahn, A. D. Goodson, C. Staal and N. Vaughan. 1997. The effects of various sounds on a harbour porpoise *Phocoena phocoena*. The Biology of the Harbour Porpoise. Woerden, the Netherlands. De Spil Publishers.

Kastelein, R. A., D. de Hahn, N. Vaughan, C. Staal and NM Schooneman. 2001. The influence of three acoustic alarms on the behaviour of harbour porpoises (*Phocoena phocoena*) in a floating pen. Mar. Enviro. Res. 52:351-371.

Kastelein, R. A., S. van der Heul, W. C. Verboom, N. Jennings, J. van der Veen, D. de Haan. 2008. Startle response of captive North Sea fish species to underwater tones between 0.1 and 64 kHz. Mar. Environ. Res. 65:369–377

Kastelein, R. A., R. van Schie, W. C. Verboom and D. de Haan. 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (*Eumetopias jubatus*). J. Acoust. Soc. Amer. 118:1820-1829.

Kruse, S. 1991. "The interactions between killer whales and boats in Johnston Strait, B.C." Pp. 149-159 in K. Pryor and K. S. Norris (eds.), *Dolphin Societies: Discoveries and Puzzles*, UC Press, Berkeley.

Kraus, S. D., A. J. Read, A Solow, K. Baldwin, T. Spradlin, E. Anderson & J. Williamson. 1997. Acoustic alarms reduce porpoise mortality. Nature. 388:525.

Laake, J. L., P. J. Gearin and R. L. DeLong. 1999. Further evaluation of harbor porpoise habituation to pingers in a set gillnet fishery. AFSC Processed Rep. 99-08.

25

Laake, J. L., P. J. Gearin, M. E. Gosho and R. L. DeLong. 1997. Evaluation of effectiveness of pingers to reduce incidental entanglement of harbor porpoise in a set gillnet fishery. In (P. S. Hill and D. P. DeMaster, eds.) MMPA and ESA implementation program, 1996. AFSC Processed Report 97-10. 75-81.

Laake, J., D. Rugh and L. Baraff. 1998. Observations of harbor porpoise in the vicinity of acoustic alarms on a set gill net. NOAA Tech. Memo. NMFS-AFSC-84.

Lusseau D., Slooten E. & Currey R.J. 2006. Unsustainable dolphin watching activities in Fiordland, New Zealand. Tourism in Marine Environments 3: 173-178.

Malme, C. I., B. Würsig, J. E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. Pp. 55-73 in Port and Ocean Engineering Under Arctic Conditions, Volume III (W. M. Sackinger, M. O. Jeffries, J. L. Imm, and S. D. Treacy eds.). (University of Alaska, Fairbanks).

Malme, C. I., P. R. Miles, C. W. Clark, P. Tyack, and J. E. Bird. 1984. Investigations on the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Rep. From Bolt Beranek and Newman, Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. Var. pag. NTIS PB86-218377.

Malme, C. I., P. R. Miles, C. W. Clark, P. Tyack, and J. E. Bird. 1983. Investigations on the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. BBN Rep. 5366. Rep. From Bolt Beranek and Newman, Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. Var. pag. NTIS PB86-174174.

Møhl, B. 1968. Auditory sensitivity of the common seal in air and water. J. Aud. Res. 8:27-38.

Moore, P.W.B. and R. J. Schusterman. 1987. Audiometric assessment of northern fur seals, *Callorhinus ursinus*. Mar. Mamm. Sci. 3:31-53.

Morton, A.B., and H.K. Symonds. 2002. "Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada." *ICES J. Mar. Sci.* 59: 71-80.

Nachtigall. P. E., J. L. Pawloski and W. W. L. Au. 2003. Temporary threshold shifts and recovery following noise exposure in Atlantic bottlenosed dolphins (*Tursiops truncatus*). Journal of the Acoustical Society of America 113: 3425-3429.

NMFS OPR. 2005. Assessment of Acoustic Exposures on Marine Mammals in Conjunction with *USS Shoup* Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington ~ 5 May 2003 ~. Unpublished report. 13 pp.

26

NOAA (National Oceanographic and Atmospheric Administration) and U.S. Department of the Navy. (2001). Joint interim report: Bahamas marine mammal stranding event of 15-16 March 2000. (U.S. Department of Commerce, Washington, DC), 59 pp. http://www.nmfs.noaa.gov/prot_res/overview/Interim_Bahamas_Report.pdf

Nowacek, D.P., M.P. Johnson, and P.L. Tyack, 2004. "North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli," Proceedings of the Royal Society of London, Part B., 271:227-231.

Nowacek, S.M., Wells, R.S. & Solow, A.R. 2001. Short-term effects of boat traffic on bottlenose dolphins, Tursiops truncatus, in Sarasota Bay, Florida. Mar. Mam. Sci. 17: 673-688.

Olesiuk, P. F., M. A. Bigg and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. IWC Special Issue 12:209-243.

Olesiuk, P. F., L. M. Nichol, M. J. Sowden, and J. K. B. Ford. 2002. Effect of the sound generated by an acoustic harassment device on the relative abundance of harbor porpoises in retreat passage, British Columbia. Marine Mammal Science **18**, 843-862.

OSHA. 2007. Occupational noise exposure. CFR (29) part number 1910.95. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9735&p_table=STANDARDS

Reeves, R. R., R. J. Hofman, G. K. Silber and D. Wilkinson. 1996. Acoustic deterrence of harmful marine mammal-fishery interactions: proceedings of a Workshop held in Seattle, WA, USA, 20-22 March 1996. U. S. Dept. Commerce NOAA Tech. Memo NMFS-OPR-10. 68 pp.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, California.

Richardson, W.J., Wursig, B. and Greene, C.R. Jr. 1990. Reactions of bowhead whales, Balaena mysticetus, to drilling and dredging noise in the Canadian Beaufort Sea. Mar. Environ. Res. 29(2): 135-160.

Ridgway, S. H., D. A. Carder., R. R. Smith., T. Kamolnick., C. E. Schlundt and W. R. Elsberry. 1997. Behavioural responses and temporary shift in masked hearing threshold of bottlenose dolphins *Tursiops truncatus*, to 1 second tones of 141 to 201 dB re 1μPa. Technical Report Number 1751, Naval Command Control and Ocean Surveillance Center, RDT&E Division, San Diego California.

27

Romano, T. A., M. J. Keogh, C. Kelly, P. Feng, L. Berk, C. E. Schlundt, D. A. Carder and J. J. Finneran. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Can. J. Fish. Aquat. Sci. 61:1124-1134.

Schroeder, J. P., B. Wood and D. Bain. 2007. A73/Springer Health Evaluation, November 2007. NMFS Contract Report.

Schusterman, R. J., R. Gentry and J. Nixon. 1972. Underwater audiogram of the California sea lion by the conditioned vocalization technique. J. Exp. Anal. Behav. 17:339-350.

Širović, A. 2006. Blue and fin whale acoustics and ecology off Antarctic Peninsula. Ph.D. Diss. Univ. Calif., San Diego. San Diego, CA. 163 pp.

Stone, G., S. Kraus, A Hutt, S. Martin, A. Yoshinaga and L. Joy. 1997. Reducing bycatch: can acoustic pingers keep Hector's dolphins out of fishing nets? Mar. Technol. J. 31:3-7.

Szymanski, M. D., D. E. Bain, K. Kiehl, K. R. Henry, S. Pennington and S. Wong. 1999. Killer whale (*Orcinus orca*) hearing: auditory brainstem response and behavioral audiograms. J. Acoust. Soc. Amer. 106:1134-1141.

Trites, A. W. and D. E. Bain. 2000. Short- and long-term effects of whale watching on killer whales (*Orcinus orca*) in British Columbia. Paper presented to the IWC Workshop on the Long-Term Effects of Whale Watching. Adelaide, Australia.

Trites, A.W., W. Hochachka and S. K. Carter. 1995. "Killer whales and vessel activity in Robson Bight from 1991 to 1994." Report to BC Ministry of Environment, Land and Parks.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Wade, P., M. P. Heide-Jørgensen, K. Shelden, J. Barlow, J. Carretta, J. Durban, R. LeDuc, L. Munger, S. Rankin, A. Sauter and C. Stinchcomb. 2006. Acoustic detection and satellite-tracking leads to discovery of rare concentration of endangered North Pacific right whales. Biol. Lett. doi:10.1098/rsbl.2006.0460

Williams, R. and Ashe, E. 2007. Killer whale evasive tactics vary with boat number. J. Zool. (London) 272: 390-397.

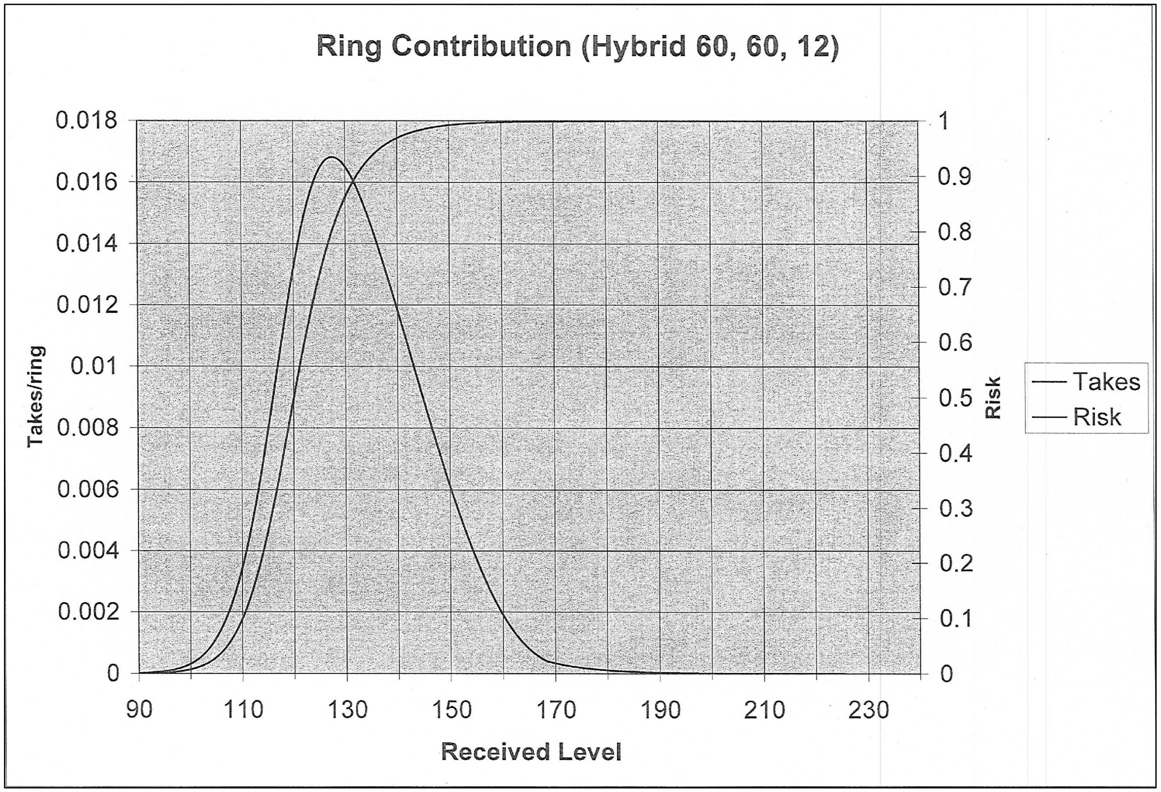
Williams, R., D. E. Bain, J. K. B. Ford and A. W. Trites. 2002a. Behavioural responses of killer whales to a "leapfrogging" vessel. J. Cet. Res. Manage. 4:305-310.

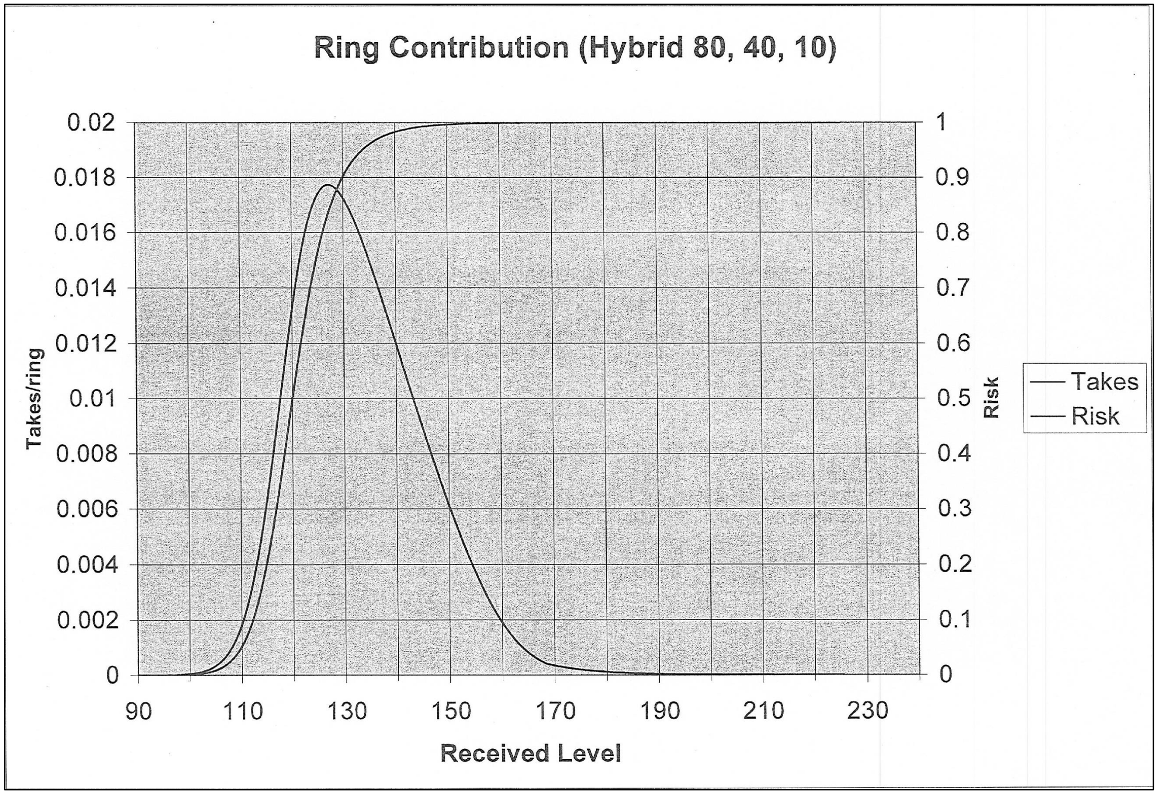
Williams, R., A. Trites and D. E. Bain. 2002b. Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. J. Zool. (Lond.). 256:255-270.

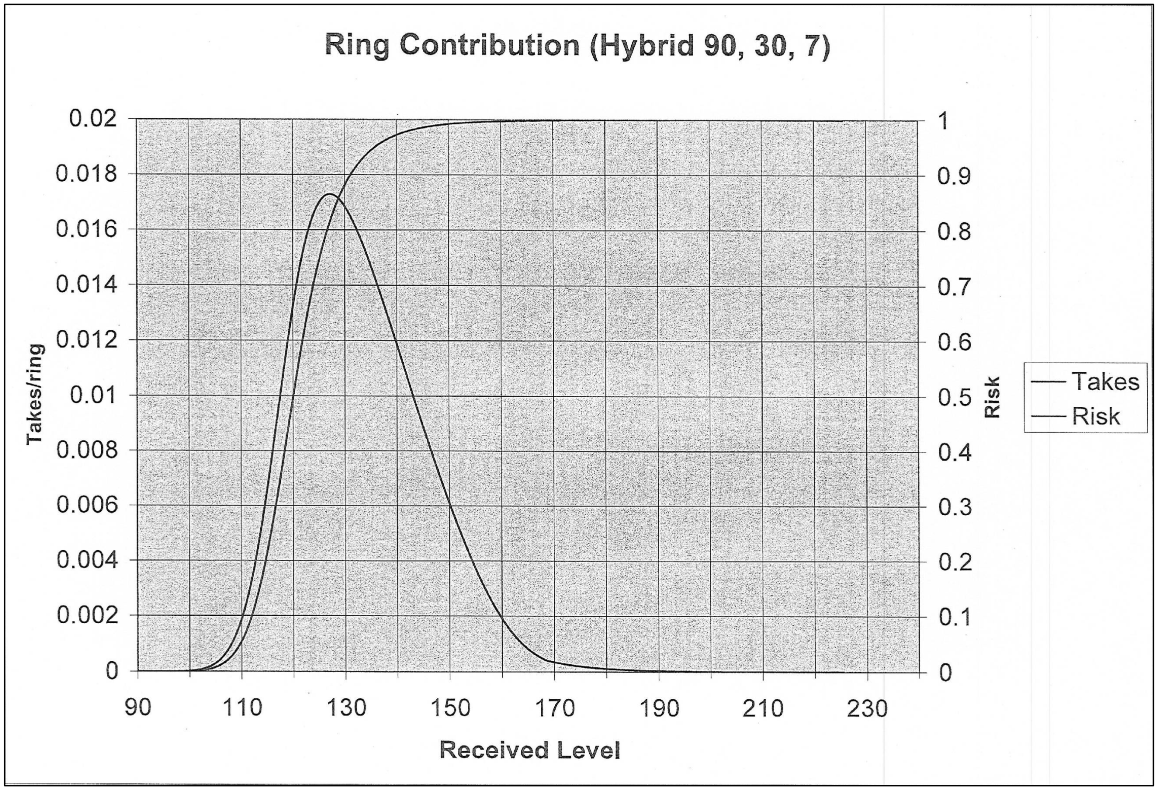
Williams, E. S., and E. T. Thorne. 1996. Exertional myopathy (capture myopathy). Pp. 181-193 in A. Fairbrother, L. N. Locke and G. L. Hoff (eds.), Non-infectious diseases of wildlife. Iowa State University Press, Ames, Iowa

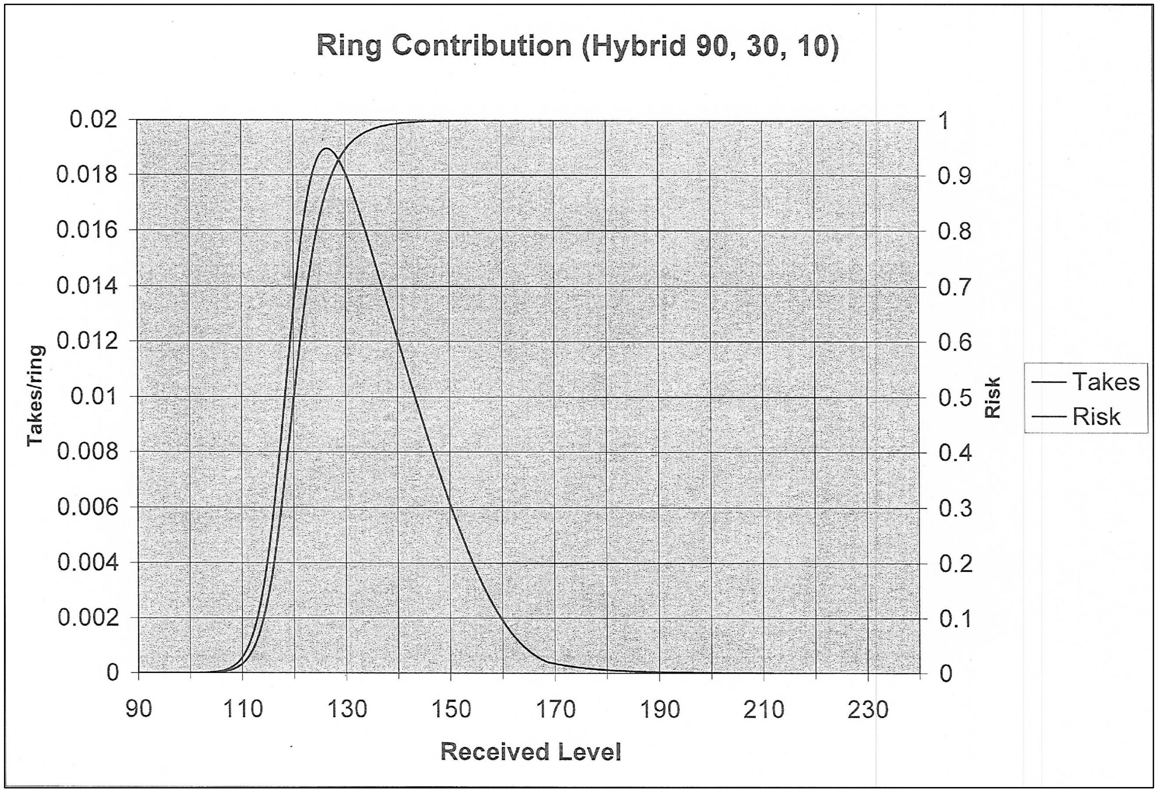
Yano, K., and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fish. Bull., U.S. 93:355-372.

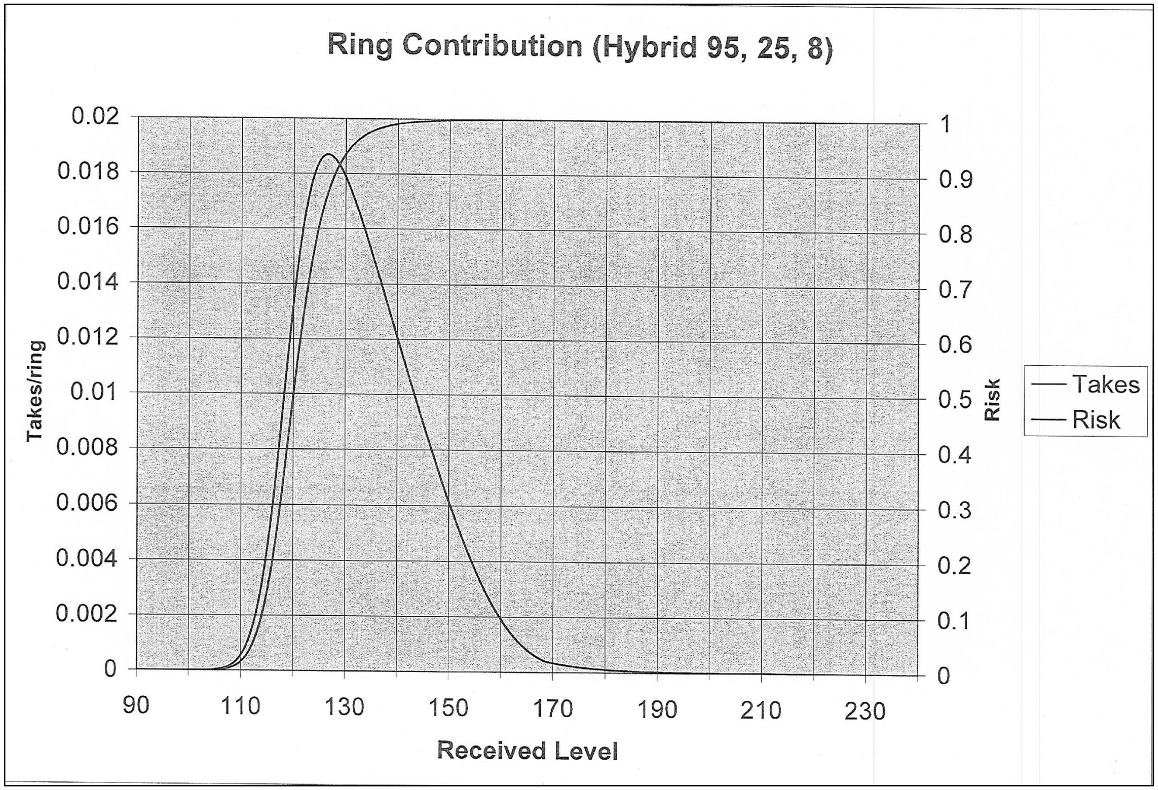
Zimmer, W. M. X. and P. L. Tyack. 2007. Repetitive shallow dives pose decompression risk in deep-diving beaked whales. Mar. Mam. Sci. 23: 888–925.

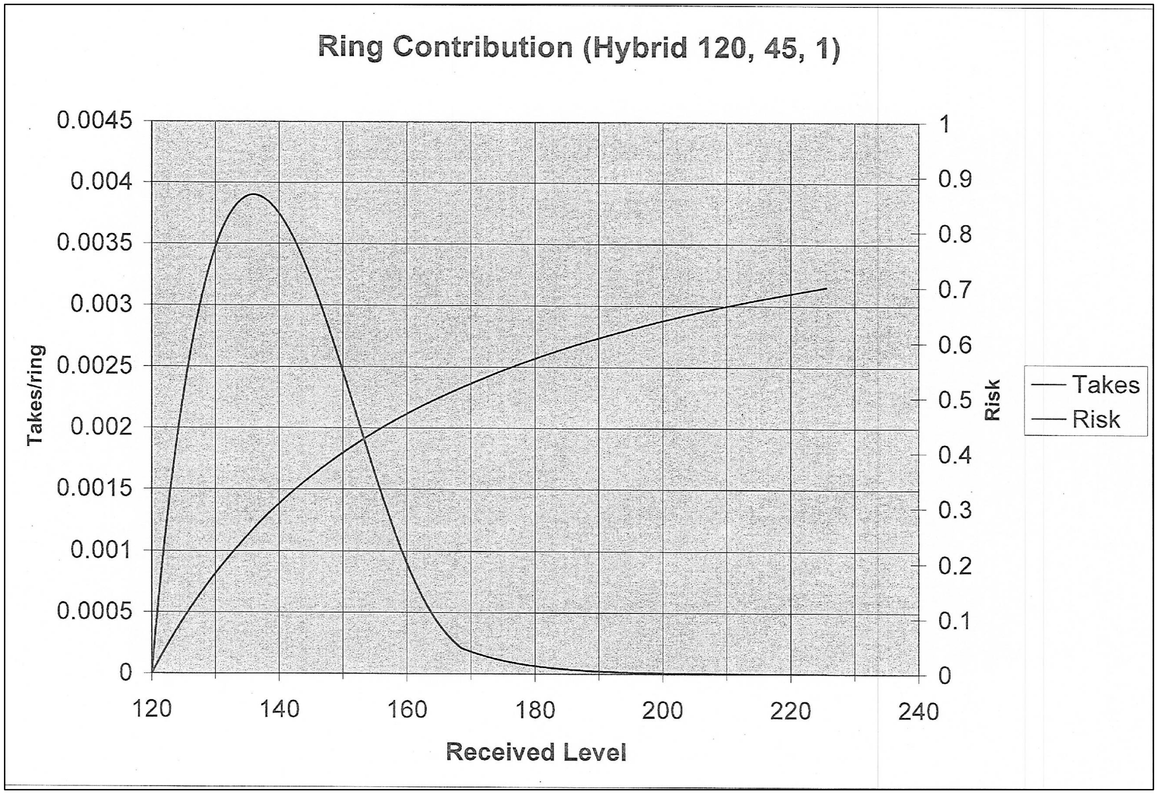

Ring Contribution (Hybrid 60, 60, 12)
Takes/ring
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
90
110
130
150
170
190
210
230
Received Level
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Takes
Risk

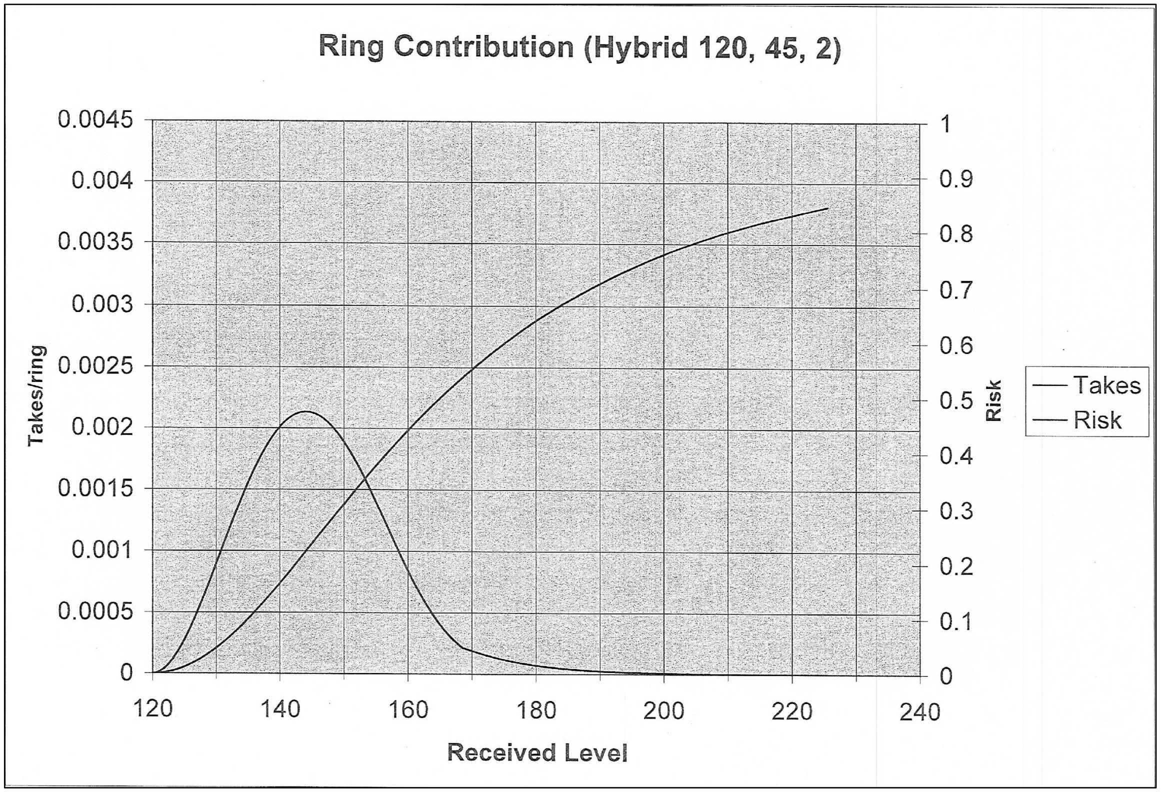

Ring Contribution (Hybrid 80, 40, 10)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Takes/ring
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Risk
Takes
Risk
90
110
130
150
170
190
210
230
Received Level

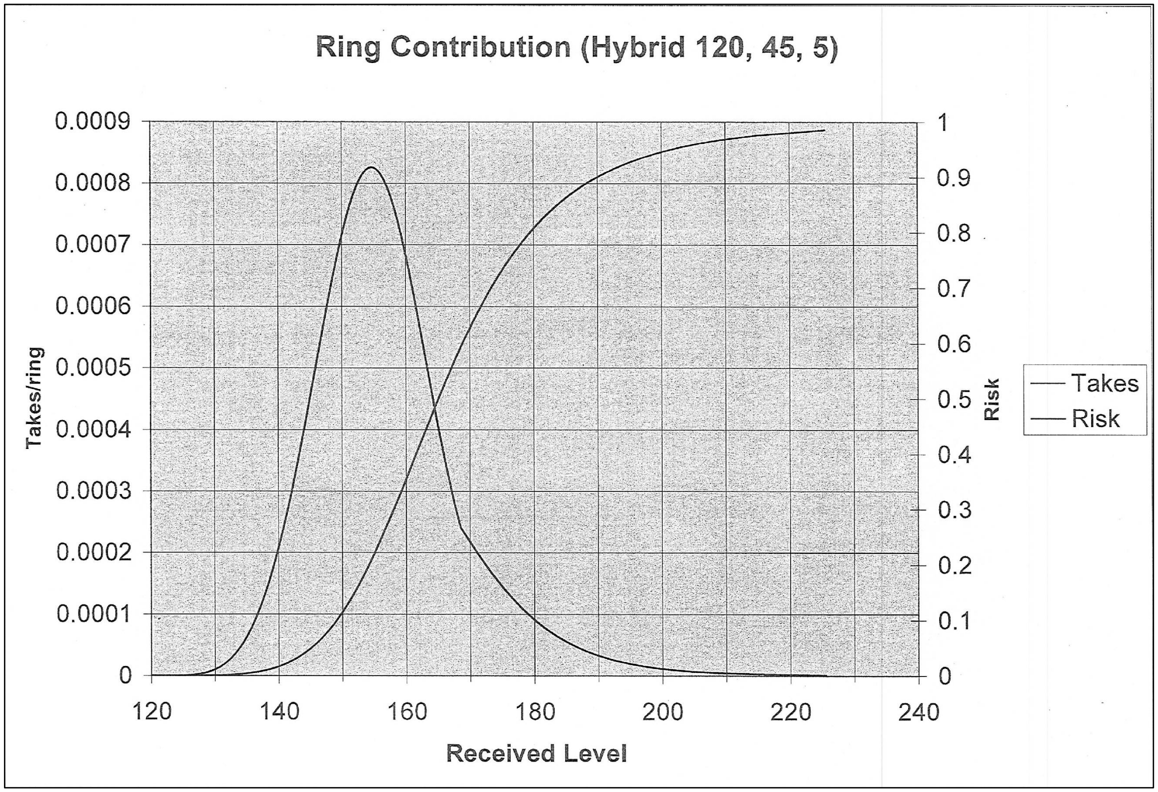

Ring Contribution (Hybrid 90, 30, 7)
Takes/ring
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
90
110
130
150
170
190
210
230
Received Level
Takes
Risk

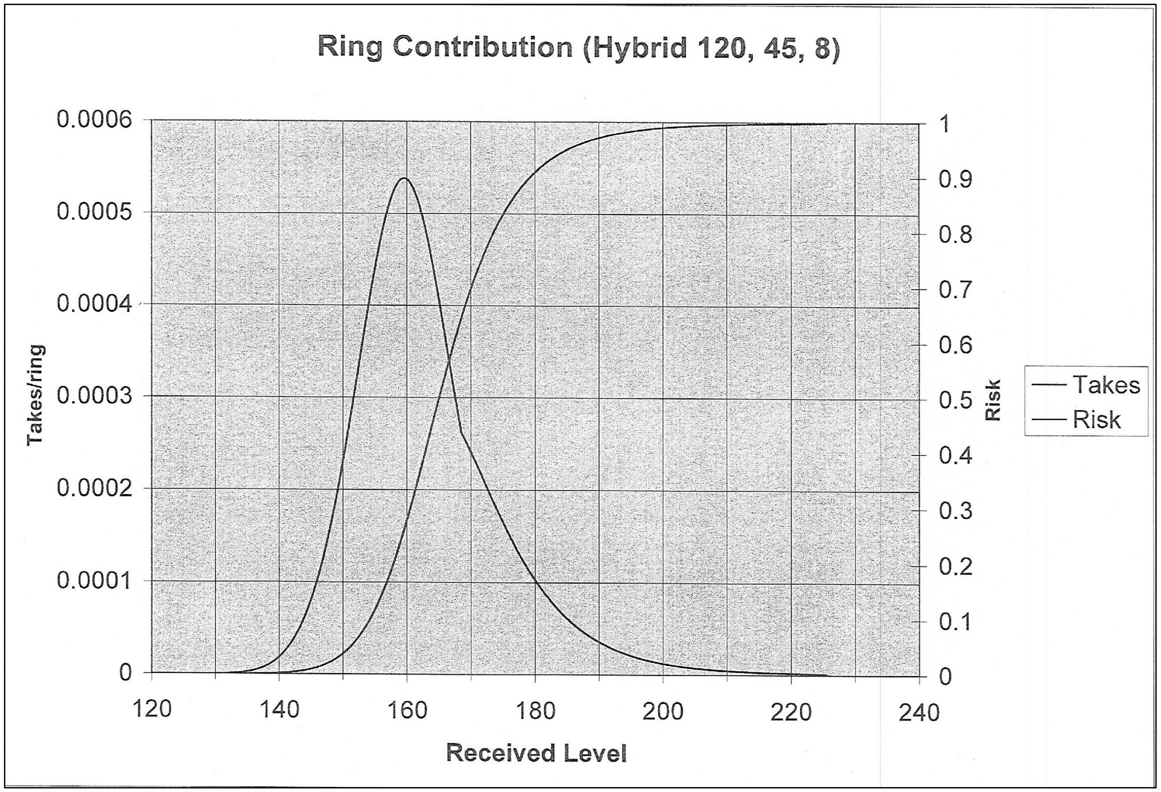

Ring Contribution (Hybrid 90, 30, 10)
Takes/ring
Risk
Received Level
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
90
110
130
150
170
190
210
230
Takes
Risk

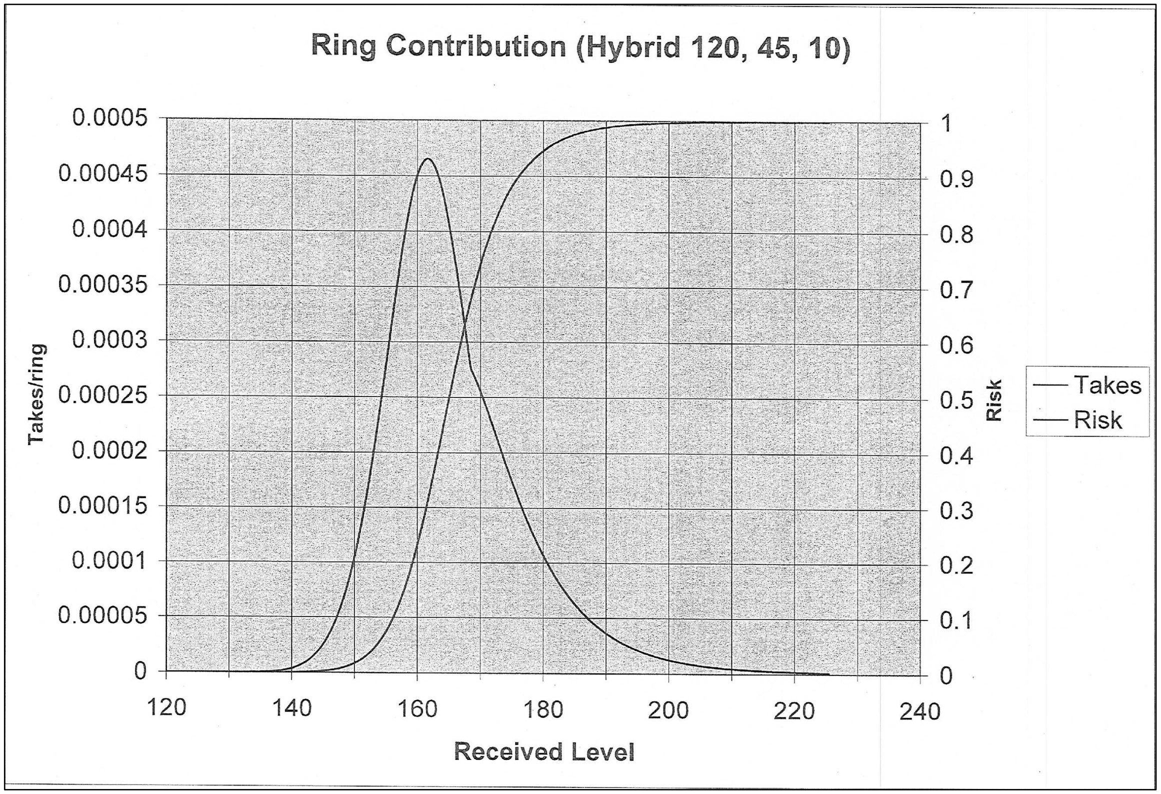

Ring Contribution (Hybrid 95, 25, 8)
Takes/ring
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
90
110
130
150
170
190
210
230
Received Level
Takes
Risk

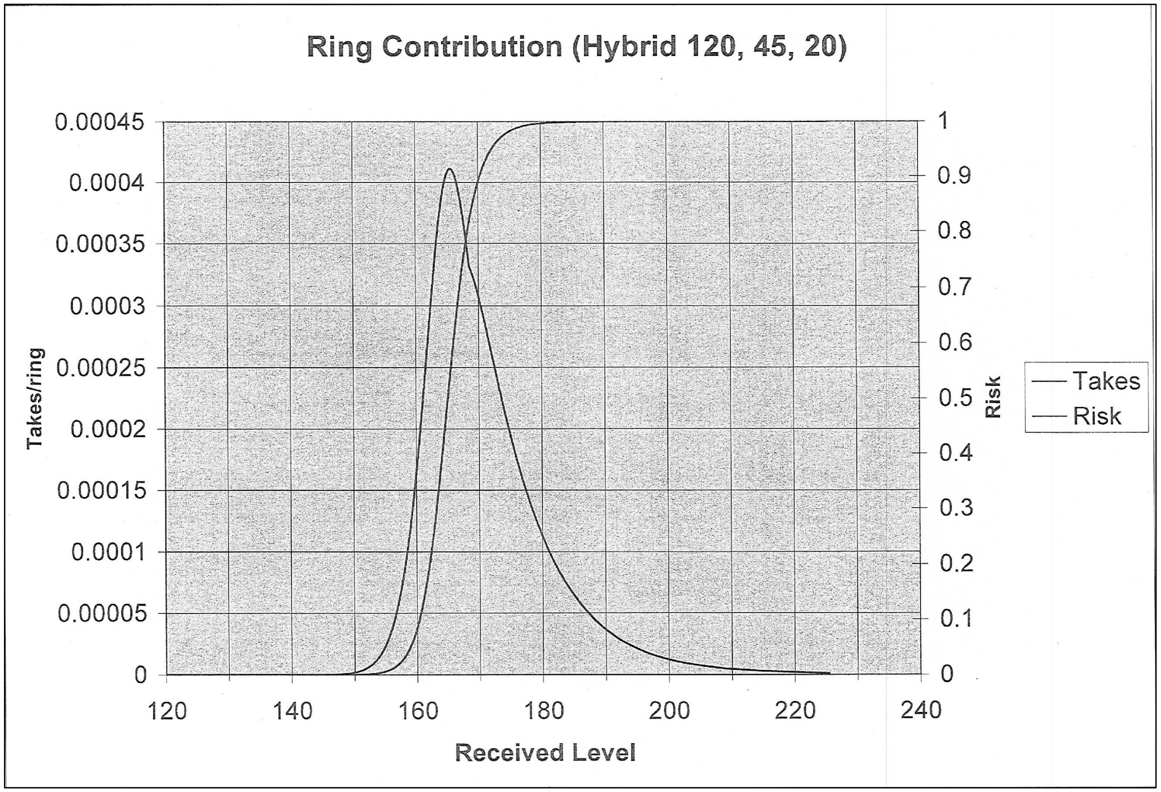

Ring Contribution (Hybrid 120, 45, 1)
Takes/ring
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Received Level
Takes
Risk

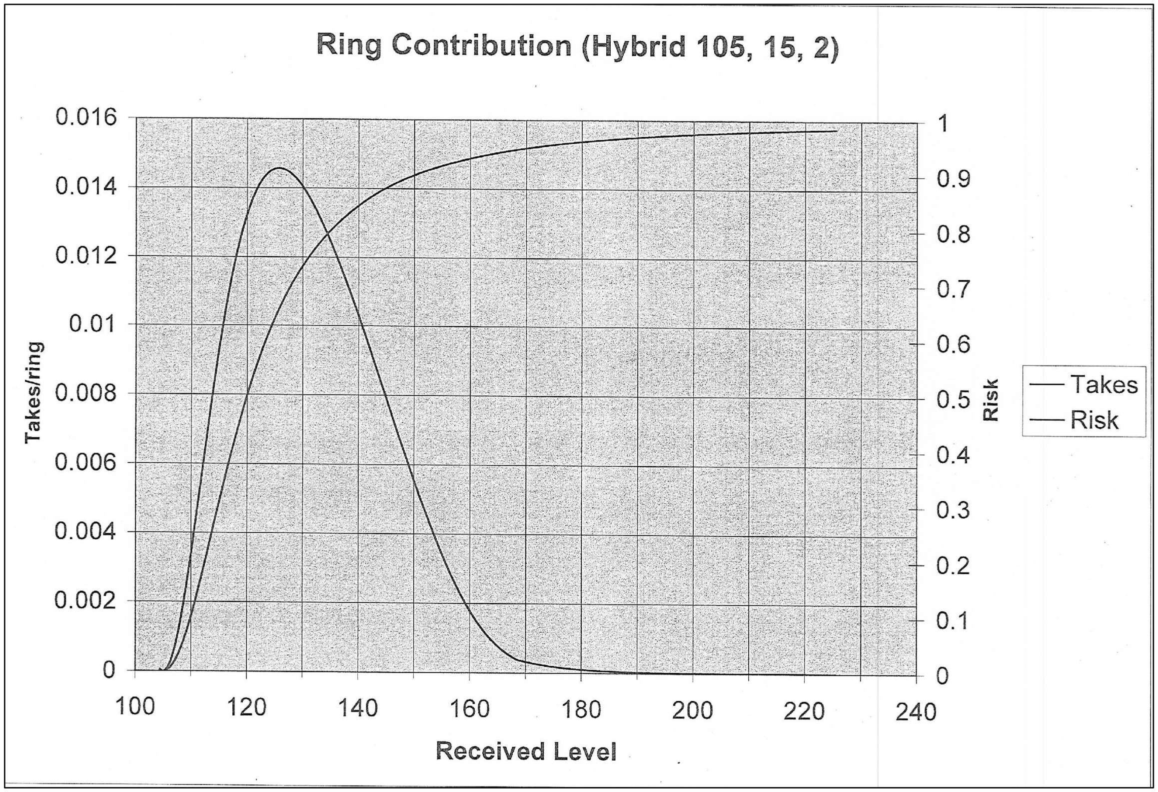

Ring Contribution (Hybrid 120, 45, 2)
Takes/ring
Risk
Received Level
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Takes
Risk

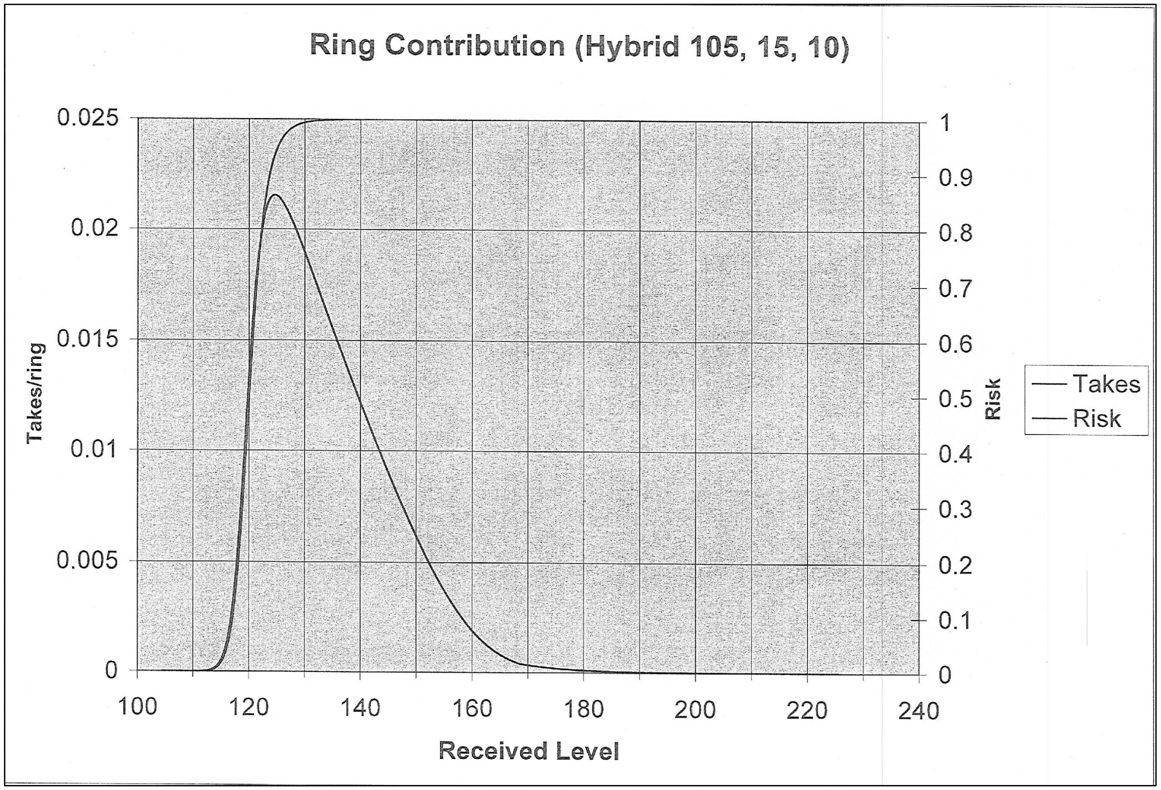

Ring Contribution (Hybrid 120, 45, 5)
Takes/ring
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Received Level
Takes
Risk

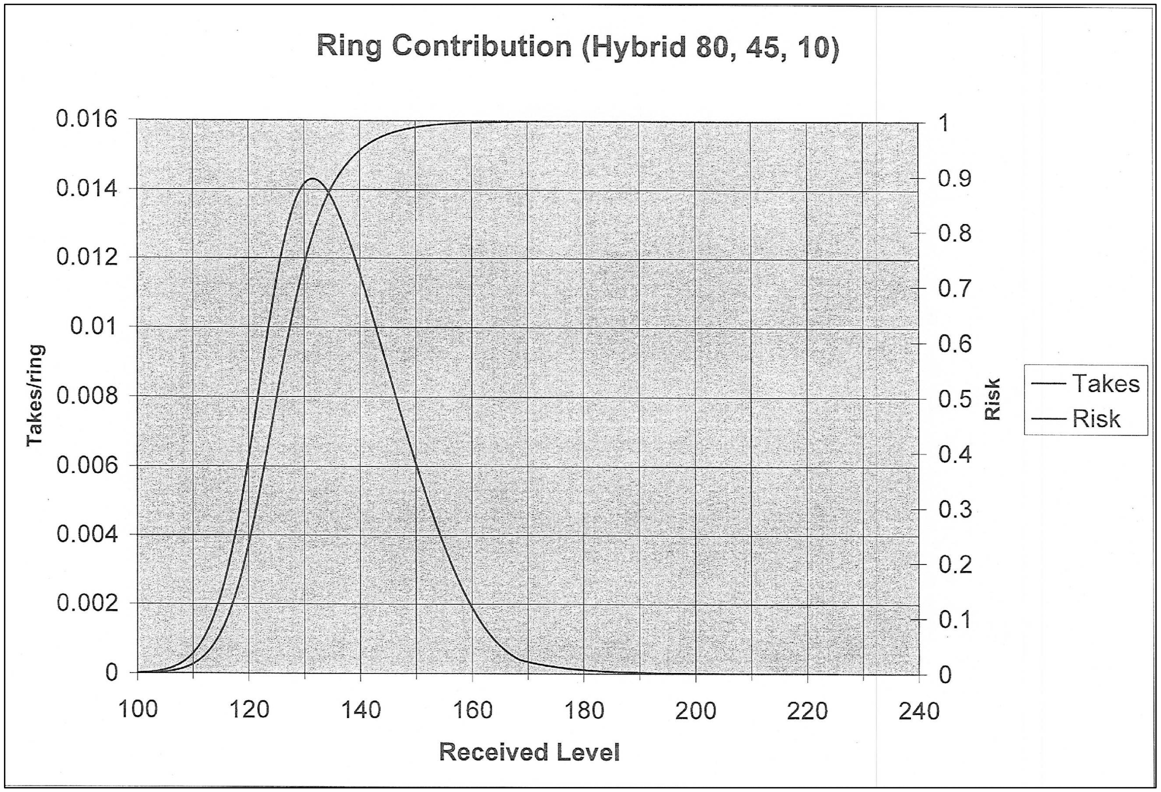

Ring Contribution (Hybrid 120, 45, 8)
Takes/ring
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Received Level
Takes
Risk

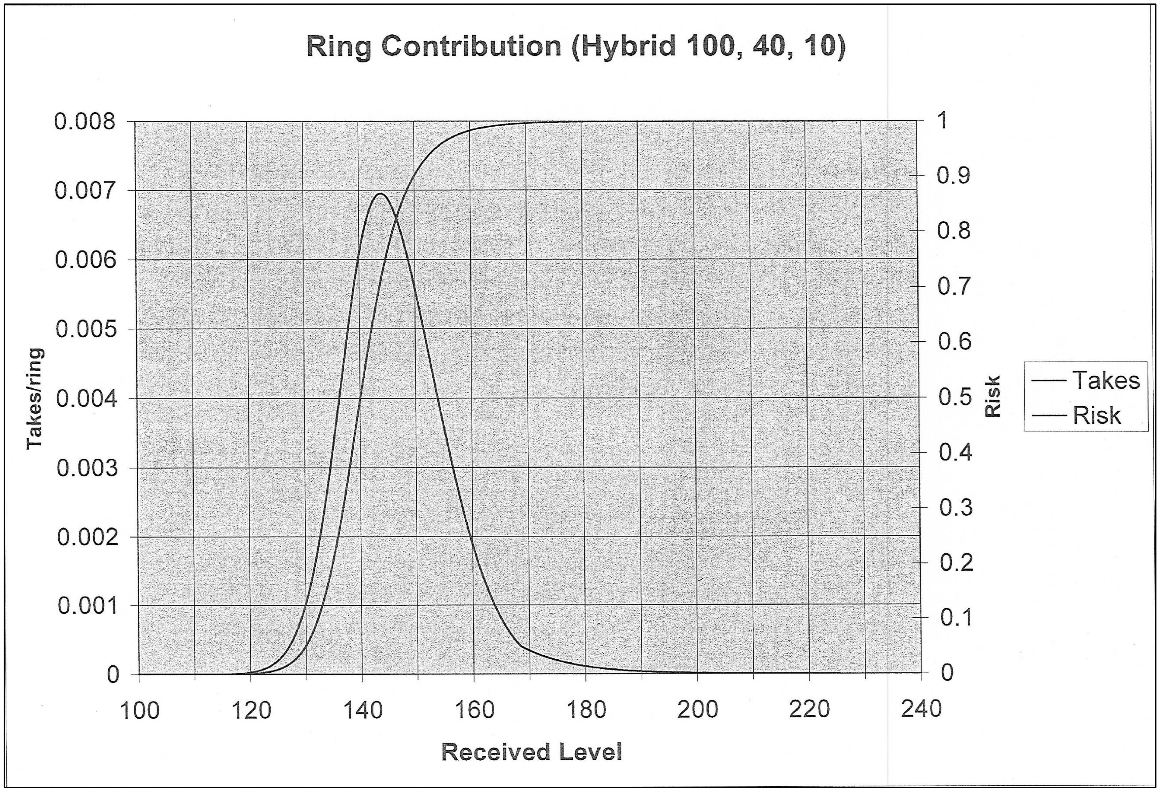

Ring Contribution (Hybrid 120, 45, 10)
Takes/ring
0.0005
0.00045
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Received Level
Takes
Risk

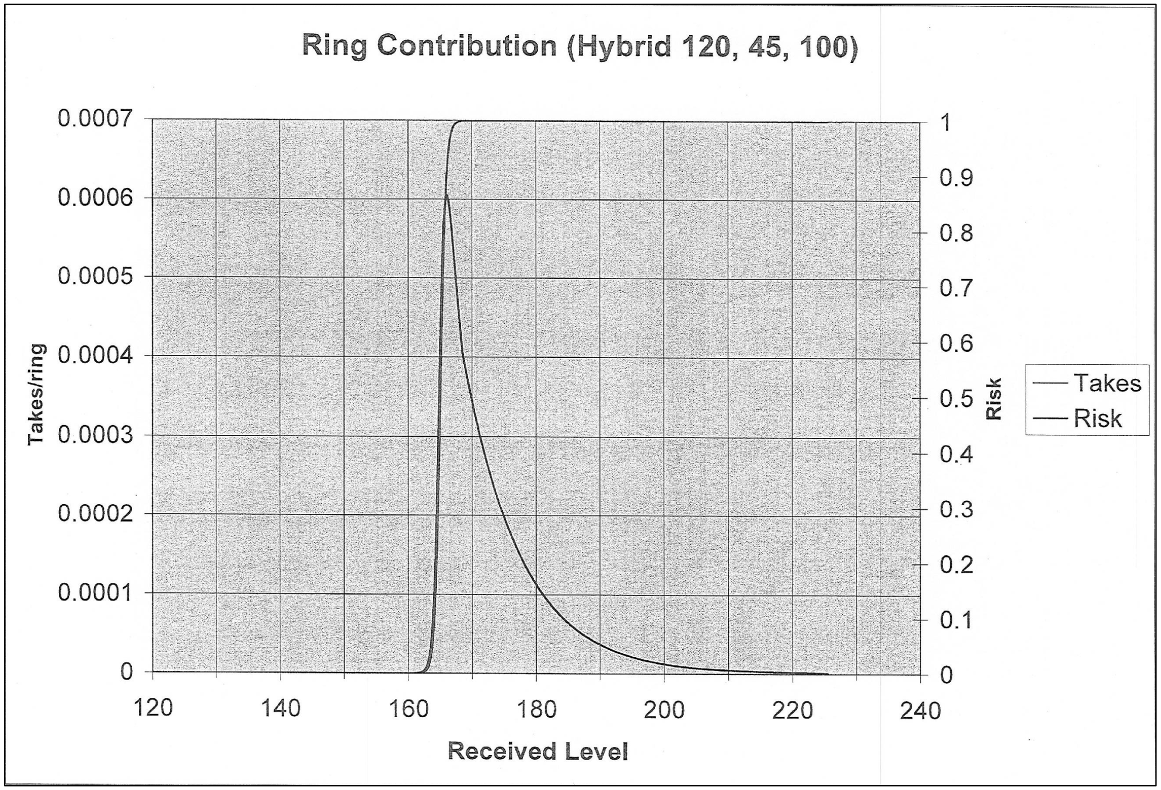

Ring Contribution (Hybrid 120, 45, 20)
Takes/ring
0.00045
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Received Level
Takes
Risk

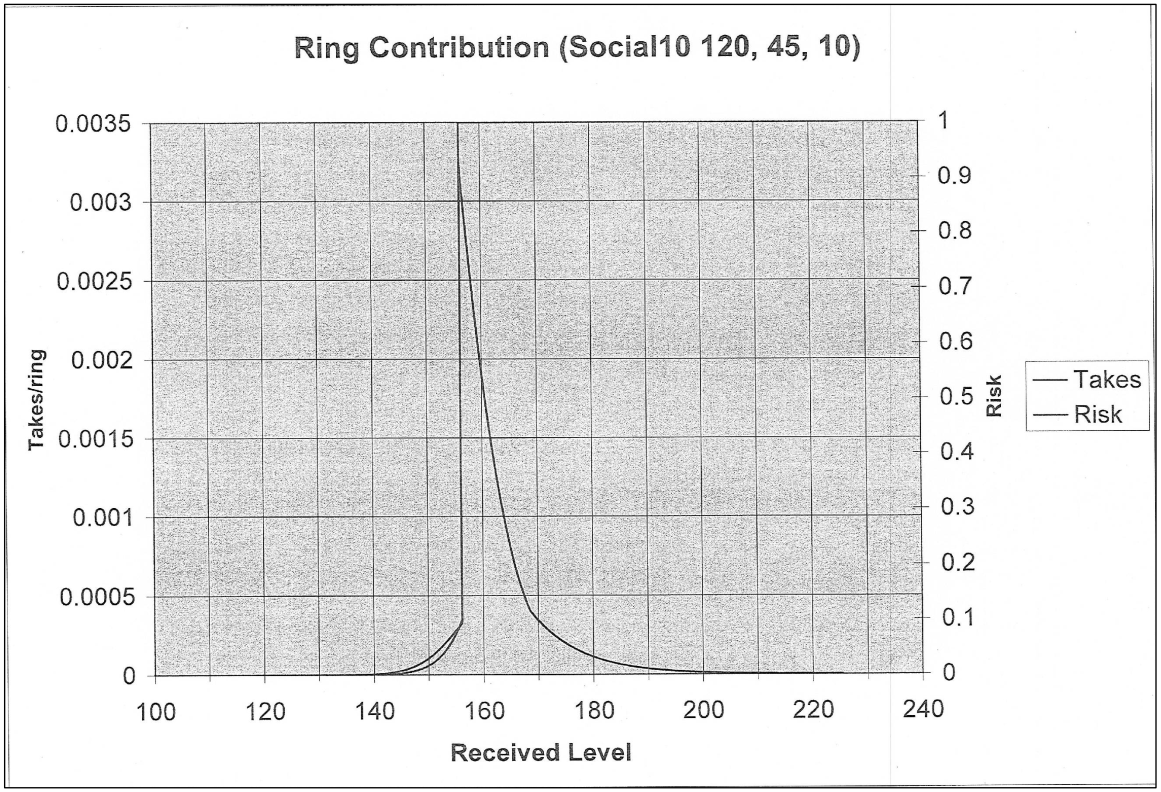

Ring Contribution (Hybrid 105, 15, 2)
Takes/ring
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
100
120
140
160
180
200
220
240
Received Level
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Takes
Risk

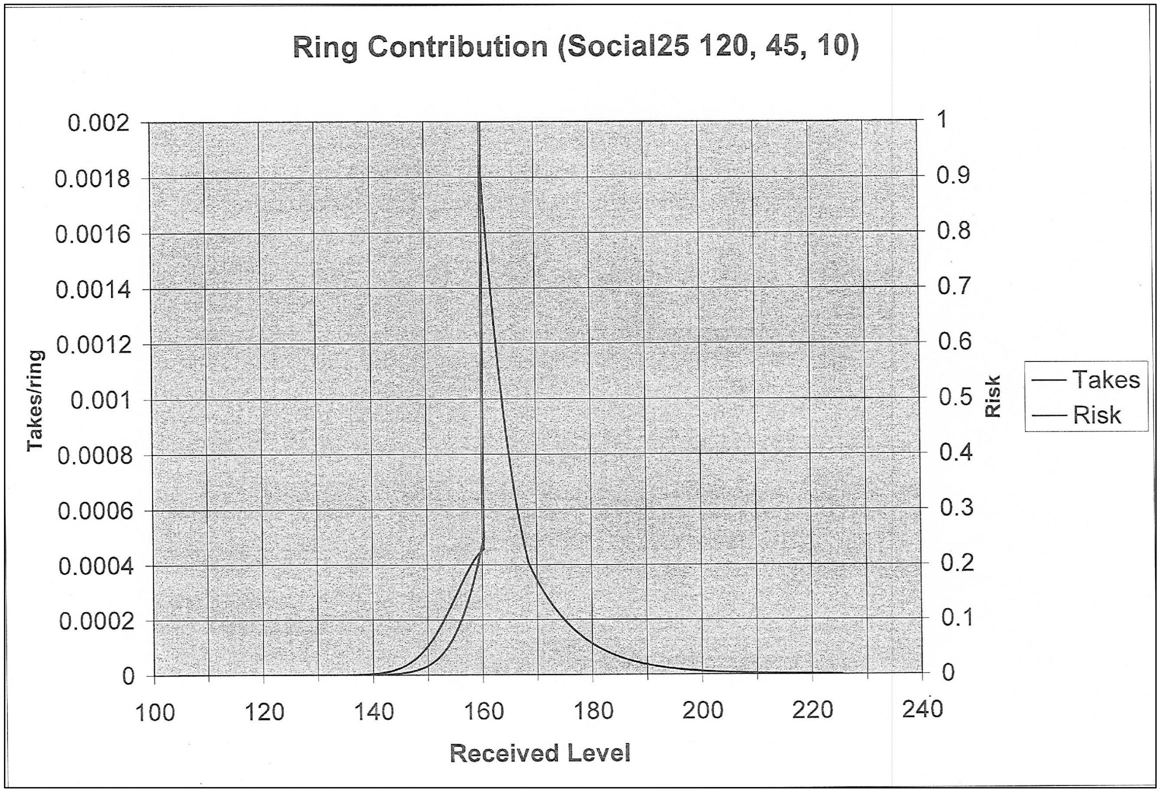

Ring Contribution (Hybrid 105, 15, 10)
Takes/ring
0.025
0.02
0.015
0.01
0.005
0
100
120
140
160
180
200
220
240
Received Level
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Takes
Risk

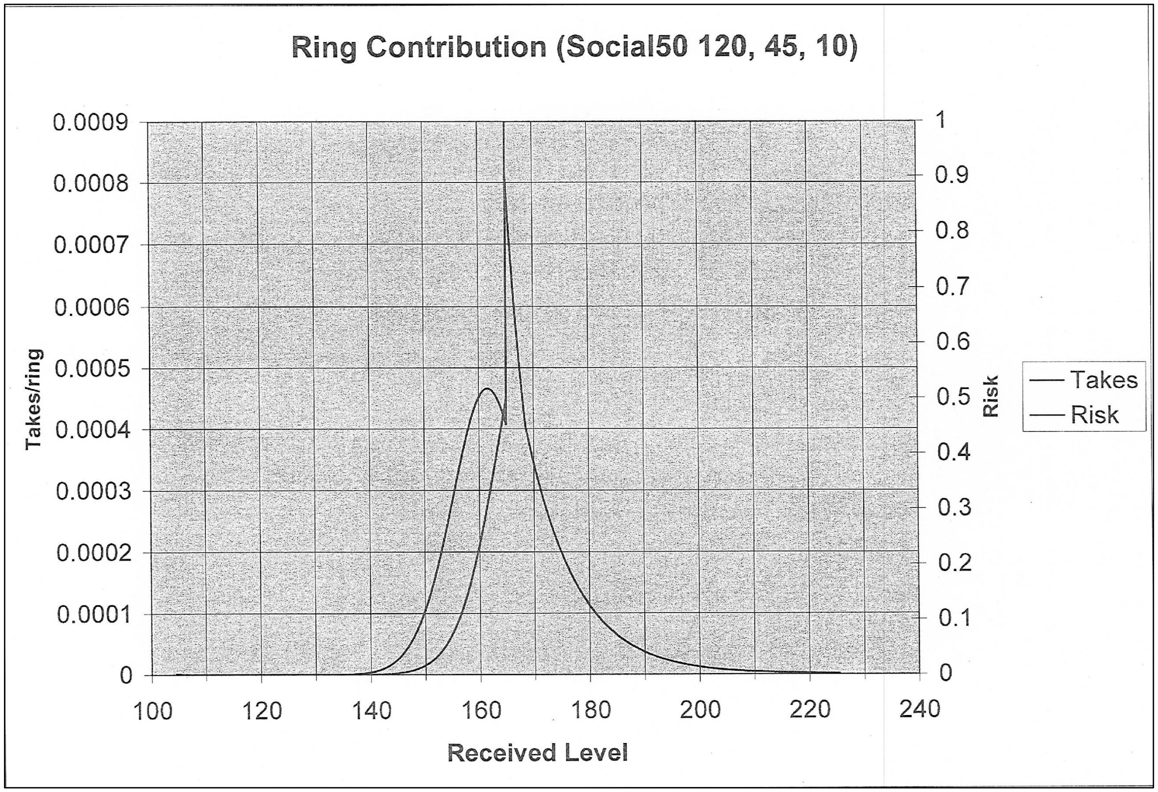

Ring Contribution (Hybrid 80, 45, 10)
Takes/ring
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
100
120
140
160
180
200
220
240
Received Level
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Takes
Risk

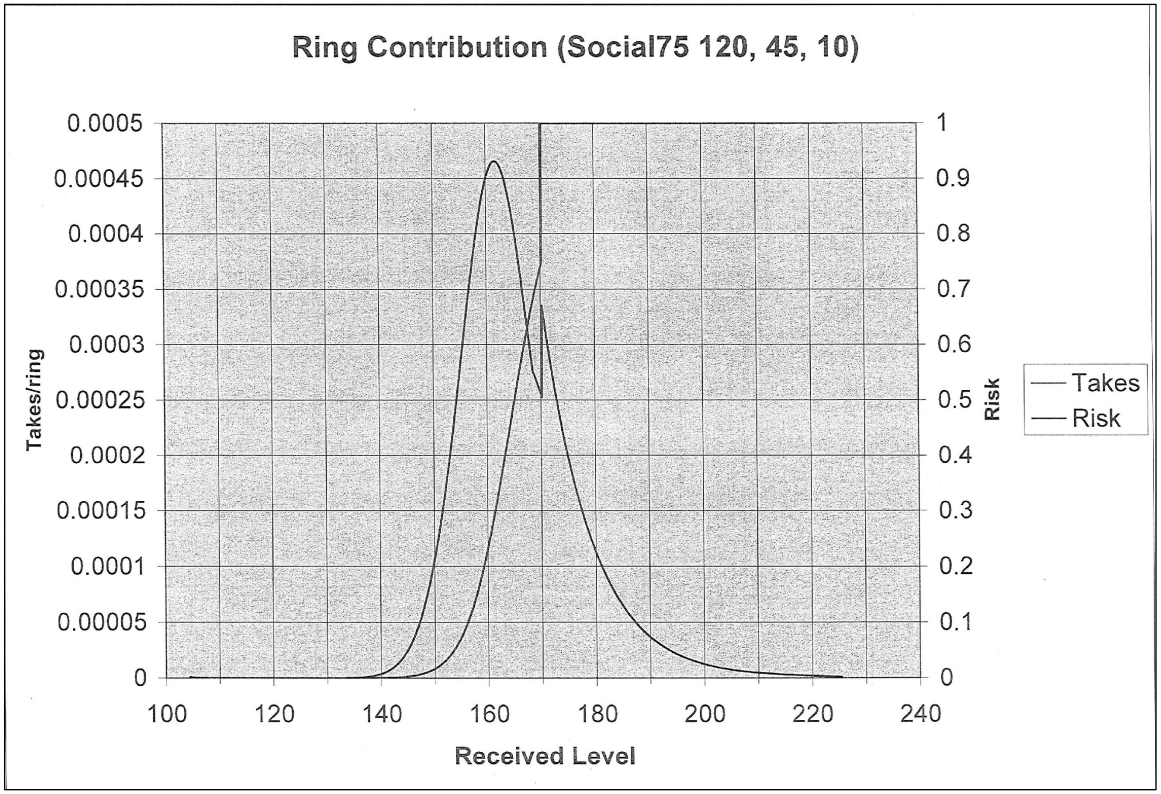

Ring Contribution (Hybrid 100, 40, 10)
Takes/ring
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
120
140
160
180
200
220
240
Received Level
Takes
Risk


Ring Contribution (Hybrid 120, 45, 100)
Takes/ring
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
120
140
160
180
200
220
240
Received Level
Takes
Risk


Ring Contribution (Social10 120, 45, 10)
Takes/ring
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
120
140
160
180
200
220
240
Received Level
Takes
Risk


Ring Contribution (Social25 120, 45, 10)
Takes/ring
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
120
140
160
180
200
220
240
Received Level
Takes
Risk


Ring Contribution (Social50 120, 45, 10)
Takes/ring
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
120
140
160
180
200
220
240
Received Level
Takes
Risk


Ring Contribution (Social75 120, 45, 10)
Takes/ring
0.0005
0.00045
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Risk
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
120
140
160
180
200
220
240
Received Level
Takes
Risk

This Page Intentionally Left Blank

APPENDIX J

ESSENTIAL FISH HABITAT AND CORAL REEF ASSESSMENT FOR THE MARIANA ISLANDS RANGE COMPLEX EIS/OEIS

This page intentionally left blank.

ESSENTIAL FISH HABITAT AND CORAL REEF ASSESSMENT FOR THE MARIANA ISLANDS RANGE COMPLEX EIS/OEIS

Prepared for:

ManTech SRS Technologies, Inc.
3865 Wilson Boulevard, Suite 800
Arlington, VA 22203

Prepared by:

Merkel & Associates, Inc.
5434 Ruffin Road
San Diego, CA 92123
Phone: (858) 560-5465
Fax: (858) 560-7779

May 2010

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

°	Degree
°C	degrees Celsius
AAV	Amphibious Assault Vehicle
AAW	Anti-Air Warfare
ACM	Air Combat Maneuver
AGL	Above Ground Level
AIW	Antarctic Intermediate Water
AMW	Amphibious Warfare
ASUW	Anti-Surface Warfare
ASW	Antisubmarine Warfare
AT	Anti-Terrorism
ATCAA	Air Traffic Control Assigned Airspace
BMUS	bottomfish management unit species
BOMBEX	Bombing Exercise
C2	Command and Control
cm	centimeter
CCD	carbonate compensation depth
CDW	Circumpolar Deep Water
CHCRT	Currently Harvested Coral Reef Taxa
CIWS	Close In Weapon System
CMUS	crustacean management unit species
CNMI	Commonwealth of the Northern Mariana Islands
COMNAVMARIANAS	U.S. Naval Forces Marianas
COTS	crown-of-thorns starfish
CPX	Command Post Exercise
CRED	Coral Reef Ecosystem Division
CRE	coral reef ecosystem
CRRC	combat rubber raiding craft
CSAR	Combat Search and Rescue
DAWR	Division of Aquatic and Wildlife Resources
dB	decibel
DoD	Department of Defense
DoD REP	DoD Representative Guam, CNMI, FSM, and Republic of Palau
DoN	Department of Navy
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS/OEIS	Environmental Impact Statement/Overseas Environmental Impact Statement
EMATT	Expendable Mobile Training Targets
EMUA	Exclusive Military Use Area
ENSO	El Niño Southern Oscillation
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ERA	Ecological Reserve Area
ESG	Expeditionary Strike Group
EXTORP	Exercise Torpedo
FAD	Fish Aggregating Devices
FAST	Floating At Sea Target
FDM	Farallon de Medinilla
FIREX	Fire Support
FMP	Fishery Management Plan
FP	Force Protection
FSM	Federated States of Micronesia
FTX	Field Training Exercise
ha	hectare
HAPC	Habitats Areas of Particular Concern
ft	foot/feet
ft^2	square foot
ft^3	cubic foot
g	gram
GEPA	Guam Environmental Protection Agency
GUNEX	Gunnery Exercise
Hz	Hertz
IAH	Inner Apra Harbor
JFCOM	Joint Forces Command
lbs.	pounds
kHz	kilohertz
km	kilometer
km^2	square kilometer
kph	km per hour
LAV	light armored vehicle
LBA	leaseback area
LCAC	Landing Craft Air Cushioned
LCPW	Lower Circumpolar Water
LFA	Low Frequency Active
m	meter
m^2	square meter
m^3	cubic meter
mg	milligram
m/sec	meters per second
µm	micron
µPa	micro pascal
ml/l	milliliters per liter
mm	millimeters
MCMEX	Mine Exercise
MFA	medium-frequency active sonar
MIRC	Mariana Islands Range Complex
MIW	Mine Warfare
MMU	minimum mapping unit
MRA	Marine Resources Assessment
MOUT	Military Operations in Urban Terrain
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSS	Mobile Security Squadrons
MUS	management unit species
NCA	National Command Authority
NCCOS	National Centers for Coastal Ocean Science
NEC	North Equatorial Current
NEO	Non-Combatant Evacuation Order
NEW	net explosive weight
nm	nautical mile
nm^2	square nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDW	North Pacific Deep Water
NPEC	North Pacific Equatorial Current
NPSG	North Pacific Subtropical Gyre

NSW	Naval Special Warfare
OAH	Outer Apra Harbor
OPAREA	Operations Area
OTB	Over the Beach
PDO	Pacific Decadal Oscillation
Potentially	PHCRT Harvested Coral Reef Taxa
PMUS	pelagic management unit species
ppt	parts per thousand
PTS	permanent threshold shift
PUTR	Portable Undersea Tracking Range
RCMP	Range Complex Management Plan
RDT&E	Research, Development, Test, and Evaluation
re 1 μPa-m	referenced to 1 micropascal at 1 meter
REXTORP	Recoverable Exercise Torpedo
RHIB	Rigid Hull Inflatable Boat
S&R	Surveillance and Reconnaissance
SAR	search and rescue
SCD	silicate compensation depth
SFA	Sustainable Fisheries Act
SHAREM	Ship ASW Readiness and Evaluation Measuring
SINKEX	Sinking Exercise
SLP	sea level pressure
SST	sea surface temperature
STOM	Ship to Objective Maneuver
STW	Strike Warfare
SURTASS	Surveillance Towed Array Sensor System
SUW	Surface Warfare
TRACKEX	Tracking Exercise
TORPEX	Torpedo Exercise
TTS	temporary threshold shift
UAV	Unmanned Aerial Vehicles
UJTL	Universal Joint Task List
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USWEX	Undersea Warfare Exercise
UUV	unmanned underwater vehicles
UXO	Unexploded Ordnance
VBSS	Visit Board Search and Seizure
WPRFMC	Western Pacific Regional Fishery Management Council

EXECUTIVE SUMMARY

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth new mandates for the National Marine Fisheries Service (NMFS), eight regional fishery management councils (Councils), and other federal agencies to identify and protect important marine and anadromous fish habitat. The Councils (with assistance from NMFS) are required to delineate Essential Fish Habitat (EFH) for all managed species. Federal agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential impacts on EFH, and respond in writing to NMFS recommendations.

The MSFCMA defines EFH as those waters and substrates necessary (required to support a sustainable fishery and the managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle) (16 U.S.C. Section 1802). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hardbottom, structures underlying the waters, and associated biological communities.

Since coral reefs are considered EFH, this EFH Assessment also includes a Coral Reef Assessment in accordance with Executive Order (EO) 13089 Coral Reef Protection and subsequent guidance documents from the Department of Defense (DoD) and the Navy. EO 13089 on Coral Reef Protection (63 FR 32701) was issued in 1998 “to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment.” It is DoD policy to protect the U.S. and International coral reefs and to avoid impacting coral reefs to the maximum extent possible.

Military activities in the Mariana Islands Range Complex (MIRC) occur on the ocean surface, under the ocean surface, in the air, and on land, extending from the waters south of Guam to north of Pagan (CNMI), and from the Pacific Ocean east of the Mariana Islands to the Philippine Sea to the west; encompassing 450,187 square nautical miles (nm^2) of open ocean and littorals. The area is used to conduct training activities, training, and evaluation of military hardware, personnel, tactics, munitions, explosives, and electronic combat systems.

EFH species within the MIRC have been divided into management units according to their ecological relationships and preferred habitats. Management units include bottomfish management unit species (BMUS), pelagic management unit species (PMUS), crustacean management unit species (CMUS), and coral reef ecosystem management unit species (CRE MUS). For each management unit, the status, distribution (including range), habitat preference (depth, bottom substrate), life history (migration, spawning), and EFH/Habitats Areas of Particular Concern (HAPC) designations are provided.

Taking an ecosystem-based management approach, the proposed training activities in the MIRC have the potential to result in direct and indirect impacts to EFH and managed species, such as physical disruption of open ocean habitat, physical destruction or adverse modification of benthic habitats, alteration of water or sediment quality from expended materials or discharge, and cumulative impacts. The ecosystem-based EFH assessment focuses on activities and impacts common to training activities, but also discusses individual exercises/training activities that have unique aspects such as MISSILEX, BOMBEX, Expeditionary Assault, TORPEX, and SINKEX.

Potential ecosystem impacts from expended material (e.g., flares, chaff, dye, torpedo accessories, sunken targets and vessels) could result from exposure to toxic chemicals, through contact with or ingestion of expended materials, and from entanglement. However, the small quantity of material expended (ranging from 0.8 pounds per nm^2 for the No Action Alternative to 1.3 pounds per nm^2 for Alternative 2), the rapid dilution of dissolved constituents, the relatively non-toxic nature of the expended materials, and its eventual encrustation and incorporation into the sediments would minimize impacts to resident marine communities. From an ecosystem-based management perspective, bioaccumulation of toxic metals and organic compounds to higher-order food chain species is not expected. Expended material would not significantly disturb the sea floor or compromise habitat components that support critical ecosystem functions such as feeding, resting, sheltering, reproduction, or migration of managed species.

With respect to ecosystem structure and function, underwater detonations and weapons firing could disrupt habitats, release hazardous chemical by-products, kill or injure marine life, affect hearing organs, modify behavior, mask biologically-relevant sounds, induce stress, and have indirect effects on prey species and other components of the food web. Initial concentrations of explosion by-products are not hazardous to marine life and would not accumulate because training exercises are widely dispersed over time and space. A small number of fish would be killed by shock waves from explosions or would be injured and could subsequently die or suffer greater rates of predation. Beyond the range of direct, lethal or sub-lethal impacts to fish, minor, short-term behavioral reactions would not be ecologically significant or substantially impact ecosystem structure or function with respect to survival, growth, or reproduction. No lasting adverse effect as a result of underwater detonations or weapons training on prey availability or on the food web is expected.

Most bombs and missiles used in MIRC exercises would not have explosive warheads. The shock force from dummy bombs and missiles hitting the sea surface could result in a limited number of fish kills or injuries, and minor acoustic displacement, but would not substantially affect local species and habitats or ecosystem structure and function. Although few fish would be directly struck by Naval gun fire, explosive 5-inch gunnery rounds could kill or injure a small proportion of any nearby assemblage. Behavioral reactions of fish would extend over a larger area. However, adverse regional ecosystem-based management consequences are not anticipated.

With respect to ecosystem structure and function, most fish species would be able to detect mid frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that non-impulsive acoustic sources result in fish mortality.

Under Alternatives 1 and 2, in addition to accommodating the No Action Alternative will be the addition of increased training activities and capability requirements for personnel and platforms, to an overall increase in the number and types of activities such as major exercises and development of new Portable Undersea Tracking Range (PUTR) capabilities. Due to the temporal and spatial variation of major range events which would include multiple training activities over a large area, and avoidance of HAPCs, they are not expected to result in long-term adverse impacts to EFH. Although some individual activities could affect EFH or managed species at the individual level due to localized impacts, these impacts are not additive when considering major range events or the increase in tempo. Therefore, no long-term adverse impacts to EFH would be expected from major range events or increased tempo.

The assessment concludes that based on the limited extent, duration, and magnitude of potential impacts from MIRC training and testing, there would not be adverse impacts to ecosystem structure and function or critical ecosystem services relative to EFH or managed species. From an ecosystem-based management perspective, range training activities would not adversely contribute to cumulative impacts on present or future uses of the area.

1.0 BACKGROUND

1.1 ESSENTIAL FISH HABITAT ASSESSMENT

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth new mandates for the National Marine Fisheries Service (NMFS), eight regional fishery management councils (Councils), and other federal agencies to identify and protect important marine and anadromous fish habitat. The Councils (with assistance from NMFS) are required to delineate Essential Fish Habitat (EFH) for all managed species. Federal agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential impacts on EFH, and respond in writing to NMFS recommendations.

The MSFCMA defines EFH as those waters and substrates necessary (required to support a sustainable fishery and the managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle) (16 U.S.C. Section 1802). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hardbottom, structures underlying the waters, and associated biological communities.

Since coral reefs are considered EFH, this EFH Assessment also includes a Coral Reef Assessment in accordance with Executive Order (EO) 13089 Coral Reef Protection and subsequent guidance documents from the Department of Defense (DoD) and the Navy. EO 13089 on Coral Reef Protection (63 FR 32701) was issued in 1998 “to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment.” It is DoD policy to protect the U.S. and International coral reefs and to avoid impacting coral reefs to the maximum extent possible.

The Navy adopts an ecosystems management strategy on land and sea; a strategy based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. "Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Therefore, the Navy recognizes that impacts to particular resource areas analyzed in the Environmental Impact Statement/Overseas Envirnmental Impact Statement (EIS/OEIS) can affect other resource areas within the ecosystem, and this EFH assessment incorporates and relies on the analysis conducted for other resource sections wherever possible. The ecosystem-based management approach employed in this document also recognizes that humans, with their cultural diversity, are an integral component of ecosystems, and human impacts, like natural disturbances, affect ecosystems on global, regional and local scales.

EFH can consist of both the water column and the underlying surface (e.g. seafloor) of a particular area. Areas designated as EFH contain habitat essential to the long-term survival and health of our nation’s fisheries. Certain properties of the water column such as temperature, nutrients, or salinity are essential to various species. Some species may require certain bottom types such as sandy or rocky bottoms, vegetation such as seagrasses or kelp, or structurally complex coral or oyster reefs.

EFH includes those habitats that support the different life stages of each managed species. A single species may use many different habitats throughout its life to support breeding, spawning, nursery, feeding, and protection functions. EFH encompasses those habitats necessary to ensure healthy fisheries now and in the future.

Habitat Areas of Particular Concern (HAPC) are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. Councils may designate a specific habitat area as an HAPC based on one or more of the following reasons:

- Importance of the ecological function provided by the habitat
- Extent to which the habitat is sensitive to human-induced environmental degradation
- Whether, and to what extent, development activities are, or will be, stressing the habitat type
- Rarity of the habitat type

The HAPC designation does not confer additional protection or restrictions upon an area, but can help prioritize conservation efforts. Healthy populations of fish require not only the relatively small habitats identified as HAPCs, but also other areas that provide suitable habitat functions. HAPCs alone will not suffice in supporting the larger numbers of fish needed to maintain sustainable fisheries and a healthy ecosystem.

Since coral reefs are considered EFH, this EFH Assessment also includes a Coral Reef Assessment in accordance with Executive Order (EO) 13089 Coral Reef Protection and subsequent guidance documents from the Department of Defense (DoD) and the Navy. EO 13089 on Coral Reef Protection (63 FR 32701) was issued in 1998 "to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment." It is DoD policy to protect the U.S. and International coral reefs and to avoid impacting coral reefs to the maximum extent possible. No concise definition of coral reefs has been promulgated, with regard to regulatory compliance of EO 13089. In general, coral reefs shall consist of tropical reef building Scleractinian and Hydrozoan corals, as well as calcified Octocorals in the families Tubiporidae and Helioporidae, non-calcified Octocorals (soft corals) and Gorgonian corals, all growing in the 0 to 300 foot depth range. Deep water (300 to 3,000 foot [ft] depth range) precious corals and other deep water coral communities will only be considered in the case of a SINKEX, where the vessel might ultimately land on a deep water coral community.

2.0 PROPOSED ACTION

The Department of Defense (DoD) Representative Guam, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia (FSM) and Republic of Palau (DoD REP) proposes to improve training activities in the Mariana Islands Range Complex (MIRC) by selectively improving critical facilities, capabilities, and training capacities. The Proposed Action would result in focused critical enhancements and increases in training that are necessary to maintain a state of military readiness commensurate with the national defense mission. The Proposed Action includes minor repairs and upgrades to facilities and capabilities but does not include any military construction requirements. This is part of the periodically scheduled reviews of facilities and capabilities within the MIRC.

The U.S. Military Services (Services) need to implement actions within the MIRC to support current, emerging, and future training and Research, Development, Test, and Evaluation (RDT&E) activities. Training and RDT&E activities do not include combat operations, operations in direct support of combat, or other activities conducted primarily for purposes other than training. These actions will be evaluated in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) and include:

- Maintaining baseline training and RDT&E activities at mandated levels;
- Increasing training activities and exercises from current levels;
- Accommodating increased readiness activities associated with the force structure changes (human resources, new platforms, additional weapons systems, including undersea tracking capabilities and training activities to support Intelligence, Surveillance, and Reconnaissance[ISR]/Strike); and
- Implementing range complex investment strategies that sustain, upgrade, modernize, and transform the MIRC to accommodate increased use and more realistic training scenarios.

This chapter is divided into the following major subsections: Subsection 2.1 provides a detailed description of the MIRC. Subsections 2.2 to 2.5 describe the major elements of the Proposed Action and Alternatives to the Proposed Action. Subsections 2.4 and 2.5 describe Alternative 1 and Alternative 2.

2.1 DESCRIPTION OF THE MIRC[1]

Military activities in MIRC occur (1) on the ocean surface, (2) under the ocean surface, (3) in the air, and (4) on land. Summaries of the land, air, sea, undersea space addressed in this EIS/OEIS are provided in Tables 2-1, 2-2, 2-3, 2-4, and 2-5. To aid in the description of the training areas covered in the MIRC EIS/OEIS, the range complex is divided into major geographic and functional areas. Each of the individual training areas fall into one of three major MIRC training areas:

- The Surface/Subsurface Area consists of all sea and undersea training areas in the MIRC.
- The Airspace Area includes all Special Use Airspace (SUA) in the MIRC.
- The Land Area includes all land training area in the MIRC.

Summaries of the land, air, sea, undersea space addressed in the EIS/OEIS are provided in Appendix A.

---

1 For the purposes of this EIS, the MIRC and the Study Area are the same geographical areas. The complex consists of the ranges and the ocean areas surrounding the ranges that make up the Study Area. The Study Area does not include the sovereign territory (including waters out to 12 nm) of the Federated States of Micronesia (FSM).

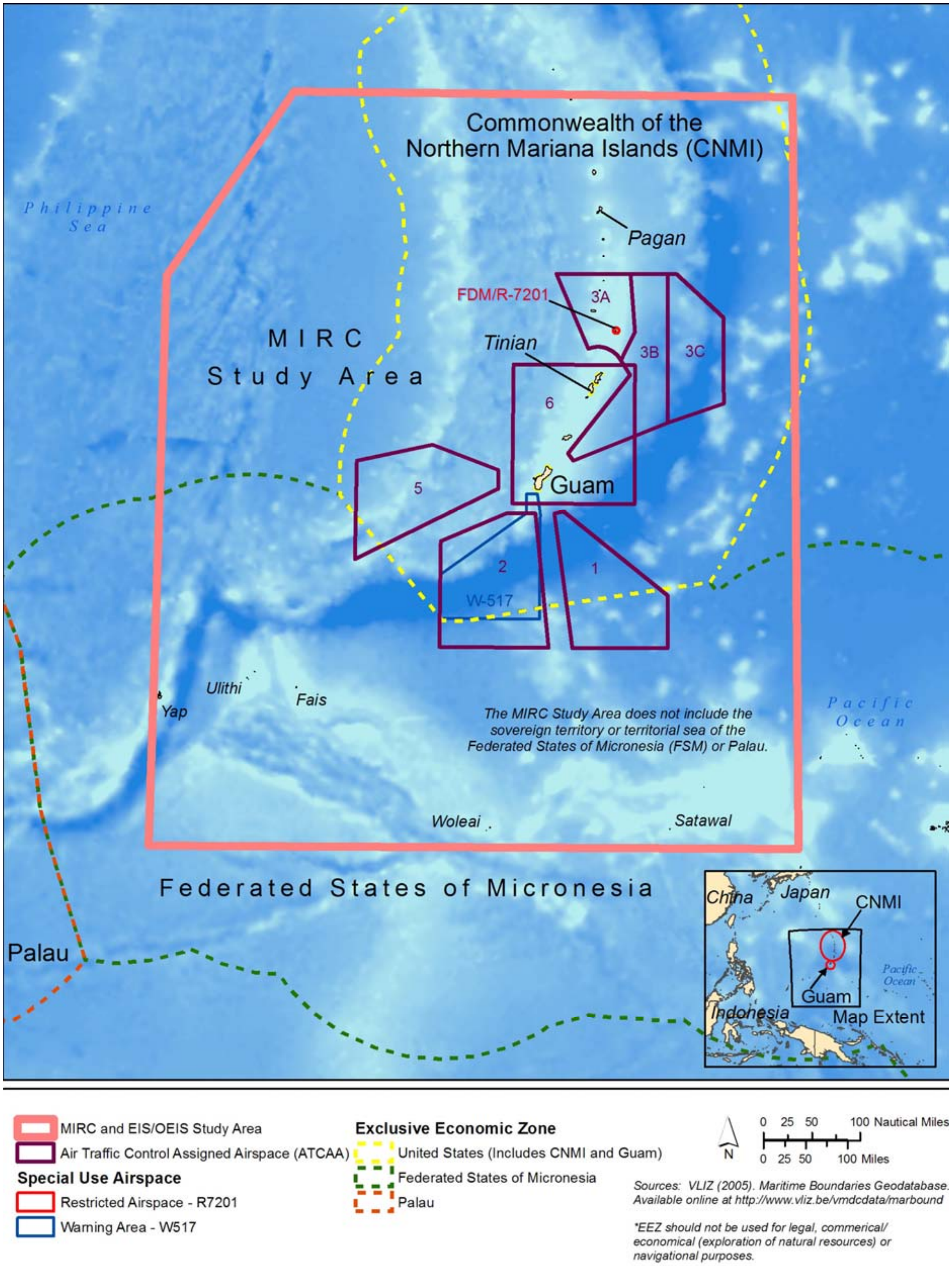


Figure 2-1. Mariana Islands Range Complex and EIS/OEIS Study Area.

2.2 NO ACTION ALTERNATIVE–CURRENT TRAINING WITHIN THE MIRC

The No Action Alternative is the continuation of training activities, RDT&E activities, and continuing base activities. This includes all multi-Service training activities on DoD training areas, including either a joint expeditionary warfare exercise or a joint multi-strike group exercise. The current military training in the MIRC was initially analyzed in the 1999 *Final Environmental Impact Statement Military Training in the Marianas* (DoD 1999) and in several EAs (*e.g*., OEA Notification for Air/Surface International Warning Areas (DoD 2002) and Valiant Shield OEA [DoN 2007]) for more specific training events or platforms. As such, evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 (Preferred Alternative), and Alternative 2, as described in the following subsections.

While the No Action Alternative meets a portion of the Service's requirements, it does not meet the purpose and need. This Alternative does not provide for training capabilities for ISR/Strike, undersea warfare improvements, or increased training activities within the MIRC. With reference to the criteria identified in Section 2.2.1, the No Action Alternative does not satisfy criteria 7, 8, and 9 (relating to support for the full spectrum of training requirements).

2.2.1 DESCRIPTION OF CURRENT TRAINING ACTIVITIES WITHIN THE MIRC

Each military training activity described in this EIS/OEIS meets a requirement that can be traced ultimately to requirements from the National Command Authority (NCA) composed of the President of the United States and the Secretary of Defense. Based upon NCA requirements, the Joint Staff develops a set of high-level strategic warfighting missions, called the Universal Joint Task List (UJTL). The Joint Forces Command (JFCOM) and each military Service uses the UJTL to develop specific statements of required tactical tasks. Each Service derives its tactical tasks from the UJTLs. These Service-level tactical task lists are in turn applied to training requirements that the MIRC is to support with range and training area capabilities. Service tactical tasks that encompass the current training activities within the MIRC are listed in Table 2-8, are briefly described below in Service-specific groupings, and are described in greater detail in Appendix D. The source for these lists is the MIRC Range Complex Management Plan (RCMP) (DoN 2006). A complete description, including tempo and ordnance expended for each activity for the No Action Alternative, Alternative 1, and Alternative 2 is provided in Appendix A.

2.3 ALTERNATIVE 1— CURRENT TRAINING, INCREASED TRAINING SUPPORTED BY MODERIZATION AND UPGRADES/MODIFICATIONS TO EXISTING CAPABILITIES, TRAINING ASSOCIATED WITH ISR/STRIKE, AND MULTI-NATIONAL AND/OR JOINT EXERCISES (PREFERRED ALTERNATIVE)

Alternative 1 is a proposal designed to meet the Services' current and foreseeable training requirements. If Alternative 1 were to be selected, in addition to accommodating the No Action Alternative, it would include increased training as a result of upgrades and modernization of existing capabilities, and include establishment of a danger zone and restricted area around FDM (a 10-nm zone around FDM to be established in accordance with C.F.R. Title 33 Part 334; see Figure 2-3). Alternative 1 also includes training associated with ISR/Strike and other

Andersen AFB initiatives. Training will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range (PUTR) capabilities. PUTR trains personnel in undersea warfare including conducting TRACKEX and TORPEX activities. Helicopter, ship, and submarine sonar systems will use this capability. Small arms range capability improvements and MOUT training facility improvements would also increase training activities. Training activities will increase as a result of the development of a laser certified range area in W-517. This laser range capability will aid in the training of aircrews in the delivery of air-to-surface missiles against surface vessel targets. Primarily conducted in W-517, the weapon systems commonly used in this training activity are the laser guided HELLFIRE missile or an inert captive air training missile (CATM). The CATM is a missile shape that contains electronics only, and it remains attached to the aircraft weapon mounting points. The MISSILEX involves in-flight laser designation and guidance, and arming and releasing of the air to surface weapon by aircraft, typically against a small stationary, towed, or maneuvering target; however a CATM Exercise (CATMEX) may be conducted against any laser reflective target mounted on or towed by a target support vessel. Table 2-8 of the EIS/OEIS summarizes these increases in training activities. These increased capabilities will result in increased multi-national and/or joint exercises.

Major Exercise—Training would increase to include additional major exercises involving multiple strike groups and expeditionary task forces (see EIS/OEIS Table 2-7). Major exercises provide multi-Service and multi-national participation in realistic maritime and expeditionary training that is designed to replicate the types of operations and challenges that could be faced during real-world contingency operations. Major exercises provide training for command elements, submarine, ship, aircraft, expeditionary, and special warfare forces in tactics, techniques, and procedures.

(Note: the *Guam and CNMI Military Relocation EIS/OEIS* is being prepared for the relocation of Marine Corps forces from Okinawa to Guam. The Military Relocation EIS/OEIS examines the potential impact from activities associated with the Marine Corps units' relocation, including training activities and infrastructure changes on and off DoD lands. Since the MIRC EIS/OEIS covers DoD training on existing DoD land and training areas in and around Guam and the CNMI, there will be overlap between the two EIS/OEISs in the area of land usage. These documents are being closely coordinated to ensure consistency.)

ISR/Strike—The Air Force has established the ISR/Strike program at Andersen AFB, Guam. ISR/Strike will be implemented in phases over a planning horizon of FY2007–FY2016. ISR/Strike force structure consists of up to 24 fighter, 12 aerial refueling, six bomber, and four unmanned aircraft with associated support personnel and infrastructure. Aircraft operations and training out of Andersen AFB ultimately will increase by 45 percent over the current level (FY2006). Environmental impacts associated with ISR/Strike have been analyzed in the *2006 Establishment and Operation of an Intelligence, Surveillance and Reconnaissance/Strike, Andersen Air Force Base, EIS (USAF 2006a)*. The anticipated 45 percent increase in aircraft operations and training out of and into Andersen AFB requires improved range infrastructure to accommodate this increased training tempo, newer aircraft, and weapon systems commensurate with ISR/Strike force structure. There will be increased activity on all the current training areas supporting Air Force training activities: W-517, ATCAAs, and FDM/R-7201. The ISR/Strike EIS analyzed environmental impacts related to the infrastructure improvements required (USAF 2006a). This EIS/OEIS analyzes the impacts of the increased training resulting from the ISR/Strike implementation.

FDM— As usage of FDM increases under implementation of either Alternative 1 or Alternative 2, a 10-nm danger zone would be established to restrict all private and commercial vessels from entering the area during the conduct of hazardous training activity. Development of a 10-nm danger zone would be supplemented by temporary advisory notices as required. FDM and the near shore waters are leased to the United States for military purposes specifically for use as a live fire naval gunfire and air warfare air strike training range. As such FDM and its near shore area have always been an off-limits area to all personnel both civilian and military due to unexploded ordnance concerns. The lease agreement between CNMI and the United States, states in pertinent part, at Article 12 of the lease: “c. **Farallon de Medinilla:**. Public access to Farallon de Medinilla Island and the waters of the Commonwealth immediately adjacent thereto shall be permanently restricted for safety reasons.” This restriction will continue and FDM and near shore areas including the fringing reef and other near shore formations remain a restricted area which prohibits the entry of all personnel, civilian and military from the island without specific permission from Commander US Naval Forces, Marianas. The creation of the proposed danger zone does not affect the continued implementation of restricted access as indicated in the lease agreement; and, therefore no trespassing is permitted on the island or near shore waters and reef at any time.

The proposed danger zone would designate a surface safety zone of 10 nm radius surrounding FDM. Public access to FDM will remain strictly prohibited and there are no commercial or recreational activities on or near the island. Aircraft and marine vessels continue to be restricted in accordance with the lease agreement. Notice to Mariners (NOTMAR) and Notice to Airmen (NOTAM) will continue to be issued at least 72 hours in advance of potentially hazardous FDM range events and may advise restrictions for certain training events. These temporary advisory restrictions are used to maintain the safety of the military and the public during training sessions by providing public notice of potentially hazardous training activity and associated danger zones and restriction areas.

As usage of FDM increases, a danger zone would be established to restrict all private and commercial vessels from entering the area during the conduct of hazardous training activity. Development of a 10-nm danger zone would continue to be supplemented by temporary advisory notices as required. Scheduled training will be communicated to the stakeholders (e.g., local mayors, resource agencies, fishermen) using a telephone tree and e-mail (developed by COMNAVMAR with stakeholders’ input) to send, facsimiles to mayors and fishermen, and notices on the NOAA and local cable channels, and emergency management offices. This safety zone provides an additional measure of safety for the public during hazardous training activities involving the island. The Surface Danger Zone is propose as a surface safety exclusion area to be established in accordance with 33 CFR § 334.1. The ACOE may promulgate regulations restricting commercial public and private vessels from entering the restricted safety zone to minimize danger from the hazardous activity in the area.

Modernization and Upgrades of Training Areas

Anti-Submarine Warfare (ASW)—ASW describes the entire spectrum of platforms, tactics, and weapon systems used to neutralize and defeat hostile submarine threats to combatant and non-combatant maritime forces. A critical component of ASW training is the Portable Underwater Tracking Range (PUTR). This is an instrumented range that allows near real-time tracking and feedback to all participants. The tracking range should provide for both a shallow water and deep water operating environment, with a variety of bottom slope and sound velocity profiles similar to potential contingency operating areas. Guam-homeported submarine crews, as well as crews of transient submarines, require ASW training events to maintain qualifications. A MIRC instrumented ASW PUTR, target support services, and assigned torpedo retriever craft would meet support requirements for TORPEX and TRACKEX activities in the MIRC in support of submarines and other deployed ASW forces.

Military Operations in Urban Terrain (MOUT)—MOUT training is conducted within a facility that replicates an urban area, to the extent practicable. The urban area includes a central urban infrastructure of buildings, blocks, and streets; an outlying suburban residential area; and outlying facilities. Suburban area structures should represent a local noncombatant populace and infrastructure. The existing MOUT facilities will be maintained and remodeled as necessary to support training requirements of units stationed at or deployed to the MIRC. In addition modular and temporary facilities may be assembled to support MOUT exercises.

MISSILEX [A-S] and BOMBEX [A-S] in W-517—MISSILEX is authorized in W-517, however in support of HSC-25 a permanent Laser Hazard Area and Missile Hazard Area is required to support HELLFIRE Missile Exercise unit level training requirements. The HELLFIRE laser range location and schedule will be established and coordinated with the Guam FAA. BOMBEX [A-S] is authorized in W-517, however in support of USAF requirements for live fire BOMBEX, Area Training and USAF have developed range safety and mitigation procedures for support of Joint Direct Attack Munitions (JDAM) in W-517. JDAM is capable of over-the-horizon release and GPS guidance to target aimpoint.

A complete description, including tempo and ordnance expended for each activity for the No Action Alternative, Alternative 1, and Alternative 2 is provided in Appendix A.

2.4 ALTERNATIVE 2— CURRENT TRAINING, INCREASED TRAINING SUPPORTED BY MODERIZATION AND UPGRADES/MODIFICATIONS TO EXISTING CAPABILITIES, TRAINING ASSOCIATED WITH ISR/STRIKE, INCREASED MULTI-NATIONAL AND/OR JOINT EXERCISES; INCLUDING ADDITIONAL NAVAL EXERCISES

Implementation of Alternative 2 would include all the actions proposed for MIRC in Alternative 1 and increased training activity associated with major at-sea exercises (see Appendix A Tables A-7 and A-8). Additional major at-sea exercises would provide additional ships and personnel maritime training including additional use of sonar that would improve the level of joint operating skill and teamwork between the Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures required in carrying out the primary mission areas of maritime forces. The additional maritime exercises would take place within the MIRC and would focus on carrier strike group training and ASW activities similar to training conducted in other Seventh Fleet locations, including a Fleet Strike Group Exercise, an Integrated ASW Exercise, and a Ship Squadron ASW Exercise.

Additional Major Exercises proposed for Alternative 2:

The **Fleet Strike Group Exercise** and an additional **Integrated ASW Exercise** would be conducted in the MIRC by forward-deployed Navy Strike Groups to sustain or assess their proficiency in conducting tasking within the Seventh Fleet. Training would be focused on conducting Strike Warfare or ASW in the most realistic environment, against the level of threat expected in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of the Navy Strike Group. Although these exercises would emphasize Strike or ASW, there is significant training value inherent in all at-sea exercises and the opportunity to exercise other mission areas. Each exercise would last a week or less.

The **Ship Squadron ASW Exercise** overall objective is to sustain and assess surface ship ASW readiness and effectiveness. The exercise typically involves multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less. Maximizing opportunities to collect high-quality data to support quantitative analysis and assessment of training activities is an additional goal of this training.

A complete description, including tempo and ordnance expended for each activity for the No Action Alternative, Alternative 1, and Alternative 2 is provided in Appendix A.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
ARMY TRAINING			
	Surveillance and Reconnaissance (S&R)	Finegayan House, Barrigada House, Tinian-Exclusive Military Use Area, and the Lease Back Area	S&R are conducted to evaluate the battlefield and enemy forces, and to gather intelligence. For training of assault forces, opposition forces (OPFOR) units may be positioned ahead of the assault force and permitted a period of time to conduct S&R and prepare defenses against an assaulting force. S&R training has occurred at urban training facilities at Finegayan and Barrigada on Guam, and both the Exclusive Military Use Area (EMUA) and the Lease Back Area (LBA) on Tinian.
	Field Training Exercise (FTX)	Polaris Point Field, Orote Point Airfield/Runway, NLNA, Andersen Air Force Base Northwest Field, and Andersen South Housing Area, and on Tinian at the EMUA	An FTX is an exercise wherein the battalion and its combat and combat service support units deploy to field locations to conduct tactical training activities under simulated combat conditions. A company or smaller-sized element of the Army Reserve, GUARNG, or Guam Air National Guard (GUANG) will typically accomplish an FTX within the MIRC, due to the constrained environment for land forces. The headquarters and staff elements may simultaneously participate in a Command Post Exercise (CPX) mode.
	Live Fire	Pati Pt. CATM Range	Live-fire training is conducted to provide direct fire in support of combat forces.
	Parachute Insertions and Air Assault	Orote Point Triple Spot, Polaris Point Field, and the Ordnance Annex Breacher House. Additionally, Orote Point Airfield/Runway supports personnel, equipment, and Container Delivery System (CDS) airborne parachute insertions.	These air training activities are conducted to insert troops and equipment by parachute and/or by fixed or rotary wing aircraft to a specified objective area.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
ARMY TRAINING			
	Military Operations in Urban Terrain (MOUT)	OPCQC House, Ordnance Annex Breacher House, Barrigada Housing, and Andersen South Housing Area. Additionally, the OPCQC supports "raid" type MOUT training on a limited basis	MOUT training activities encompass advanced offensive close quarter battle techniques used on urban terrain conducted by units trained to a higher level than conventional infantry. Techniques include advanced breaching, selected target engagement, and dynamic assault techniques using organizational equipment and assets. MOUT is primarily an offensive operation, where noncombatants are or may be present and collateral damage must be kept to a minimum. MOUT training involves clearing buildings; room-by-room, stairwell-by-stairwell, and keeping them clear. It is manpower intensive, requiring close fire and maneuver coordination and extensive training.
MARINE CORPS TRAINING			
	Ship to Objective Maneuver (STOM)	EMUA on Tinian	STOM is conducted to gain a tactical advantage over the enemy in terms of both time and space. The maneuver is not aimed at the seizure of a beach, but builds upon the foundations of expanding the battlespace.
	Operational Maneuver	Northern and Southern Land Navigation Area	This training exercise supports forces achieving a position of advantage over the enemy for accomplishing operational or strategic objectives.
	Non-Combatant Evacuation Order (NEO)	EMUA on Tinian	NEO training activities are conducted when directed by the Department of State, the DoD, or other appropriate authority whereby noncombatants are evacuated from foreign countries to safe havens or to the United States, when their lives are endangered by war, civil unrest, or natural disaster.
	Assault Support (AS)	Polaris Point Field, Orote Point KD Range, and EMUA on Tinian	AS exercises provide helicopter support for C2, assault escort, troop lift/logistics, reconnaissance, search and rescue (SAR), medical evacuation (MEDEVAC), reconnaissance team insertion/extract and Helicopter Coordinator (Airborne) duties. Assault support provides the mobility to focus and sustain combat power at decisive places and times. It provides the capability to take advantage of fleeting battlespace opportunities.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
MARINE CORPS TRAINING			
	Reconnaissance and Surveillance (R & S)	EMUA on Tinian	R&S is conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, OPFOR units may be positioned ahead of the assault force and permitted a period of time to conduct R&S and prepare defenses to the assaulting force.
	Military Operations in Urban Terrain (MOUT)	Ordnance Annex Breacher House	Marine Corps MOUT training is similar in nature and intent to Army MOUT training.
	Direct Fire	FDM and ATCAA 3A airspace	Direct Fire, similar in nature and content to Navy Marksmanship exercises, is used to train personnel in the use of all small arms weapons for the purpose of defense and security. Direct Fire training activities are strictly controlled and regulated by specific individual weapon qualification standards. These training activities have occurred at FDM and OPKDR. Another form of Marine Corps Direct Fire exercises involves the use of aircraft acting as forward observers for Naval Surface Fire Support (NSFS). During this training, Marine aircraft will act as spotters for the ships and relay targeting and battle hit assessments information.
	Exercise Command and Control (C2)	Andersen AFB	This type of exercise provides primary communications training for command, control, and intelligence, providing critical interpretability and situation awareness information.
	Protect and Secure Area of Operations (Protect the Force)	Northwest Field on Andersen Air Force Base	Force protection training activities increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Tracking Exercise	MIRC Offshore Areas, W-517	ASW TRACKEX trains aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines. The use of sonobuoys is generally limited to areas greater than 100 fathoms, or 600 feet, in depth.
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Torpedo Exercise	MIRC Offshore Areas, W-517	ASW TORPEX training activities train crews in tracking and attack of submerged targets, using active or passive acoustic systems, and firing one or two Exercise Torpedoes (EXTORPs) or Recoverable Exercise Torpedoes (REXTORPs). TORPEX targets used in the Offshore Areas include live submarines, MK-30 ASW training targets, and MK-39 Expendable Mobile ASW Training Targets (EMATT).
Anti-Air Warfare (AAW)	Missile Firing Exercises (MISSILEX)	MIRC Offshore Areas, W-517, ATCAA 1/2/3/5	MISSILEX is an operation in which missiles are fired from either aircraft or ships against aerial targets. Air-to-Air exercises involve a fighter or fighter/attack aircraft firing a missile at an aerial target. Aerial targets are typically launched. In the MIRC this event refers to training activities in which air-to-air missiles are fired from aircraft against unmanned aerial target drones, gliders, or flares. The missiles fired are not recovered.
Anti-Air Warfare (AAW)	Chaff Exercise (CHAFFEX)	MIRC Offshore Areas, W-517, ATCAA 1/2	A CHAFFEX trains aircraft and shipboard personnel in the use of chaff to counter antiship missile threats. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, which are used to reflect echoes to deceive radars.
Anti-Air Warfare (AAW)	Flare Exercise	MIRC Offshore Areas, W-517	A flare exercise is an aircraft defensive operation in which the aircrew attempts to cause an infrared (IR) or radar energy source to break lock with the aircraft.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Anti-Surface Warfare (ASUW)	Surface-to-Surface Gunnery Exercise (GUNEX)	MIRC Offshore Areas, W-517	Surface-To-Surface GUNEX take place in the open ocean to provide gunnery practice for Navy and Coast Guard ships utilizing shipboard gun systems and small craft crews supporting NSW, EOD, and Mobile Security Squadrons (MSS) utilizing small arms. GUNEX training activities conducted in W-517 involve only surface stationary targets such as a MK-42 Floating At Sea Target (FAST), MK-58 marker (smoke) buoys, or 55 gallon drums. The systems employed against surface targets include the 5-inch, 76mm, 25mm chain gun, 20mm Close In Weapon System (CIWS), .50 caliber machine gun, 7.62mm machine gun, small arms, and 40mm grenade.
Anti-Surface Warfare (ASUW)	Air-to-Surface Gunnery Exercise (GUNEX)	MIRC Offshore Areas, W-517	Air-to-Surface GUNEX training activities are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would use either 7.62mm or .50 caliber door-mounted machine guns. GUNEX training occurs frequently in the MIRC Offshore Areas other than W-517, but exact data on this open ocean training evolution outside of W-517 is not recorded or tracked.
Anti-Surface Warfare (ASUW)	Visit Board Search and Seizure (VBSS)	MIRC Offshore Areas, W-517, Outer Apra Harbor	These exercises involve the interception of a suspect surface ship by a Navy ship and are designed to train personnel to board a ship, other vessel or transport to inspect and examine the vessel's papers or examine it for compliance with applicable laws and regulations. Seizure is the confiscating or taking legal possession of the vessel and contraband (goods or people) found in violation of laws or regulations. A VBSS can be conducted both by ship personnel trained in VBSS or by Naval Special Warfare (NSW) SEAL teams trained to conduct VBSS on uncooperative vessels. Employment onto the vessel designated for inspection is usually done by small boat or by helicopter.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Anti-Surface Warfare (ASUW)	Sink Exercise (SINKEX)	MIRC Offshore Areas, W-517	A SINKEX provides training to ship and aircraft crews in delivering live ordnance on a real target. Each SINKEX uses an excess vessel hulk as a target that is eventually sunk during the course of the exercise. The target is an empty, cleaned, and environmentally remediated ship hull that is towed to a designated location where various platforms would use multiple types of weapons to fire shots at the hulk.
Strike Warfare (STW)	Air to Ground Bombing Exercises (Land) (BOMBEX-Land)	FDM, ATCAA 3	BOMBEX (Land) allows aircrews to train in the delivery of bombs and munitions against ground targets. The weapons commonly used in this training are inert training munitions (e.g., MK-76, BDU-45, BDU-48, BDU-56 and MK-80-series bombs), and live MK-80-series bombs and precision guided munitions (Laser Guided Bombs [LGBs] or Laser Guided Training Round [LGTRs]). BOMBEX exercises can involve a single aircraft, a flight of two, four, or multiple aircraft.
Strike Warfare (STW)	Air to Ground Missile Exercises (MISSILEX)	FDM, ATCAA 1/2/3/5	Air-to-ground Missile Exercise trains aircraft crews in the use of air-to-ground missiles. It is conducted mainly by H-60 Aircraft using Hellfire missiles and occasionally by fixed wing aircraft using Maverick missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire the target, and launch the missile. The missile is launched in forward flight or at hover at an altitude of 300 feet Above Ground Level (AGL).
Naval Special Warfare (NSW)	Naval Special Warfare Operations (NSW OPS)	Various	NSW personnel perform special activities using tactics that are applicable to the specific tactical situations where the NSW personnel are employed.
Naval Special Warfare (NSW)	Airfield Seizure	Northwest Field on Andersen Air Force Base	Airfield Seizure training activities are used to secure key facilities in order to support follow-on forces, or enable the introduction of follow-on forces. An airfield seizure consists of a raid/seizure force from over the horizon assaulting across a hostile territory in a combination of helicopters, vertical takeoff and landing (VTOL aircraft), and other landing craft with the purpose of securing an airfield or a port.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Naval Special Warfare (NSW)	Breaching	OPCQC House, Ordnance Annex Breacher House (OABH)..	Breaching training teaches personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This enables a force to maintain its mobility by removing or reducing natural and man-made obstacles. In the NSW sense, breacher training activities are designed to provide personnel experience knocking down doors to enter a building or structure. During the conduct of a normal breach activity, battering rams or less than 1.2 pounds net explosive weight (NEW) is used to knock down doors.
Naval Special Warfare (NSW)	Direct Action	Gab Gab Beach to Apra Harbor and Orote Point training areas, FDM	NSW Direct Action is either covert or overt directed against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. Training activities are small-scale offensive actions including raids; ambushes; standoff attacks by firing from ground, air, or maritime platforms; designate or illuminate targets for precision-guided munitions; support for cover and deception operations; and sabotage inside enemy-held territory. Units involved are typically at the squad or platoon level staged on ships at sea. They arrive in the area of operations by helicopter or CRRC across a beach. NSW teams are capable of using small craft to island hop from Guam to Rota, Rota to Tinian, Tinian to Saipan, and Saipan to FDM; however, this is not a frequent event. Once at FDM, small arms, grenades, and crew-served weapons (weapons that require a crew of several individuals to operate) are employed in direct action against targets on the island. Participation in Tactical Air Control Party/Forward Air Control (TACP/FAC) training in conjunction with a BOMBEX-Land also occurs.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Naval Special Warfare (NSW)	Insertion/Extraction	Outer Apra Harbor, Inner Apra Harbor, Gab Gab Beach (western half), Reserve Craft Beach, and Polaris Point Field.	Insertion/extraction activities train forces, both Navy (primarily Special Forces and EOD) and Marine Corps, to deliver and extract personnel and equipment. These activities include, but are not limited to, parachute, fast rope, rappel, Special Purpose Insertion/Extraction (SPIE), CRRC, and lock-in/lock-out from underwater vehicles. Additionally, parachute, fast rope, and rappel training have been conducted at Orote Point Airfield/Runway, Orote Point Triple Spot, OPCQC House, Dan Dan Drop Zone, OPKD Range, and the Ordnance Annex Breacher House.
Naval Special Warfare (NSW)	Military Operations in Urban Terrain (MOUT)	Ordnance Annex Breacher House. Additionally, the OPCQC supports "raid" type MOUT training on a limited basis.	NSW MOUT training is similar in nature and intent to Army and Marine Corps MOUT training, but typically on a smaller scale.
Naval Special Warfare (NSW)	Over the Beach (OTB)	Various	NSW personnel use different methods of moving forces from the sea across a beach onto land areas in order to get closer to a tactical assembly area or target depending on threat force capabilities. A typical OTB exercise would involve a squad (8 personnel) to a platoon (16 personnel) or more of NSW personnel being covertly inserted into the water off of a beach area of hostile territory. However, the insertion could be accomplished by other means, such as fixed-winged aircraft, helicopter, submarine, or surface ship. From the insertion point several miles at sea, the SEALs may use a CRRC, Rigid Hull Inflatable Boat (RHIB), SEAL Delivery Vehicle (SDV), Advanced SEAL Delivery System (ASDS), or swim to reach the beach, where they will move into the next phase of the exercise and on to the objective target area and mission of that phase of the exercise.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Amphibious Warfare (AMW)	Naval Surface Fire Support (FIREX Land)	FDM	FIREX (Land) on FDM consists of the shore bombardment of an Impact Area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed. On FDM, spotting may be conducted from the special use "no fire" zone or provided from a helicopter platform. No one may land on the island without the express permission of COMNAVMAR (COMNAVMARINST 3502.1).
Amphibious Warfare (AMW)	Marksmanship	Orote Point and Finegayan small arms ranges, and Orote Point KD range	Marksmanship exercises are used to train personnel in the use of small arms weapons for the purpose of ship self defense and security. Basic marksmanship training activities are strictly controlled and regulated by specific individual weapon qualification standards. Small arms include but are not limited to 9mm pistol, 12-gauge shotgun, and 7.62mm rifles.
Amphibious Warfare (AMW)	Expeditionary Raid	Reserve Craft Beach	An Expeditionary Raid (Assault) is an attack involving swift incursion into hostile territory for a specified purpose. The attack is then followed by a planned withdrawal of the raid forces. A raid force can consist of varying numbers of aviation, infantry, engineering, and fire support forces. Expeditionary Raids conducted in support to movement of operational forces are normally directed against objectives requiring specific outcomes not possible by other means. A key influence in every raid is the ability to insert, complete the assigned mission, and extract without providing the enemy force with opportunity to reinforce their forces or plan for counter measures. The expeditionary raid is the foundation for all MEU SOC operational missions and is structured based upon mission requirements, situational settings, and force structure. Reserve Craft Beach is capable of supporting a small Expeditionary Raid training event followed by a brief administrative buildup of forces ashore.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Amphibious Warfare (AMW)	Hydrographic Surveys	FDM, Outer Apra Harbor, Tinian EMUA, and Tipalao Cove	Hydrographic Reconnaissance is conducted to survey underwater terrain conditions and report findings to provide precise analysis typically in support of amphibious landings and precise ship and small craft movement through cleared routes (Q-Routes). Exercises involve the methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and to determine the feasibility of landing an amphibious force on a particular beach.
Mine Warfare (MIW)	Land Demolition	Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC House, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, and Barrigada Housing.	Training activities using land demolition training are designed to develop and hone EOD detachment mission proficiency in location, excavation, identification, and neutralization of buried land mines. During the training, teams transit to the training site in trucks or other light-wheeled vehicles. A search is conducted to locate inert (nonexplosively filled) land mines or Improvised Explosive Devices (IEDs) and then designate the target for destruction. Buried land mines and Unexploded Ordnance (UXO) require the detachment to employ probing techniques and metal detectors for location phase. Use of hand tools and digging equipment is required to excavate. Once exposed and/or properly identified, the detachment neutralizes threats using simulated or live explosives. Land demolition training is actively conducted throughout the MIRC. Explosive Ordnance Disposal Mobile Unit (EODMU)-5 is stationed at Main Base and EOD Detachment, Marianas (DET MARIANAS) is a small unit of EOD personnel who are permanently attached to COMNAVBASE MARIANAS and are actively involved in disposing of old munitions and UXO found throughout the MIRC.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Mine Warfare (MIW)	Underwater Demolition	Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization	Underwater demolitions are designed to train personnel in the destruction of mines, obstacles, or other structures in an area to prevent interference with friendly or neutral forces and noncombatants. It provides NSW and EOD teams experience detonating underwater explosives. Outer Apra Harbor supports this training near the Glass Breakwater at a depth of 125 feet and with up to a 10-pound net explosive weight (NEW) charge. Piti and Agat Bay Floating Mine Neutralization areas also support this type of training, with up to a 20-pound NEW charge.
Logistics and Combat Services Support	Combat Mission Area Training	Orote Point Airfield/Runway	Special Forces and EOD units conduct mission area training that supports their own and other services combat service needs in both the water and on land. At Orote Point Airfield/Runway, this task includes providing patrolling, scouting, observation, imagery, and air control services and training.
Logistics and Combat Services Support	Command and Control (C2)	Reserve Craft Beach	C2 training activities provide primary communications for command, control, and intelligence, providing critical interpretability and situation awareness information. EOD personnel have provided USMC C2 support at Reserve Craft Beach.
Combat Search and Rescue (CSAR)	CSAR Training activities	North Field on Tinian	CSAR activities train rescue forces personnel in the tasks needed to be performed to affect the recovery of distressed personnel during war or military operations other than war. These training activities could include aircraft, surface ships, submarines, ground forces (NSW and USMC), and their associated personnel in the execution of training events.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Protect and Secure Area of Operations	Embassy Reinforcement (Force Protection)	Main Base, Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Airfield/Runway, Orote Point Close Quarters Combat House, Orote Point Radio Tower, and Orote Point Triple Spot	Force protection training increases the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers; detection and assessment of threats; delay or denial of access of the adversary to their target; appropriate response to threats and attack; and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures. Base Naval Security Forces and Marine Support Squadrons frequently conduct force protection training throughout the Main Base, but all forces will participate in force protection training to some degree in multiple locations throughout the MIRC.
Logistics and Combat Services Support	Command and Control (C2)	Reserve Craft Beach	C2 training activities provide primary communications for command, control, and intelligence, providing critical interpretability and situation awareness information. EOD personnel have provided USMC C2 support at Reserve Craft Beach.
Combat Search and Rescue (CSAR)	CSAR Training activities	North Field on Tinian	CSAR activities train rescue forces personnel in the tasks needed to be performed to affect the recovery of distressed personnel during war or military operations other than war. These training activities could include aircraft, surface ships, submarines, ground forces (NSW and USMC), and their associated personnel in the execution of training events.
Protect and Secure Area of Operations	Embassy Reinforcement (Force Protection)	Main Base, Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Airfield/Runway, Orote Point Close Quarters Combat House, Orote Point Radio Tower, and Orote Point Triple Spot	Force protection training increases the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers; detection and assessment of threats; delay or denial of access of the adversary to their target; appropriate response to threats and attack; and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures. Base Naval Security Forces and Marine Support Squadrons frequently conduct force protection training throughout the Main Base, but all forces will participate in force protection training to some degree in multiple locations throughout the MIRC.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
NAVY TRAINING			
Protect and Secure Area of Operations	Anti-Terrorism (AT)	Inner Apra Harbor, Polaris Point Site III, Ordnance Annex Breacher House, and Orote Annex Detonation Range, Northwest Field	AT training activities concentrate on the deterrence of terrorism through active and passive measures, including the collection and dissemination of timely threat information, conducting information awareness programs, coordinated security plans, and personal training. The goal is to develop protective plans and procedures based upon likely threats and strike with a reasonable balance between physical protection, mission requirements, critical assets and facilities, and available resources to include manpower. AT training activities may involve units of Marines dedicated to defending both U.S. Navy and Marine Corps assets from terrorist attack. The units are designated as the Fleet Anti-Terrorism Security Team, or FAST. FAST Company Marines augment, assist, and train installation security when a threat condition is elevated beyond the ability of resident and auxiliary security forces. They are not designed to provide a permanent security force for the installation. They also ensure nuclear material on submarines is not compromised when vessels are docked. FAST Companies deploy only upon approval of the Chief of Naval Operations (CNO). USMC Security Force FAST Platoons stationed in Yokuska, Japan have conducted AT training with Base Naval Security, NSW, and EOD support in multiple locations within the MIRC.
Major Exercises	Joint Exercise/USPACOM; USMC-Navy STOM/USMC-Navy; USMC Urban Ops/USMC	Various	Multiple Strike Group Exercises (Primarily Offshore; annual event, but may include nearshore, Guam, FDM, and CNMI) and Amphibious Assault Group Exercise – No Action Alternative would be one of the two exercises. Alt 1 and Alt 2 consist of one Multiple Strike Group Exercise, and one Amphibious Assault Exercise Expeditionary Warfare Exercise (Offshore/Nearshore/ Tinian/Guam/Saipan/Rota/FDM) Urban Warfare Exercise (Sustainment) (Primarily on Guam; semi-annually, 3-4 weeks per event; may include STOM and Tinian/Saipan/Rota)

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
NO ACTION ALTERNATIVE			
AIR FORCE TRAINING			
	Counter Land	FDM, ATCAA 3	Counter Land is similar in nature and content to the Navy's BOMBEX (Land) operation.
	Counter Air	W-517 and ATCAA 1 & 2	Counter air is single to multiple aircraft engaged in advanced, simulated radar, infrared (IR), or visual air-to-air training. During this training, aircraft may dispense chaff and flares as part of missile defense training. Flares are high incendiary devices meant to decoy IR missiles. Burn time for flares usually lasts from 3 to 5 seconds. Chaff exercises train aircraft and/or shipboard personnel in the use of chaff to counter anti-ship and anti-aircraft missile threats. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, which are used to reflect echoes to deceive radars. During a chaff exercise, the chaff layer combines aircraft maneuvering with deployment of multiple rounds of chaff to confuse incoming missile threats. In an integrated Chaff Exercise scenario, ships/helicopters/fixed wing craft will deploy ship- and air-launched, rapid bloom offboard chaff in preestablished patterns designed to enhance missile defense.
	Airlift	Northwest Field, Andersen Air Force Base	Airlift training activities provide airlift support to combat forces.
	Air Expeditionary	Northwest Field, Andersen Air Force Base	This type of training provides air expeditionary support to forward deployed forces.
	Force Protection	Northwest Field, Tarague Beach Small Arms Range, Main, Andersen Air Force Base	This type of training is to provide Force Protection to individuals, buildings, and specific areas of interest.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION
ALTERNATIVE 1— INCREASE OPERATIONAL TRAINING, MODERNIZATION AND UPGRADES			
Major Exercises	Joint Exercise/USPACOM; USMC-Navy STOM/USMC-Navy; USMC Urban Ops/USMC	Various	Training activities would be increased to include training in major exercises, multi-Service and Joint exercises involving multiple strike groups and task forces.
ISR/Strike		Andersen AFB	The Air Force has established the ISR/Strike program at Andersen AFB, Guam. ISR/Strike will be implemented in phases over a planning horizon of FY2007–FY2016. ISR/Strike force structure consists of up to 48 fighter, 12 aerial refueling, six bomber, and six unmanned aircraft with associated support personnel and infrastructure. Aircraft operations and training out of Andersen AFB ultimately will increase by 45 percent over the current level (FY2006).
Modernization and Upgrades of Training Areas	Anti-Submarine Warfare (ASW)	No Undersea Tracking Range site has been identified for the Mariana Islands.	A critical component of ASW training is the Underwater Tracking Range (UTR). This is an instrumented range that allows near real-time tracking and feedback to all participants. The tracking range should provide for both a shallow water and deep water operating environment, with a variety of bottom slope and sound velocity profiles similar to potential contingency operating areas. Guam-homeported submarine crews, as well as crews of transient submarines, require ASW training events to maintain qualifications. A MIRC instrumented ASW PUTR, target support services, and assigned torpedo retriever craft would meet support requirements for TORPEX and TRACKEX activities in the MIRC in support of Fast Attack Submarine (SSN) and Ballistic Missile Submarine (SSBN) and other deployed forces.
	Military Operations in Urban Terrain (MOUT)		The MIRC will need to acquire range space, design, and develop a MOUT facility that will support the training requirements of the Army, Marine Corps, and special warfare units stationed at or deployed into the MIRC.

Table 2-1. Description of Training Activities in the MIRC for No Action Alternative, Alternative 1, and Alternative 2 (cont'd)

ALTERNATIVE 2— NEW DEDICATED CAPABILITIES ON EXISTING DoD RANGES AND TRAINING AREAS			
MISSION AREA	**EVENT**	**ACTIVITY AREA**	**BRIEF DESCRIPTION**
Increase Major At Sea Exercises and Training	Major At Sea Exercises	Various	Additional major at sea exercises would provide additional ships and personnel maritime training including additional use of sonar that would improve the level of joint operating skill and teamwork between the Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures required in carrying out the primary mission areas of maritime forces. The additional maritime exercises would take place within the MIRC and would focus on carrier strike group training and ASW activities similar to training conducted in other Seventh Fleet locations, including a Fleet Strike Group Exercise, an Integrated ASW Exercise, and a Ship Squadron ASW Exercise.

3.0 EXISTING HABITAT CONDITIONS

The existing habitat information and citations provided below come from the *Marine Resources Assessment (MRA) for the Marianas Operating Area* (DoN 2005b), with additional technical information incorporated throughout this section. The MRA documents and describes the marine resources in the U.S. Pacific Fleet military ranges and training areas located in the waters off of Guam, Tinian, and Farallon de Medinilla, including Warning Area W-517, which is collectively known as the Marianas MRA study area. The MRA does not discuss nearshore areas where training does not occur. The MIRC study area is larger and overlaps the MRA study area; however, the primary difference is open ocean habitat, which would not affect the analysis, as the regional descriptions for open ocean habitat within the MRA study area would apply to the MIRC study area.

3.1 PHYSICAL ENVIRONMENT AND HABITATS

The islands of the Mariana archipelago lie between latitude 13 degrees (°) N and 20°N and are approximately 5,800 kilometer (km) west of Hawaii, 2,250 km south of Japan, and 7,600 km north of Sydney, Australia (DoN 1998; DoN 2003a, 2003b). The archipelago extends roughly 800 km from Guam in the south to the uninhabited island of Farallon de Pajaros in the north (DoN 1998) and is divided into three relatively parallel arcs. The outer frontal arc is composed of the more southerly limestone islands while the inner, or active arc, extends to the north to form the only active volcanic islands in Micronesia (Eldredge 1983). The MIRC study area extends from the high tide shore line along the islands of Guam, Tinian, Farallon De Medinilla (FDM) to over 11,000 m of water depth in the Marianas Trench. The MIRC study area includes several dominant physiographic features including the Marianas Trench, seamounts, and active submarine volcanoes.

3.1.1 CLIMATE AND WEATHER

The tropical climate of the MIRC study area is influenced by easterly trade winds and can be described as warm and humid throughout the year, although rainfall and wind exhibit distinct seasonal patterns (Eldredge 1983). Average temperatures range from 29° to 32° Celsius (C) during the day and drop to 21° to 24°C overnight (Eldredge 1983; DoD 1999). The months of January through March are generally the coolest months of the year, with May and June being the warmest. Throughout the year, relative humidity ranges from 65 to 75% in the afternoon and increases at night to 85 to 100%. Annual rainfall ranges from 1,775 to 2,285 millimeters [mm] per year with the more southerly (more tropical) islands in the study area receiving higher levels of rainfall than the more northern islands. The MIRC study area experiences two distinct seasons, a dry and a rainy season, separated by brief periods of transitional weather (Eldredge 1983; DoD 1999). Climatic anomalies influencing the MIRC study area include El Niño Southern Oscillation (ENSO), La Niña, and the Pacific Decadal Oscillation (PDO) (Trenberth 1997; Giese and Carton 1999; Sugimoto et al. 2001; Mantua 2002; NOAA 2005a, 2005b).

During normal conditions, trade winds blowing west across the tropical Pacific pile up warm water in the west Pacific (~0.5 m sea surface height difference between Indonesia and Ecuador) (Conlan and Service 2000; NOAA 2005a, 2005b). The equatorward flow of the eastern boundary Peru Current along the South America coastline and the easterly trade winds cause the offshore transport of cool surface water (Ekman layer) (Pickard and Emery 1982, NOAA 2005b) visualized as a large "cold tongue" extending westward across the Equatorial Pacific. The removed surface water is replaced by upwelled cold and nutrient-rich water which favors increased primary productivity and higher trophic levels (including fisheries). Under these normal conditions, rainfall is scare in the eastern Pacific and is concentrated over the warmest water in the west Pacific.

3.1.1.1 Seasons

The dry season (December to June) is characterized by strong and consistent tradewinds blowing from the east to northeast at 24 to 40 km per hour (kph) (Eldredge 1983, DoD 1999, Paulay 2003). Winds are heaviest during the late morning and afternoon and are lightest during the night. On average less than 20% of the MIRC study area's rain falls during the dry season and thunderstorms are rare (Eldredge 1983, DoD 1999).

During the rainy season (July through November), the MIRC study area experiences heavy winds and rains, with squalls and gales becoming more common (Eldredge 1983, DoD 1999). Rain falls during more than 75% of the days. More than 60% of the annual rainfall is received in the MIRC study area during the rainy season.

Tropical cyclones commonly traverse the MIRC study area from August to November with the peak typhoon season extending from July through October (Elsner and Liu 2003). Typhoons are tropical cyclones with maximum sustained surface wind speeds greater or equal to 33 meters per second (m/sec) and less than 65 m/sec (JTWC 1998). Super typhoons have sustained surface winds with speeds greater than 65 m/sec. From 1960 to 2001, there were on average 2.7 to 3.5 typhoons per year in the northwestern Pacific Ocean (JTWC 2005). Typhoons have occurred on Guam in every month of the year (DoN 2005b).

Storm surge, winds, salt stress, and heavy rainfall generated by tropical cyclones can cause a number of damages to marine and terrestrial resources (Schlappa 2004). The storm surge (difference between the mean tide level and the tide level during the tropical cyclone) and excessive rainfalls caused by tropical cyclones can cause flooding, a change in the nearshore salinity, the erosion and sedimentation of marine resources, destruction of shoreline structures, and terrestrial and marine habitat destruction. Strong winds and salt stress can cause the defoliation and uprooting of trees which in turn will cause a pulse of debris and nutrients affecting both terrestrial and marine resources (Schlappa 2004). Typhoons have impacted algal and coral communities of the Mariana Islands (Randall and Eldredge 1977, Paulay 2003). In waters shallower than 30 m, windward exposed fore reefs of the Mariana Islands rarely include fragile growth forms (including tabular growth forms) because of the recurrent typhoon wave damage (Paulay 2003, Schlappa 2004). *Acropora* as a genus is abundant in this depth zone (DoN 2005b).

3.1.1.2 El Niño/Southern Oscillation (ENSO), La Niña

The ENSO is the result of interannual swings in sea level pressures in the tropical Pacific between the eastern and western hemispheres (Conlan and Service 2000). ENSO events typically last 6 to 18 months, and can initiate large shifts in the global atmospheric circulation. El Niño occurs when unusually high atmospheric pressure develops over the western tropical Pacific and Indian Oceans and low sea level pressures develop in the southeastern Pacific (Trenberth 1997, Conlan and Service 2000). El Niño means The Little Boy or Christ child in Spanish, and was originally defined by fisherman off the western coast of South America with the onset of unusually warm waters occurring near the beginning of the year. This name was used for the tendency of the phenomenon to arrive around Christmas. During El Niño conditions, the trade winds weaken in the central and west Pacific which impedes the east to west surface water transport and the upwelling of cold water along South America and causes the sea surface temperature (SST) to increase across the mid to eastern Pacific (Donguy et al.

1982). In the western equatorial Pacific, SST is lower than in non-El Niño years (Kubota 1987) and rainfall patterns shift eastward across the Pacific as the strength of the tradewinds weakens, resulting in increased (sometimes extreme) rainfall in the southern U.S. and Peru and drought conditions in the west Pacific (Conlan and Service 2000).

La Niña and El Niño are opposite phases of the ENSO cycle (NOAA 2005a). La Niña is a condition in which the tradewinds strengthen and push the warmer surface waters back to the western tropics. Under these conditions, the thermocline in the western Pacific deepens and becomes shallower in the eastern Pacific resulting in abnormally cold SST along the equatorial Pacific. Often with La Niña, the climatic effects are the opposite of those encountered during an El Niño warming event (e.g., higher SST in the western equatorial Pacific, high production along Pacific upwelling coasts, and heavy rainfall in Australia and Indonesia) (NOAA 2005a).

The MIRC study area experiences considerable changes during El Niño or La Niña events. While the average annual rainfall in Guam does not appear to be affected during an El Niño event (93 to 100% of average conditions), the Northern Mariana Islands experience substantial differences in annual rainfall. During an El Niño, the Northern Mariana Islands experience conditions in which only 84 to 88% of average seasonal rains fall in the dry season and the beginning of the rainy season (January to September), and rainfall exceeds the average values during the rainy season (104% of historical averages) (Pacific ENSO Applications Center 1995). In addition, there is a general weakening of the Hadley circulation (in which warm air rises from the equator and travels to the north and south, sinking at 30°). This weakening reduces the strength of the high pressure system located over the western equatorial Pacific and the overall SST in the region increases (Kubota 1987). Further, typhoons in the western Pacific basin are more frequent during warm ENSO periods although their tracks are oriented northwest and away from the MIRC study area (Saunders et al. 2000, Elsner and Liu 2003).

During La Niña, Guam experiences a deficit in rain during the dry and rainy season (86% and 87% of historical averages, respectively) (Pacific ENSO Applications Center 1995). During June to September, rainfall amounts exceed historical averages (104% of average). The Northern Mariana Islands also experience a surplus of rainfall throughout the year during La Niña (104 to 139% of historical averages with excess rainfall peaking in March, April and May) (Pacific ENSO Applications Center 1995).

3.1.1.3 Pacific Decadal Oscillation (PDO)

The PDO is a long-term climatic pattern capable of altering SST, surface wind, and sea level pressure (SLP) (Mantua 2002; Mantua and Hare 2002). The PDO is a long-lived El Niño-like pattern of Pacific climate variability and experiences both warm and cool phases. However, the PDO has three main characteristics separating it from ENSO events. First, PDO events can persist for 20 to 30 years which contrasts with the relatively short duration of ENSOs (up to 18 months). Second, climatic effects of the PDO are more prominent in ecosystems outside the tropics. Third, the mechanisms controlling the PDO are unknown, while those forces creating ENSO variability have been resolved (Mantua and Hare 2002). During warm phases of the PDO, the western tropical Pacific experiences periods of increased SLP while the opposite is true during cold periods of the PDO. However, the effect of the PDO is weak in tropical areas, such as the Marianas OPAREA, and thus climatic anomalies are most likely due to ENSO forcings (Mantua 2002; Mantua and Hare 2002).

3.2 MARINE GEOLOGY

The MIRC study area is located at the intersection of the Philippine and Pacific crustal plates, atop what is believed to be the oldest seafloor on the planet dating to the Jurassic era (Handschumacher et al. 1988). The collision of the two plates has resulted in the subduction of the Pacific Plate beneath the Philippine Plate forming the Mariana Trench (Kennett 1982; Figure 3-1). The Mariana Trench is over 2,270 km long and 114 km wide. The deepest point in the trench and on Earth, Challenger Deep (11,034 m; 11°22'N, 142°25'E), is found 544 km southwest of Guam in the southwestern extremity of the trench (Fryer et al. 2003).

The seafloor of the MIRC study area region is characterized by the Mariana Trench, the Mariana Trough, ridges, numerous seamounts, hydrothermal vents, and volcanic activity. Two volcanic arcs, the West Mariana Ridge (a remnant volcanic arc than runs from approximately 21°N 142°E to 11°30'N 141°E) and the Mariana Ridge (an active volcanic arc) are separated by the Mariana Trough (Baker et al. 1996, Figure 3-1). The Mariana Trough formed when the oceanic crust in this region began to spread between the ridges as recently as four million years ago. Currently the Mariana Trough is spreading at a rate of less than 1 centimeter per year (cm/yr) in the northern region and at rates up to 3 cm/yr in the center of the trough (Yamazaki et al. 1993). The Mariana archipelago is located on the Mariana Ridge, 160 to 200 km west of the Mariana Trench subduction zone. The Mariana archipelago is comprised of fifteen volcanic islands: Guam, Rota, Tinian, Saipan, FDM, Aguijan, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrigan, Asuncion, Maug, and Farallon de Pajaros (listed from south to north) (Figure 3-2). Approximately 800 km separate Guam from Farallon de Pajaros (Eldredge 1983, DoN 1998, DoN 2003a).

The islands north of FDM are located on an active volcanic arc ridge axis and were formed between 1.3 and 10 million years ago (Randall 1985, 1995, 2003; DoN 2005). The six southern islands (Guam to FDM) are on the old Mariana fore-arc ridge axis and formed about 43 million years ago (Eocene) (Randall 1985, 2003; Birkeland 1997). The young volcanic active ridge axis is offset 25 to 35 km west of the southern arc ridge axis (Randall 1995). The islands on the southern ridge consist of a volcanic core covered by thick coralline limestone (up to several hundreds of meters) (DoN 2003a). The subsidence of the original volcanoes in the southern islands allowed for the capping of the volcanoes by limestone. Limestone covers the northern half of Guam (limestone plateau height: 90 to 180 m above mean sea level [MSL]) while volcanic rock and clay are exposed on the southern half of the island (DoD 1999). Tinian consists of rocky shoreline cliffs and limestone plateaus with no apparent volcanic rock (DoD 1999). Similar to Tinian, the uplifted limestone substrate of FDM is bordered by steep cliffs (DoN 2004).

In contrast, volcanoes north of FDM have not subsided below sea level, do not have limestone caps, and remain active (Baker et al. 1996) with the latest major known eruption (Anatahan; 16°22'N, 145°40'E) occurring in July 2005 when ash reached an elevation in excess of 12,000 m (Smithsonian Institute 2003, Volcano Live 2005). Guguan, Alamagan, Pagan (two active volcanoes), Agrigan, Asuncion, and Farallon de Pajaros have documented volcanic activity spanning from 1883 to 1967 (DoN 2003a, USGS 2005a). Ruby Volcano and Esmeralda Bank are submarine volcanoes found east of Saipan and Tinian (USGS 2005a). Ruby Volcano erupted in 1966 (Johnson 1973) and then again in 1995 as the surrounding area experienced submarine explosions, fish kills, a sulfurous odor, bubbling water, and volcanic tremors (Smithsonian Institute 1995).

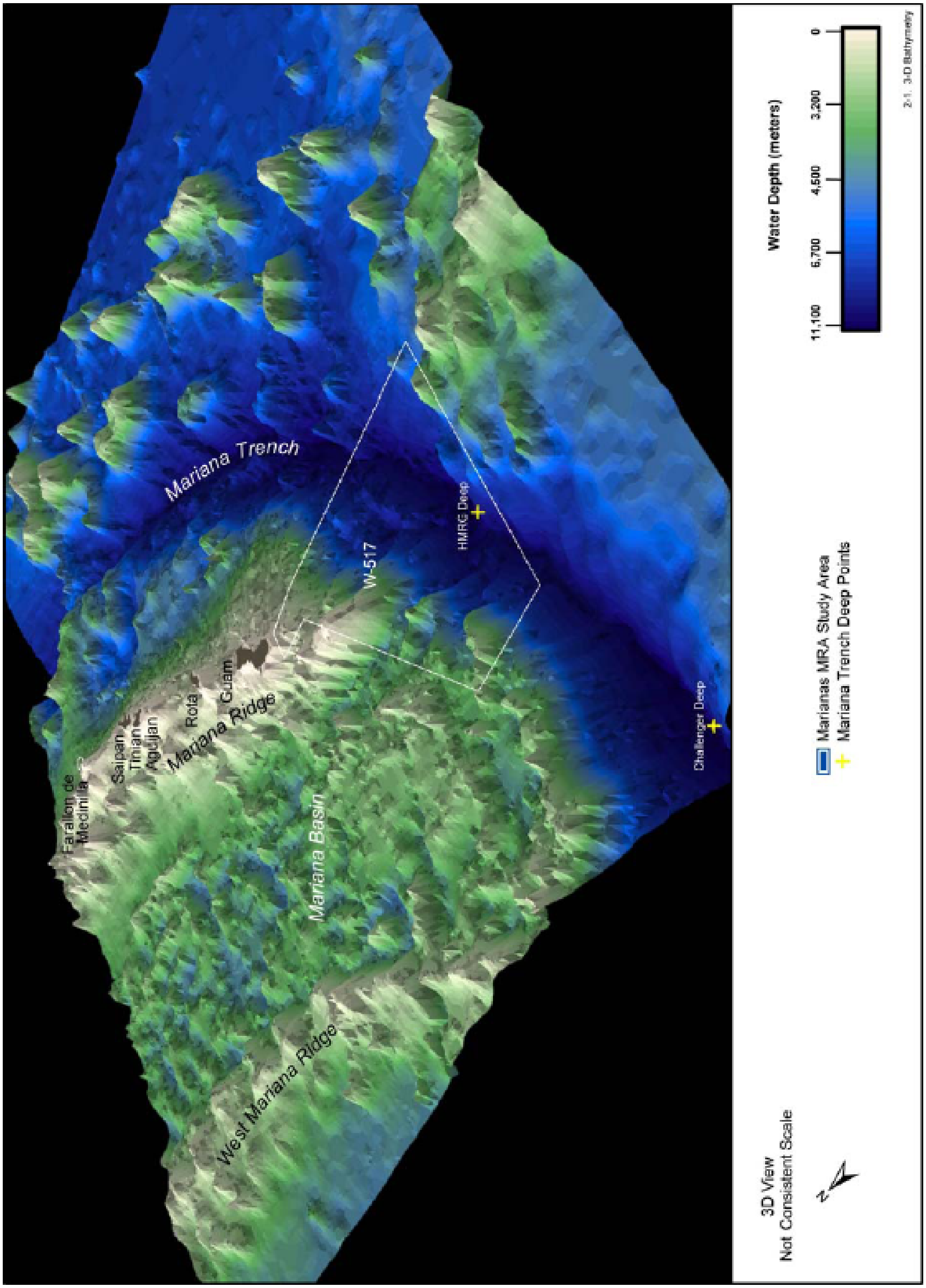


Figure 3-1. Three-dimensional bathymetry and major physiographic features of the MIRC study area. Source Data: Fryer et al. (2003) and Sandwell et al. (2004).

The MIRC study area experiences numerous shallow to intermediate depth (<300 km) normal-fault events indicative of a region that is stretching (Zhang and Lay 1992), resulting in low magnitude earthquakes (DoN 2003a, 2003b; USGS 2004; Figure 3-2). Further, the subduction of the Pacific Plate under the Philippine Plate causes abundant seismic activity in the MIRC study area, with occasional intense and destructive earthquakes (magnitudes greater than 7 on the Richter scale) (EERI 1993; USGS 2004, 2005b).

As the Pacific plate descends into the interior of the Earth, fluids driven off lower the melting temperature of the mantle permitting partial melting of the mantle to separate (Fryer 1996). This material is less dense and rises to the surface to form seamounts (Fryer 1996, Mottl et al. 2004). Seamounts in the MIRC study area are of two distinct varieties: volcanoes and mud volcanoes. Volcanoes are formed along the spreading axis in the Mariana Trough in which molten rock from the interior of the Earth rises to the surface in the form of magma to construct the seamount conical structure. These seamounts are often associated with hydrothermal communities (Embley et al. 2004). An example of a volcanic seamount in the MIRC study area is Ruby Volcano (15°37'N, 145°32'E) last believed to erupt in May 1995 (Smithsonian Institute 1995, Figure 3-3). Mud volcanoes are formed in a band behind the axis of the Mariana Trench. They are formed when water generated by the dehydration of the subducting Pacific plate (due to increased pressure and temperature) ascends to the mantle of the overlying crust and creates low-density rock capable of rising and extruding to the seafloor. Mud volcanoes tend to have a central conduit that feeds serpentinite mud, which comprises the bulk of the seamount structure (Mottl et al. 2004) and are the location of several macrofaunal communities (Fryer et al. 1999).

3.3 MARINE ENVIRONMENT

3.3.1 OCEANIC WATERS

Oceanic waters in this document refers to the portion of the MIRC study area found in water depths exceeding 200 m, which is the area beyond the "shelf break" where there is a sharp break in the slope of the insular shelf (Kennett 1982, Thurman 1997).

3.3.1.1 Physiography and Bathymetry

The boundary, or transition, between a continent and the ocean basin is referred to as the continental margin (Kennett 1982). In general, two types of continental margins are found on the globe: passive and active. Passive continental margins are usually found in the Atlantic Ocean, and consist of three major physiographical regions that transition from one to another with depth: the continental shelf, the continental slope, and the continental rise. Passive margins are not correlated with the boundaries of continental plates but rather strictly distinguish the transition from continent to ocean (Kennett 1982). Passive margins can also be considered stable as they are not associated with seismic or volcanic activity.

Active margins border the Pacific Ocean and are characterized by the rapid transition from a shelf to a slope to a deep trench (Kennett 1982). In the MIRC study area, the margin is known as a Mariana-type, or island-arc margin, which exhibits a shallow marginal basin separating the continent from an island-arc and trench system (Kennett 1982). Additional examples of island-arc margins include Japan and the Aleutian Islands of Alaska. Unlike passive margins, active continental margins do mark the boundary between two crustal plates. Due to the collision of the crustal plates, active margins are associated with deep oceanic trenches, the formation of seamounts, seismic activity, and volcanism. The bathymetry of the MIRC study area can be divided into three main areas: the Mariana Trough, the Mariana Ridge, and the Mariana Trench.

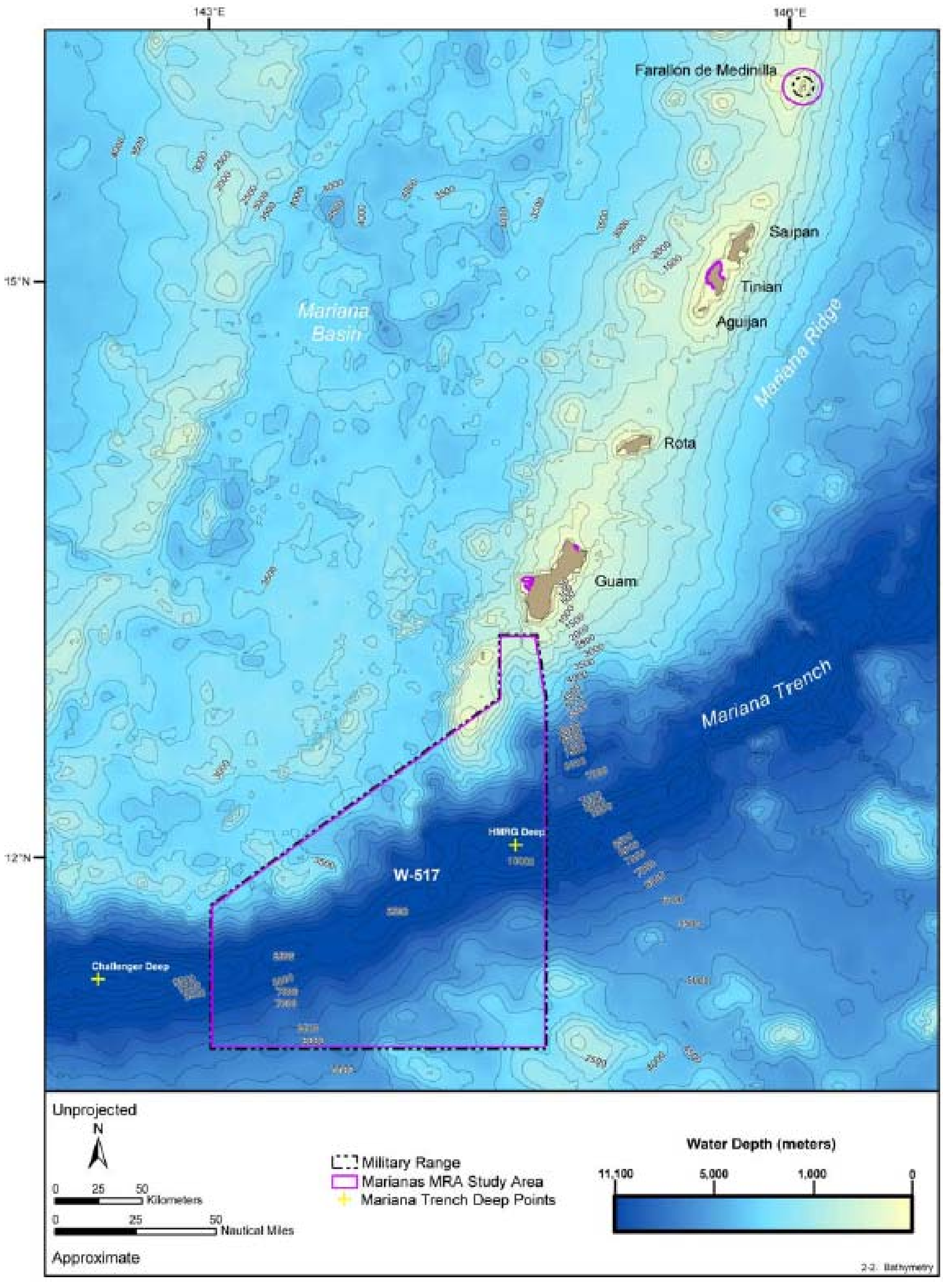


Figure 3-2. Bathymetry of the MIRC study area. Source data: Fryer et al. (2003) and Sandwell et al. (2004).

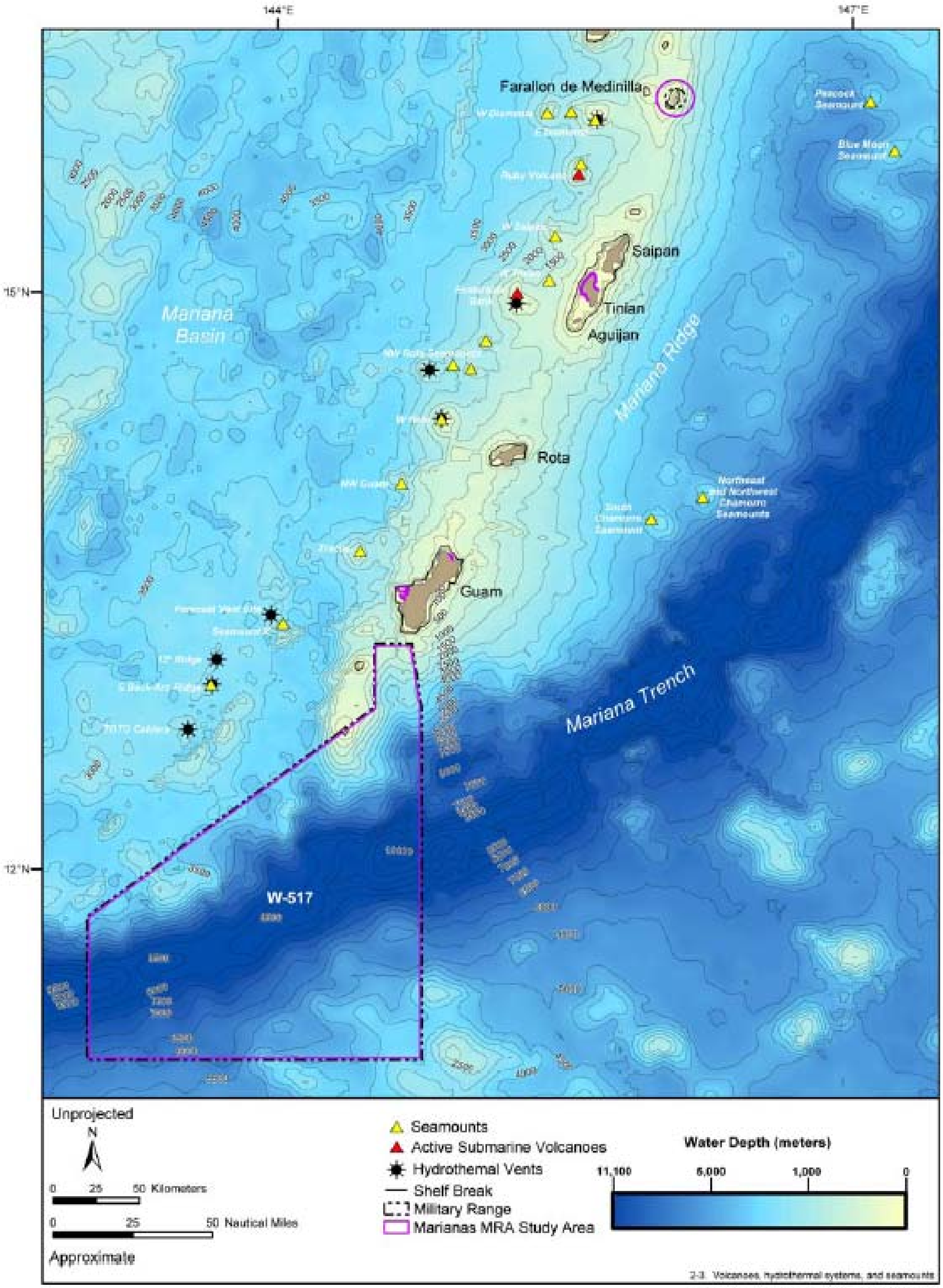


Figure 3-3. Seamounts, active submarine volcanoes, and hydrothermal vents located in the MIRC study area. Source data: Kojima (2002), Fryer et al. (2003), Embley et al. (2004), Mottl et al. (2004), and Sandwell et al. (2004).

Mariana Trough - The Mariana Trough (or Basin) spans the region to the west of the Mariana Ridge (Figure 3-2). The basin formed as the crustal plate spread between the West Mariana Ridge and the Mariana Ridge. The Mariana Trough attains its widest spread (approximately 250 km) at about 18°N (Yamazaki et al. 1993). The spreading center is located on the eastern side of the basin. The spreading of the seafloor between the two ridges is believed to have begun approximately 6 million years ago. The area between the two ridges is a flat plain averaging approximately 3,500 m in depth and is spreading at a rate of 0.3 to 1.0 cm/yr in the northern region (Taylor and Martinez 2003, Yamazaki et al. 1993).

Mariana Ridge - The Mariana Ridge consists of both active and extinct volcanoes. The latter are the islands of Guam, Rota, Tinian, Saipan, and FDM (Figure 3-2). In general these islands are surrounded by shallow fringing reefs with the occasional boulder breaking the water surface. There are barrier reefs on the leeside of the islands of Guam and Saipan and a large shoal area 2 km north of FDM at a water depth of 36.5 m (Randall 1979, Eldredge 1983). The Mariana Ridge formed as active volcanoes emerged from the ocean floor over the subducting Pacific Plate. As the subduction zone moves to the east, the Mariana Ridge will eventually subside and become submerged beneath the surface of the Pacific Ocean (Thurman 1997).

Mariana Trench - The major physiographic feature of the MIRC study area is the Mariana Trench. The trench runs from approximately 11°N, 141°E to 25°N, 143°E in an arc-like pattern extending over 2,270 km in length (Figures 3-1 and 3-2). The trench is the result of the collision and subduction of two crustal plates, the faster moving Pacific Plate and the slower moving Philippine Plate. Water depths in the trench range from 5,000 to 11,000 m with the deepest locations being southwest of Guam and becoming shallower northward (north of 14°N, the Mariana trench shallows to a depth less than 9 km; Fryer et al. 2003; Figures 3-1 and 3-2). Located within the trench is Challenger Deep (11,034 m; 11°22'N, 142°25'E) and HMRG Deep (10,732 m; 11°50'N, 144°30'E) (Fryer et al. 2003; Figures 3-1 and 3-2). Water mass characteristics at varying depths within the trench suggest that the waters of the Mariana Trench are not significantly different from those found on the abyssal plain north of the Marshall Islands (2,000 km to the east) (Mantyla and Reid 1978).

3.3.1.2 Bottom Substrate

The bottom substrate covering the seafloor in the MIRC study area is primarily volcanic or marine in nature (Eldredge 1983). Large flats of the seafloor are covered with a pavement-like covering of volcanic mud. Patches of Globigerina ooze, the calcareous shells of foraminiferan cells, also form large patches on the seafloor. Closer to island land masses are regions of coral debris, formed from the skeletons of corals comprising the fringing and barrier reefs found throughout the Mariana archipelago (Eldredge 1983). The Mariana Trench seafloor is comprised mostly of reddish-brown, pumiceous sand and silty clays (Ogawa et al. 1997). Sediment cores of the Mariana Trench seafloor also contain radiolarians, pollen, sponge spicules, diatoms, and benthic foraminiferans (Ogawa et al. 1997).

3.4 PHYSICAL OCEANOGRAPHY

3.4.1 CIRCULATION

The water column can be divided into three separate water masses: a surface layer, an intermediate layer of rapidly changing temperature referred to as the thermocline, and a deepwater layer (Pickard and Emery 1982). Wind and water density differences drive the circulation of water masses in the ocean. Surface currents are primarily driven by the wind (wind-driven circulation), which affects the upper 100 m of the water column. Variations in temperature and salinity will cause changes in water density which in turn drives the thermohaline circulation capable of moving water masses at all levels of the water column (Pickard and Emery 1982).

The general oceanic circulation surrounding the MIRC study area and the Mariana Islands is little known as few studies have investigated the major current pattern around the islands (Eldredge 1983). Due to the lack of observational data, only broad, more generalized patterns can be identified. The following is a discussion of circulation patterns that influence the study area including sea surface circulation, deepwater circulation, and the North Pacific Subtropical Gyre (NPSG).

3.4.1.1 Surface Currents

Surface currents in the study area are heavily influenced by the North Pacific Equatorial Current (NPEC) which flows westward between 8 and 15°N eventually turning to the north to form the Kuroshio current off of Japan (Pickard and Emery 1982, Wolanski et al. 2003, Figure 3-4a). The North Equatorial Current (NEC) is driven by the trade winds along the equator (Figure 3-4b). The trade winds force the NEC through the study area. This results in a net sea surface transport to the west/northwest at an average speed of 0.1 to 0.2 m/sec (Uda 1970, Wolanski et al. 2003).

However, it also should be noted that the Mariana Islands lie to the southeast of the heaviest tropical cyclone activity in the Pacific Ocean and current patterns can be influenced by tropical cyclones during the rainy season (July through November). As such, the passage of tropical cyclones (Eldredge 1983), El Niño (Lagerloef et al. 1999), and oceanic cyclonic eddies through the area (Wolanski et al. 2003) have resulted in a reversal of surface current flow in the MIRC study area.

The large mass of the islands within the MIRC study area may be capable of producing small eddies (net eastward coastal flow of several cm s-1) on the lee side of the islands capable of returning fish and coral larvae and eggs to the fringing reefs surrounding most of the islands. While the formation of these eddies have not been largely investigated, these eddies may provide the explanation as to why people lost at sea to the west side of the Mariana Islands are not advected to the west by the NEC as predicted by Coast Guard models (Wolanski et al. 2003).

Many of the islands within the MIRC study area are surrounded by fringing coral reefs (Eldredge 1983, Spalding et al. 2001). There are a number of fine scale currents within the reef and between the reef and shore (Jones et al. 1974, Eldredge et al. 1977, Marsh et al. 1982). However these fine scale current patterns are complex and there is a lack of observational data to accurately predict these current patterns (Eldredge 1983). In Guam, Marsh et al. (1982) found that incoming waves travel shoreward over the reef flats (Tumon Bay, Pago Bay) and slowly turn to form longshore currents. These currents flow along the shoreline for distances up to 1,500 m, eventually turn seaward, and then exit through cuts in the reef margin (Marsh et al. 1982).

3.4.1.2 Deepwater Currents/Water Masses

The colder, mid-depth and bottom waters of the MIRC study area do not originate in local waters. Rather, some of the water travels a great distance, including waters originating in the North Pacific and the Antarctic Sea (Pickard and Emery 1982). In fact, the water found in the Mariana Trough and Mariana Trench originates from Lower Circumpolar Water (LCPW) and North Pacific Deep Water (NPDW) and is influenced by the overlying Antarctic Intermediate Water (AIW) (Kawabe et al. 2003, Siedler et al. 2004).

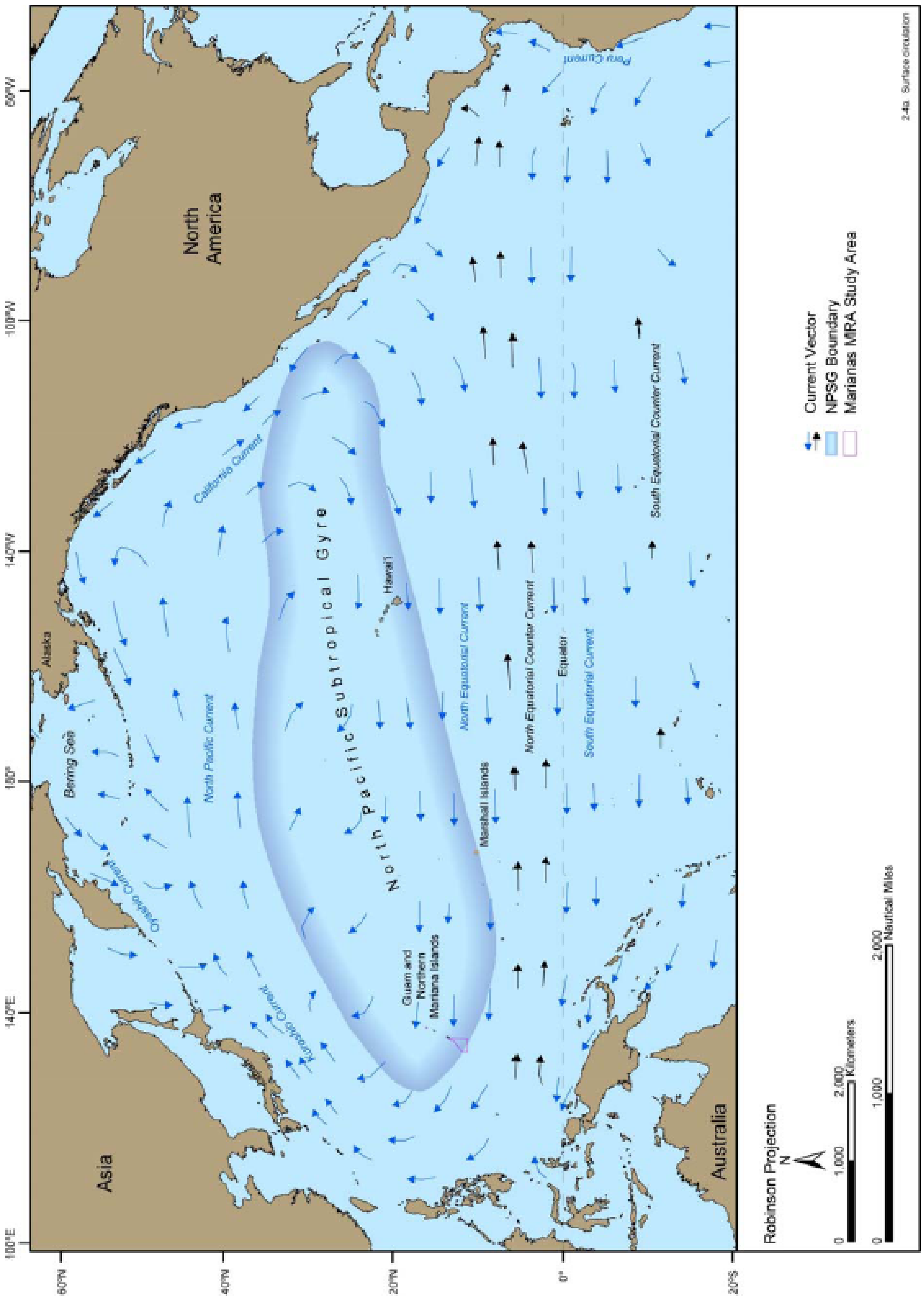


Figure 3-4a. Surface circulation of the Pacific Ocean and outline of the North Pacific Subtropical Gyre. Source Information: Pickard and Emery (1982) and Karl (1999).

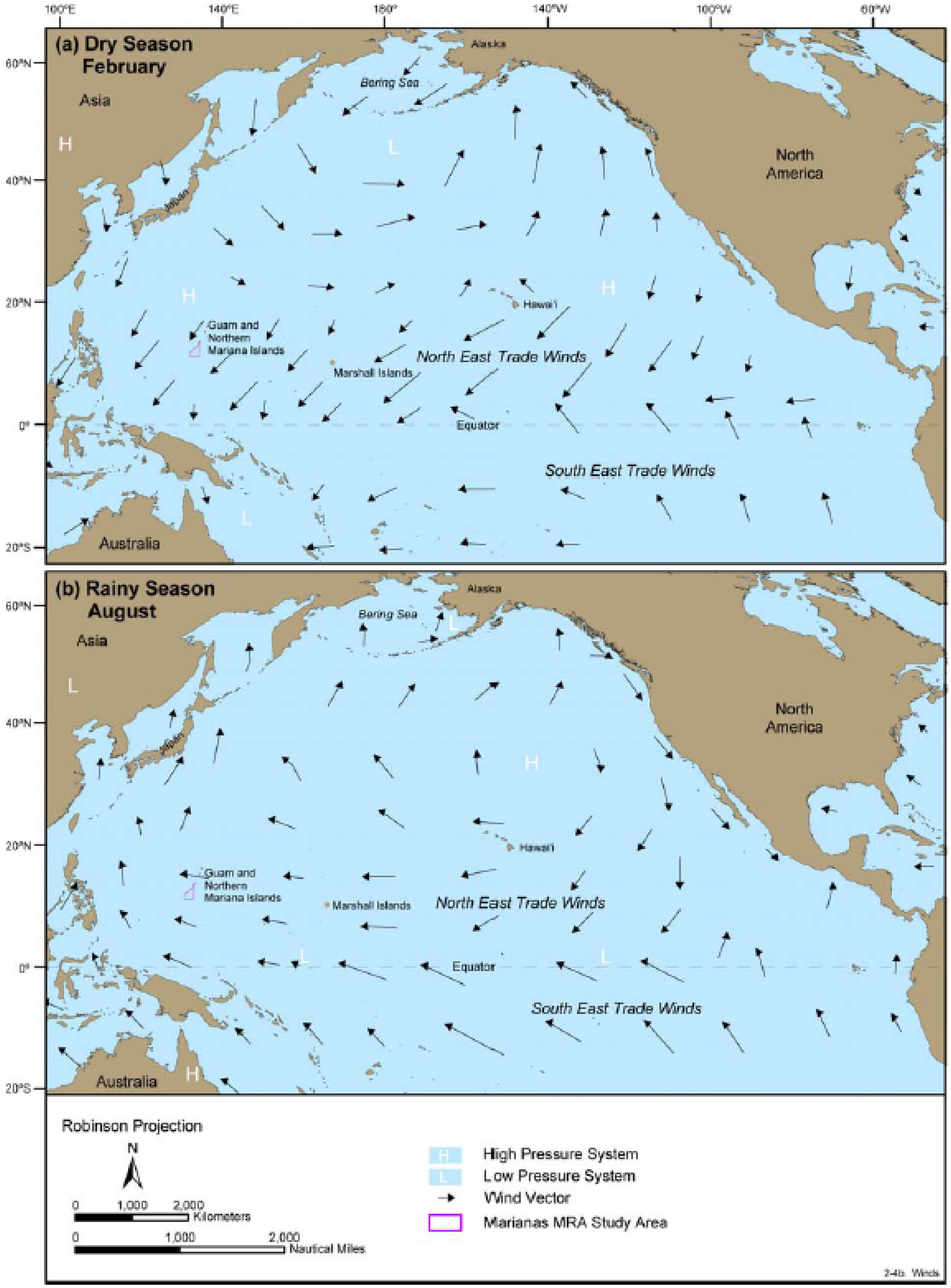


Figure 3-4b. Winds and mean atmospheric highs and lows of the northern Pacific Ocean during the (a) dry season and (b) rainy season. Source information: Pickard and Emery (1982).

The NPDW is formed in the northern Pacific as cold water from the North Pacific mixes with high silica bottom sources (Siedler et al. 2004). The low salinity and high silica content is the signature of the NPDW water mass. After sinking into the deep subarctic, this water travels from the northeast Pacific with a general westward propagation south of the Hawaiian Islands. The NPDW extends to the western edge of the Mariana Trough at a depth to 2,000 to 3,500 m, where net transport of the water mass is southward (Kawabe et al. 2003; Siedler et al. 2004).

LCPW is also referred to in the literature as Circumpolar Deep Water (CDW) (Pickard and Emery 1982). Part of the LCPW flows from the South Pacific across the equator, westward around the Marshall Islands and into the Mariana Trough and Trench (Mantyla and Reid 1978, Kawabe et al. 2003; Siedler at al. 2004). Seafloor ridges prevent the densest water of the LCPW and NPDW from reaching the Mariana Trench. Otherwise, the water characteristics in the Mariana Trench are identical to abyssal water found north of the Marshall Islands (2,000 km east). At depths ranging from 5,585 to 10,933 m, the Mariana Trench seawater temperature ranges from 1.5° to 2.5°C, salinity is approximately 34.7 parts per thousand (ppt), and dissolved oxygen concentrations are about 4 milliliters per liter (ml/l) (Mantyla and Reid 1978).

3.4.1.3 North Pacific Subtropical Gyre (NPSG)

Approximately half of all primary production is supported by phytoplankton found in the oceans (Falkowski 1994). In the marine environment oceanic provinces, or subtropical gyres, occupy 40% of the earth's surface, are located far from land, and account for the majority of primary production (Karl 1999). The MIRC study area lies within the western region of the NPSG, the most extensive gyre on Earth.

Despite being the largest ecosystem on the planet, the NPSG is remote, poorly sampled, and not well understood (Karl 1999). The NPSG extends from 15 to 35°N and 135°E to 135°W, and is bounded by the North Pacific Current to the north, the NEC to the South, the California Current to the East, and the Kuroshio Current to the west. In total, the NPSG encompasses 2 X 107 km^2, creating the planet's largest circulation pattern. Geologically, the NPSG is a very old region in which the present boundaries have existed since the Pliocene (107 years ago) (McGowan and Walker 1985) and is considered a climax community in which the climate affects the seascape, which in turn controls the community structure and dynamics (Karl 1999).

The NPSG is comprised of warm (>24°C) surface water containing low nutrient levels, low standing stocks of living organisms, and a persistent deep-water chlorophyll maximum (Karl 1999). The water column can be divided vertically into two distinct regions including a light-saturated nutrient-limited layer at the surface (0 to 70 m) and a light-limited nutrient-rich layer at depth (>70 m). Surface circulation in the gyre is wind driven, and the overall anti-cyclonic rotation of the NPSG isolates the water within the gyre, restricting exchange with adjacent current systems (Karl 1999).

Due to the isolated waters within the gyre, the NPSG is thought to be a semi-enclosed, stable, and relatively homogenous habitat; however, increasing evidence suggests that the NPSG exhibits substantial physical, chemical and biological variability on a variety of time and space scales (Karl 1999). For example, regions of the NPSG show extensive mesoscale variability via the formation of discreet eddies, near-inertial motions, and internal tides (Venrick 1990). In addition, during winter months, tropical cyclones pass through the NPSG, moving from west to east, deepening the mixed layer and injecting nutrient rich water into the surface waters fueling ephemeral blooms of phytoplankton (Karl 1999).

3.4.2 HYDROGRAPHY

Hydrography refers to the scientific study of the measurement and description of the physical features of bodies of water. The following sections describe in detail the temperature of water at the ocean surface, the vertical structure of temperature within the water column, and the horizontal and vertical distribution of the salinity in the MIRC study area.

Sea Surface Temperature (SST) - The waters of the MIRC study area undergo an annual cycle of temperature change, however this temperature flux is only a few degrees each year, as would be expected from a tropical climate (Figure 3-5). The temperature throughout the year ranges from about 25° to 31°C with an annual mean temperature of 27° to 28°C for the years ranging from 1984 to 2003 (NOAA 2004a). Temperatures increase during the summer and autumn months with peak temperatures occurring in September/October.

SST along the reef flats near the shoreline have been reported to average 2°C higher than those reported in nearshore waters and may reach temperatures as high as 34°C during periods of extensive low tide (Eldredge 1983). Increases in SST caused by El Niño events can influence the distribution pattern of fishes (Lehodey et al. 1997). Further, prolonged high SST will cause the bleaching of corals, coral mortality and induce the outbreak of coral diseases within the MIRC study area (Harvell et al. 1999; Paulay and Benayahu 1999; Richmond et al. 2002).

Thermocline - The water column in the MIRC study area contains a well-mixed surface layer ranging from 90 to 125 m. Immediately below the mixed layer is a rapid decline in temperature to the cold deeper waters. Unlike more temperate climates, the thermocline in the MIRC study area is relatively stable, rarely turning over and mixing the more nutrient waters of the deeper ocean in to the surface layer.

Salinity - The MIRC study area lies in a region near the equator of low surface salinity bound to the north and south by regions of higher salinity (Pickard and Emery 1982). Surface salinity is lower towards the southern end of the Mariana archipelago and increases towards the north. At a depth of 100 to 200 m, there is a spike in salinity that corresponds with the input of high saline tropical waters (Eldredge 1983). Below this region, the salinity drops to a minimum (approximately 34.5 ppt) and corresponds to the influx of North Pacific Intermediate Water (NPIW). NPIW is formed as cold, fresh, dense water sinks below the more saline water in the north subarctic Pacific Ocean and can be recognized by its overall lower salinity and location within the water column (500 to 700 m depth) (Eldredge 1983).

3.5 BIOLOGICAL OCEANOGRAPHY

The physical environment of an area can directly affect the distribution of marine life found within. In this section, the major groups of organisms found in the Mariana Islands OPAREA are discussed with particular reference to their geographical distribution and any physical mechanisms that may affect their distribution. The organisms that comprise the base of the food web and those to which all other oceanic organisms depend, the plankton, will be specifically discussed here while discussions of the larger species found in the MIRC study area may be found in subsequent chapters.

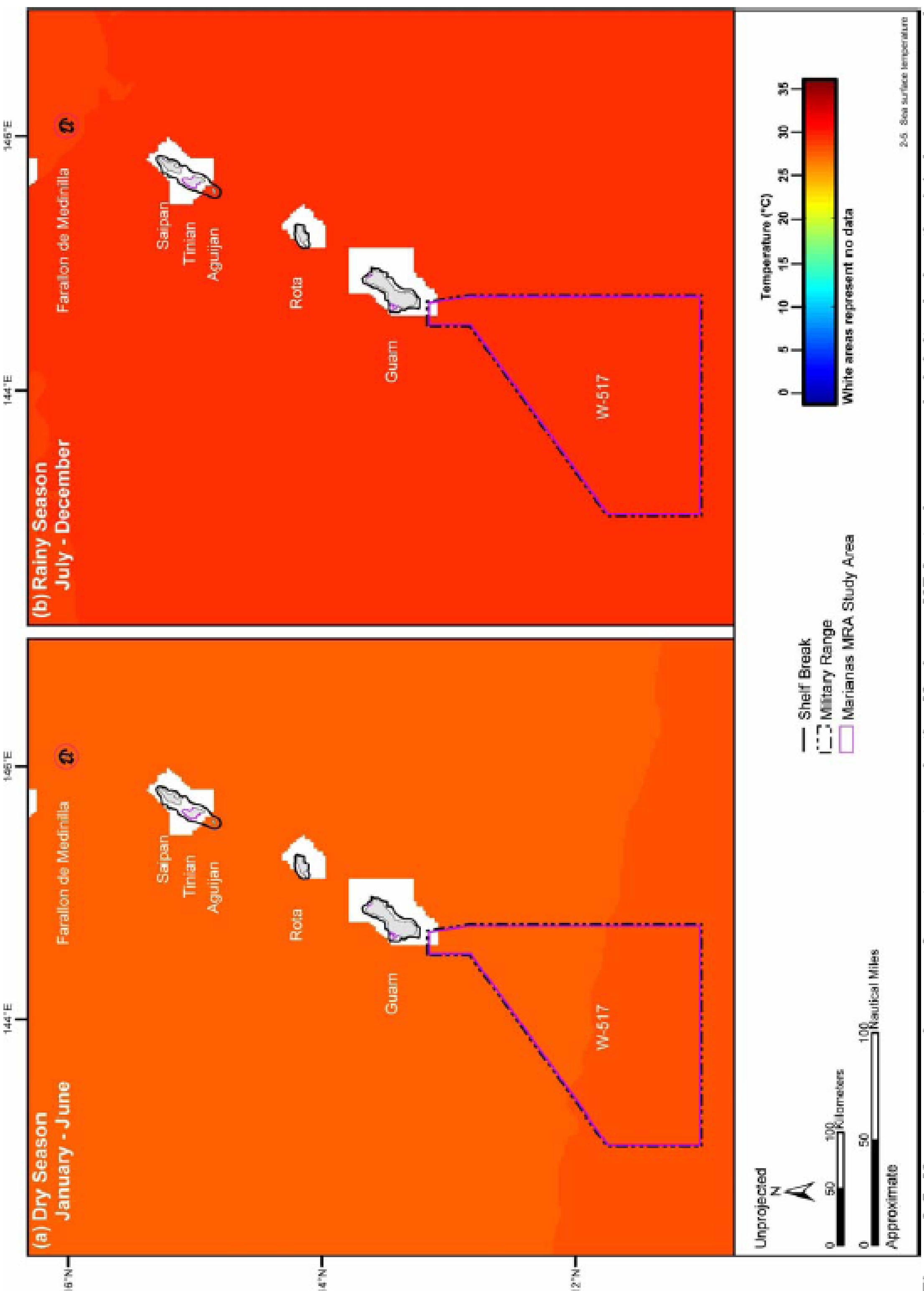


Figure 3-5. Mean seasonal sea surface temperature in the Marianas MIRC study area during the (a) dry season and (b) rainy season. The white areas surrounding Guam and the CNMI islands are areas where sea surface temperature data were unavailable. Source data: NASA (2000).

3.5.1 PRIMARY PRODUCTION

Primary production is a rate at which the biomass of organisms changes and is defined as the amount of carbon fixed by organisms in a fixed volume of water through the synthesis of organic matter using energy derived from solar radiation or chemical reactions (Thurman 1997). The major process through which primary production occurs is photosynthesis. The intensity and quality of light, the availability of nutrients, and seawater temperature all influence primary productivity as generated through photosynthesis (Valiela 1995). Chemosynthesis will also be mentioned in this section since it is another form of primary production occurring at hydrothermal vent communities along ocean spreading centers in the MIRC study area.

3.5.1.1 Photosynthesis

Photosynthesis is a chemical reaction that converts solar energy from the sun into chemical energy stored within organic molecules by combining water, carbon dioxide, and light energy to form sugar and oxygen. In the oceanic system, the majority of photosynthesis is carried out by phytoplankton utilizing a suite of light harvesting compounds to convert solar energy into chemical energy, the most common being chl a (Thurman 1997). Rates of photosynthetic production can vary from between less than 0.1 milligram (mg) of carbon (C) per square meter (m^2) per day (d) in low primary productivity (oligotrophic) regions, such as the western equatorial Pacific, to more than 10 $mgC/m^2/d$ in highly productive areas (Thurman 1997).

The western Pacific, including the MIRC study area, can be considered an oligotrophic region. The water column surrounding the MIRC study area is composed of nutrient depleted surface area overlying a deeper nutrient rich layer (Rodier and LeBorgne 1997). As such, standing stocks of phytoplankton biomass (Radenac and Rodier 1996) and concentrations of chl a are low throughout the MIRC study area (less than 0.1 mg per cubic meter [m^3]) (NASA 1998, Figure 3-6). In regions in which overall nutrient concentrations are low, the phytoplankton communities are dominated by small nanoplankton and picoplankton (Le Bouteiller et al. 1992, Higgins and Mackey 2000). This is true for the MIRC study area, as phytoplankton communities in the western Pacific are dominated by cyanobacteria (*Synechococcus* spp.), prochlorophytes, haptophytes, and chlorophytes (Higgins and Mackey 2000). These cells are less than one micron (µm) in size and comprise 60 percent of the total chl a measured (Le Bouteiller et al. 1992).

Two regions of enhanced chl a (up to 0.06 mg/m^3) can be identified in the MIRC study area off the southwest coast of Guam and in the region surrounding the islands of Tinian and Saipan (Figure 3-6). These regions of enhanced chl a persist through both the rainy and dry seasons, with higher chl a concentrations occurring during the rainy season. Reasons for these regions of higher chl a levels are not completely understood but may be a product of the island mass interacting with currents. This island mass effect has been previously observed for other islands located in oligotrophic or stratified regions including the Scilly Isles in the Celtic Sea (Simpson et al 1982), the Marquesas islands (Martinez and Maamaatuaiahutapu 2004), and the islands of Hawaii (Gilmartin and Revelante 1974) in which currents passing by the islands or through channels in island chains created turbulence mixing bringing more nutrient rich waters to the surface. This mixing may be capable of occurring along the Mariana island chain creating isolated areas of increased production. In addition, an anticyclonic eddy is formed off the southwestern coast of Guam in the same region as the increased chl a (Wolanski et al 2003; Figure 3-6). It is likely that phytoplankton is becoming trapped within the eddy and is not advected to the west, allowing for an accumulation of biomass and chl a in the region. The remainder of the MIRC study area experiences chl a levels below 0.045 mg/m^3 throughout the year (NASA 1998; Figure 3-6). ENSO appears to have little, if any, effect on primary production in the western tropical Pacific (Mackey et al. 1997, Higgins and Mackey 2000).

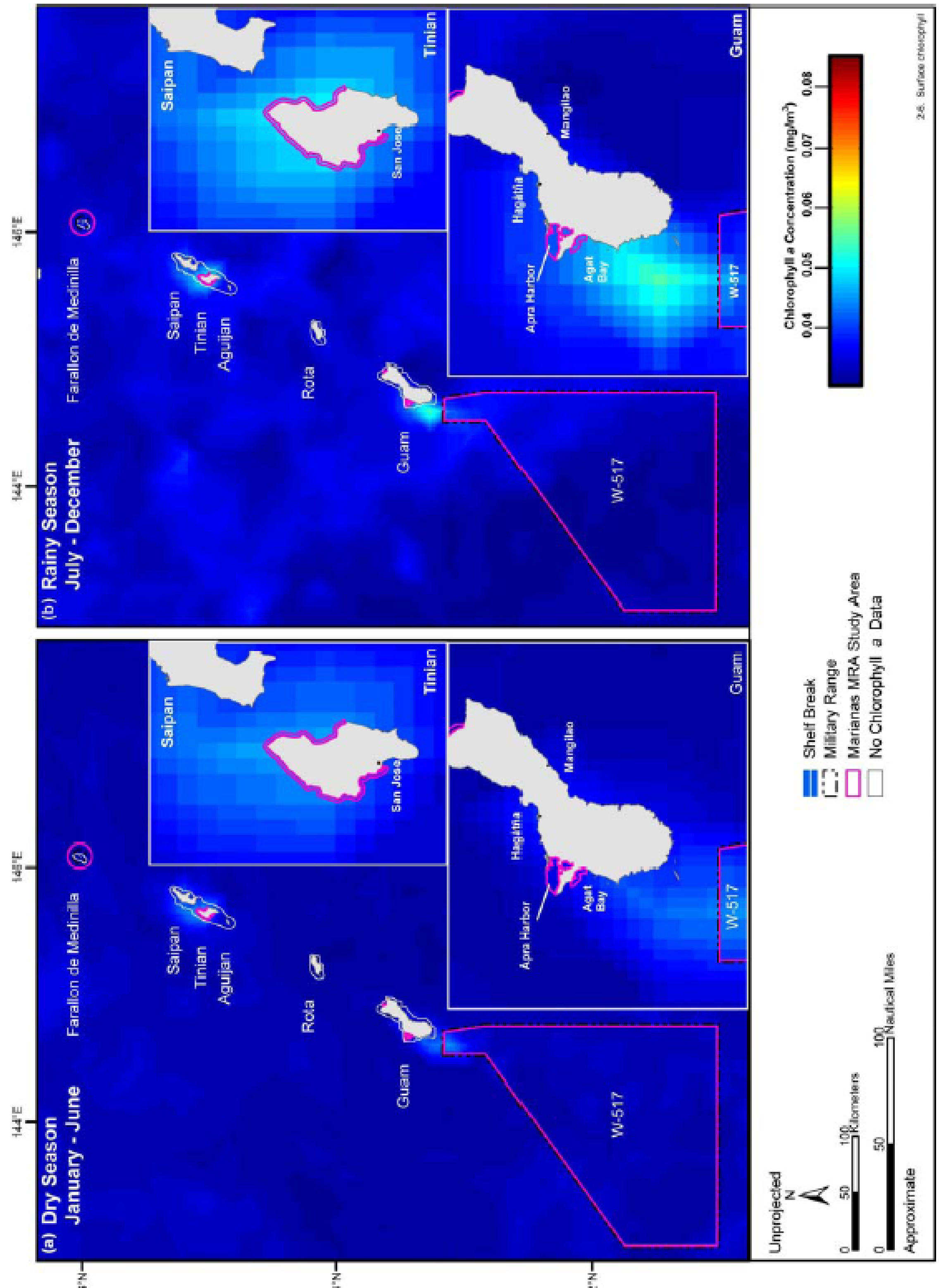


Figure 3-6. Mean seasonal surface chlorophyll a concentrations in the MIRC study area during the (a) dry season and (b) rainy season. Source data: NASA (1998).data were unavailable. Source data: NASA (2000).

3.5.1.2 Chemosynthesis

Another potentially significant source of biological productivity does not occur in the light of the surface, but rather at great depths within the ocean. In some locations, including the Mariana Trough, hydrothermal springs can support vast benthic communities (Hessler and Lonsdale 1991; Hashimoto et al. 1995; Galkin 1997). Many organisms live in association with bacteria capable of deriving energy from hydrogen sulfide that is dissolved in the hydrothermal vent water (Thurman 1997). Since these bacteria are dependant upon the release of chemical energy, the mechanism responsible for this production is called chemosynthesis. Little is known regarding the significance of bacterial productivity on the ocean floor on a global scale. Hydrothermal indicators and vents have been found within the MIRC study area (Embley et al. 2004) and locations are described in further detail in subsequent sections.

3.5.2 SECONDARY PRODUCTION

Secondary production refers to the production (change in biomass) of organisms that consume primary producers, i.e., the production of bacteria and animals through heterotrophic processes (Scavia 1988; Strayer 1988). Detailed descriptions of protected species as consumers of primary production including marine mammals and sea turtles, as well as species such as corals and seagrasses are found in later sections of this chapter. In this section, marine zooplankton is discussed.

Marine zooplankton are aquatic organisms ranging in size from 20 µm to large shrimp (>2,000 µm) (Parsons et al. 1984), and can be separated into two distinct categories based upon their dependence to coastal proximity. Oceanic zooplankton includes organisms such as salps and copepods typically found at a distance from the coast and over great depths in the open sea. Neritic zooplankton (found in waters overlying the island shelves), include such species as fish and benthic invertebrate larvae, and are usually only found short distances from the coast (Uchida 1983).

The NEC, which provides the bulk of water passing the Mariana archipelago, is composed primarily of plankton-poor water. Detailed information on the oceanic zooplankton community in the waters of the MIRC study area is practically nonexistent (Uchida 1983). Rather, data gathered in waters surrounding the MIRC study area must be explored to gain insight into the zooplankton communities within the study area. Total zooplankton biomass at the surface examined for the western Pacific and adjacent seas found that zooplankton biomass was the lowest within the NEC, reaching concentrations of only 1.35 grams (g) wet weight/m^2 (Vinogradov and Parin 1973). Vinogradov and Parin (1973) also surveyed zooplankton biomass in the tropical Pacific, and at their station nearest the MIRC study area (13°31’N, 139°58’E), zooplankton biomass was very low (11.7 mg/m^3).

Studies on the neritic plankton have centered around Apra Harbor and Piti Reef on Guam. However, the majority of studies have been performed in conjunction with more general environmental surveys, and thus no long-term surveys have been conducted. In general, abundance of zooplankton is highly variable with respect to location and time (both throughout the day and month to month) (Uchida 1983). In Apra Harbor, the commercial port contains the highest levels of zooplankton abundance and is dominated by copepods (Uchida 1983). Other organisms in the harbor include fish larvae, decapod zoeae (freeswimming larvae), and pteropods (Uchida 1983). In Tanapag Harbor, Saipan, the diurnal zooplankton community is dominated by copepods and the nocturnal zooplankton community by larval crustaceans (Uchida 1983).

3.6 OFFSHORE BENTHIC HABITATS

Deep sea benthic habitats include seamounts, hydrothermal vents, the abyssal plain, and trenches. The bottom sediments covering the sea floor in much of the MIRC study area are volcanic or marine in nature (Eldredge 1983). In the Marianas Trench, the seabed is composed mostly of sand and clays (Ogawa et al. 1997). Sediments found on the narrow shelves along the Marianas archipelago are a combination of volcanic and calcareous sediments derived from calcareous animal skeletons (Eldredge 1983).

3.6.1 SEAMOUNTS

Seamounts are undersea mountains that rise steeply from the ocean floor to an altitude greater than 1,000 m above the ocean basin (Thurman 1997). Generally, seamounts tend to be conical in shape and volcanic in origin, although some seamounts are formed by tectonic movement and converging plates (Rogers 1994). The MIRC study area contains seamounts of both types. The seamount topography is a striking difference to the surrounding flat, sediment covered abyssal plain, and the effects seamounts can impart on local ocean circulation are complex and poorly understood (Rogers 1994). However, around seamounts increased levels of phytoplankton, primary production, and pelagic and demersal fish (Zaika and Kovalev 1984; Fedorov and Chistikov 1985; Greze and Kovalev 1985; Parin et al. 1985; Rogers 1994) are correlated with current pattern alterations and Taylor columns (circulation vortices) (Darnitsky 1980; Boehlert and Genin 1987; Rogers 1994).

The large ranges in depth, hard substrate, steep vertical gradients, cryptic topography, variable currents, clear oceanic waters, and geographic isolation all combine to make seamounts a unique habitat for both deep-sea and shallow water organisms (Rogers 1994). Thus, seamounts are capable of supporting a wide range of organisms (Wilson and Kaufman 1987). To date, Richer de Forges et al. (2000) conducted the most extensive species identification on seamounts. Richer de Forges et al. (2000) found a range of 108 to 516 species of fish and macro-invertebrates from three areas of seamounts in the southwest Pacific (Tasman Sea, Coral Sea). Approximately one third of species found were new to science and potentially endemic. The number of species encountered versus the sampling effort showed that more species are probably present on the seamounts they investigated. Richer de Forges et al. (2000) noted that there were significant differences in the species composition between groups of seamounts found at a same latitude and approximately 1,000 km apart. Such differences in seamount communities suggest that species dispersal is limited to clustered seamounts and that seamount species have localized distributions (Richer de Forges et al. 2000).

3.6.2 HYDROTHERMAL VENTS

Deep-sea hydrothermal vents occur in areas of crustal formation near mid-ocean ridge systems both in fore-arc and back-arc areas (Humphris 1995). Seawater permeating and entrained through the crust and upper mantle is superheated by hot basalt and is chemically altered to form hydrothermal fluids as it rises through networks of fissures in newly-formed seafloor (Humphris 1995; McMullin et al. 2000). The temperature of the hydrothermal fluid is characteristically 200° to 400°C in areas of focused flows and less than 200°C in areas of diffuse flow. Other than being hot, hydrothermal fluids are typically poor in oxygen content, and contain toxic reduced chemicals including hydrogen sulfide and heavy metals (McMullin et al. 2000). As the hot hydrothermal fluids come in contact with seawater overlying the vent, heavy metals precipitate out of the fluid and accumulate to form chimneys and mounds. In complete darkness, under the high ambient pressure of the deep sea, in nutrient-poor conditions, and under extreme thermal and chemical conditions, metazoans (multicellular animals) are able to adapt and colonize these sites. Chemosynthetic bacteria use the reduced chemicals of the hydrothermal fluid (hydrogen sulfide) as an energy source for carbon fixation and generate a chemosynthetic-based primary production. In turn, vent organisms (metazoans) consume the chemosynthetic bacteria or form symbiotic relationships with them, and use numerous morphological, physiological, and behavioral adaptations to flourish in this extreme deep-sea environment. These chemosynthetic organisms produce communities typically characterized by a high biomass and low diversity.

A number of hydrothermal vents have been located in the MIRC study area (Figure 3-3). Evidence of active hydrothermal venting has been identified near more than 12 submarine volcanoes and at two sites along the back-arc spreading center off of the volcanic arc (Kojima 2002, Embley et al. 2004) with the potential for more systems yet to be discovered. Hydrothermal vents located in the Mariana Trough experience high levels of endemism due to their geographic isolation from other vent systems, with at least 8 of the 30 identified genera only known to occur in western Pacific hydrothermal vent systems (Hessler and Lonsdale 1991, Paulay 2003). Hydrothermal vents at Esmeralda Bank, one of the active submarine volcanoes in the MIRC study area, span an area greater than 0.2 km^2 on the seafloor and expel water with temperatures exceeding 78°C (Stüben et al. 1992). West of Guam and on the Mariana Ridge, there are three known hydrothermal vent fields: Forecast Vent site (13°24'N, 143°55'E; depth: 1,450 m), TOTO Caldera (12°43'N, 143°32'E), and the 13°N Ridge (13°05'N, 143°41'E) (Kojima 2002, Figure 3-3). The gastropod *Alviniconcha hessleri* is the most abundant chemosynthetic organism found in hydrothermal vent fields of the Mariana Trough. Vestimentiferan tube worms are also found in these sites west of Guam (Kojima 2002).

3.6.3 ABYSSAL PLAIN

The Mariana Trough is comprised of a large relatively flat abyssal plain with water depths ranging approximately from 3,500 to 4,000 m (Thurman 1997; Figure 2-2). Very little data regarding the Mariana Trough has been investigated. However, in general abyssal plains can be described as large and relatively flat regions covered in a thick layer of fine silty sediments with the topography interrupted by occasional mounds and seamounts (Kennett 1982, Thurman 1997). It is host to thousands of species of invertebrates and fish (Mariana Trench 2003).

2.6.4 Mariana Trench

The seafloor contains numerous hydrothermal vents formed by spreading tectonic plates (Mariana Trench 2003). Away from the hydrothermal vents, the seafloor is covered with soft brown sediments devoid of rock formations (Kato et al. 1998). Sediments that lack carbonate and silica shells appear to be dissolving, suggesting that the ocean floor lies below the carbonate compensation depth (CCD) and at or near the silicate compensation depth (SCD) (Ogawa et al. 1997). In addition, sediments appear to be affected by local currents, which can transport sandy or silty sediments along the trench floor (Ogawa et al. 1997). The trench is host to numerous hydrothermal vent systems supporting a wide variety of chemosynthetic organisms. In addition, the deep waters of the Mariana Trench support barophilic organisms capable of surviving in the cold, dark, high pressure environment. One mud sample taken from Challenger Deep by oceanographers yielded over 200 different microorganisms (Mariana Trench 2003).

3.7 COASTAL HABITATS

Coastal habitats of the MIRC study area encompass part of the subneritic zone, which extends from the shoreline at high tide to the edge of the insular shelf (200 m isobath) (Kennett 1982; Thurman 1997). The following discussion of shoreline habitats will focus on the intertidal zone (region of shoreline covered by water between the high and low tidal extremes), coral communities and reefs, softbottom habitats (sand beaches, mudflats, and sand flats), lagoons (semi-enclosed bays found around the islands), seagrass beds, mangroves, and artificial reefs. Since the tidal range in the MIRC study area is less than 1 m (Paulay 2003), the shoreline intertidal zone is very narrow around the Mariana Islands.

Biodiversity is high throughout the subneritic zone due to the high variability existing within the habitat (Thurman 1997). Organisms residing on or in the benthos (epifauna and infauna, respectively) can be greatly affected by sedimentation, sediment resuspension, vertical mixing, regeneration (recycling of nutrients), and light penetration (turbidity) (Valiela 1995).

3.7.1 INTERTIDAL ZONE

Within the intertidal zone, the shoreline can be divided into three subzones: the high-tide zone, the midtide zone, and the low-tide zone. In the high-tide zone, benthic organisms are covered by water only during the highest high tides. Organisms in this zone spend the majority of the day exposed to the atmosphere. In the mid-tide zone, benthic organisms spend approximately half of the time submerged. Organisms residing in this zone are exposed during periods of low tides, but are covered with water during all high tides. Organisms in the low-tide zone are submerged most of the time but may be exposed to the air during the lowest of low tides.

The islands within MIRC study area are volcanic in nature and thus the overall geology reflects this origin (Eldredge 1983). The intertidal regions along the majority of the coastlines are rocky in nature (Rock 1999), and are generally lined with rocky intertidal areas, steep cliffs and headlands, and the occasional sandy beach or mudflat (Eldredge 1983). Water erosion of rocky coastlines has produced wave-cut cliffs (produced by undercutting and mass wasting), and sea-level benches (volcanic and limestone and wave-cut notches at the base of the cliffs (Eldredge 1979, 1983). Large blocks and boulders often buttress the foot of these steep cliffs in the Marianas. Wave-cut terraces also occur seaward of the cliffs (Eldredge 1983, Myers 1999).

3.7.2 CORAL COMMUNITIES AND REEFS

Islands within the MIRC study area (Guam to FDM) support reefs (biogenic or hermatypic coral reefs) as do islands north of FDM (Anatahan, Sarigan, Guguan, Alamagan, Maug, and Farrallon de Pajaros) (Birkeland et al. 1981; Eldredge 1983; Randall et al. 1984; Randall 1985; Randall and Siegrist 1988; Birkeland 1997; Green 1997; Paulay et al. 1997, 2001; Houk 2001; Paulay 2003; Starmer 2005). Reefs are also found on offshore banks including Tatsumi Reef located 2 km southeast of Tinian, Arakane Bank located 325 km west-northwest of Saipan, Pathfinder Bank located 275 km west of Anahatan, and Supply Reef located 18.5 km northwest of Maug Island (Starmer 2005). The degree of reef development depends on a number of environmental controls including the age of the islands, volcanic activity, the availability of favorable substrates and habitats, weathering caused by groundwater discharge, sedimentation and runoff accentuated by the overgrazing of feral animals, and varying levels of exposure to wave action, trade winds, and storms (Eldredge 1983; Randall 1985, 1995; Randall et al. 1984; Paulay 2003; Starmer 2005). The southern islands (Guam to FDM) are inactive volcanic islands that have subsided and are covered by massive limestone deposits dating back more than 40 million years (Birkeland 1997, Randall 2003). The substrate of the younger islands to the north of FDM dates back to 1.3 million years and is not characterized by substantial limestone deposits (Randall 1995, 2003). In the southern islands, faulting and erosion caused by groundwater discharge have produced large, oblique, and shallow areas (lagoon, bays) favorable to extensive reef development. This contrasts with the vertical profile of the uplifted younger islands, where less favorable and fewer macrohabitats are available for reef development (Randall 1995, Birkeland 1997, Paulay 2003).

Some of the reef-building corals found in the Mariana Islands probably originated from the nearest upstream reef ecosystems, the Marshall Islands, and were transported to the Marianas as gametes and planulae by the NEC (Randall 1995). The reefs of the Marianas are within the Indo-Pacific biogeographic region, which supports the world's most diverse coral fauna. While the Marianas exhibit less diversity than some other portions of the Indo-Pacific, such as Malaysia, Indonesia and Palau, they are nearly ten times as diverse as the Caribbean or Hawaiian Islands. There are 377 scleractinian species in Marianas (Randall 2003) versus 60 in Hawaii (Maragos and Gulko 2002). Of the 377 scleractinian corals of the Marianas, 276 species harbor zooxanthellae and 101 species do not (Randall 2003).

There are fewer hard coral (reef building) species and genera in the northern islands compared to the southern islands: 159 species and 43 genera in the northern islands, versus 256 species and 56 genera in southern islands (Randall 1995, 2003; Abraham et al. 2004). The same is true for other reef dwelling organisms. For example, there is greater species diversity of fishes and mollusks on the southern than on the northern islands (Birkeland 1997). These estimates of numbers of species could increase as a function of sampling effort and percentage of reef habitats surveyed at each location.

Corals reported in the MIRC study area are found on shallow reefs and upper fore reefs (<75 m water depth), and deeper fore reef habitats (>75 m water depth) (Randall 2003). Coral habitats of the northern islands are less well sampled than those of the southern islands. In the northern islands, the most sampled coral reef habitats are at Pagan Island (20% of coral habitats) and Maug Islands (15% of coral habitats). In all other locations of the northern islands, less than 10% of the coral habitats have been sampled. In the southern islands, Guam and Saipan have the most sampled coral habitats (95% and 50% of coral habitats, respectively). Ten percent of the coral habitats have been sampled at Rota, 20% at Tinian, and 2% at FDM (Randall 2003).

Most of the shorelines in the MIRC study area are karstic and bordered by limestone cliffs (Randall 1979; Eldredge 1983; Siegrist and Randall 1992; Amesbury et al. 2001; Paulay et al. 2001, 2003). In a few areas, the shorelines consist of volcanic substrates (Randall 1979, Paulay et al. 2003). On windward shores in the MIRC study area, reefs are narrow and have steep fore reefs. Narrow reef flats or shallow fringing reefs (100 to 1,000 m wide) are characteristic of leeward and more protected coastlines. Reefs also occur in few lagoonal habitats: Apra Harbor and Cocos Lagoon on Guam, and Tanapag-Garapan Lagoon on Saipan. Reef organisms also occur on eroded limestone substrates including submerged caves and crevices, and large limestone blocks fallen from shoreline cliffs (Randall 1979, Paulay et al. 2003).

Following are summaries of the distribution, composition, and condition of reefs in the MIRC study area. The NCCOS/NOAA (2005) delineations of shallow-water benthic habitats of Guam and the CNMI were used to provide the overall distribution of reefs within the MIRC study area. The depiction of benthic habitats (including reefs) of Guam, Tinian, and FDM presented in Figures 3-7 through 3-9 are approximate due to the low resolution (1 acre minimum mapping unit [MMU]) and hierarchical mapping method (see NCCOS/NOAA 2005 for detailed information on their mapping methods). Future benthic habitat mapping of Guam and the CNMI would benefit from higher resolution techniques and site-specific input on reef structure and coral coverage from local experts. The site specific information on coral cover provided in this report is based on peer-reviewed publications and reports. In areas where coral cover was not reported in the literature, it was approximated using NCCOS/NOAA (2005).

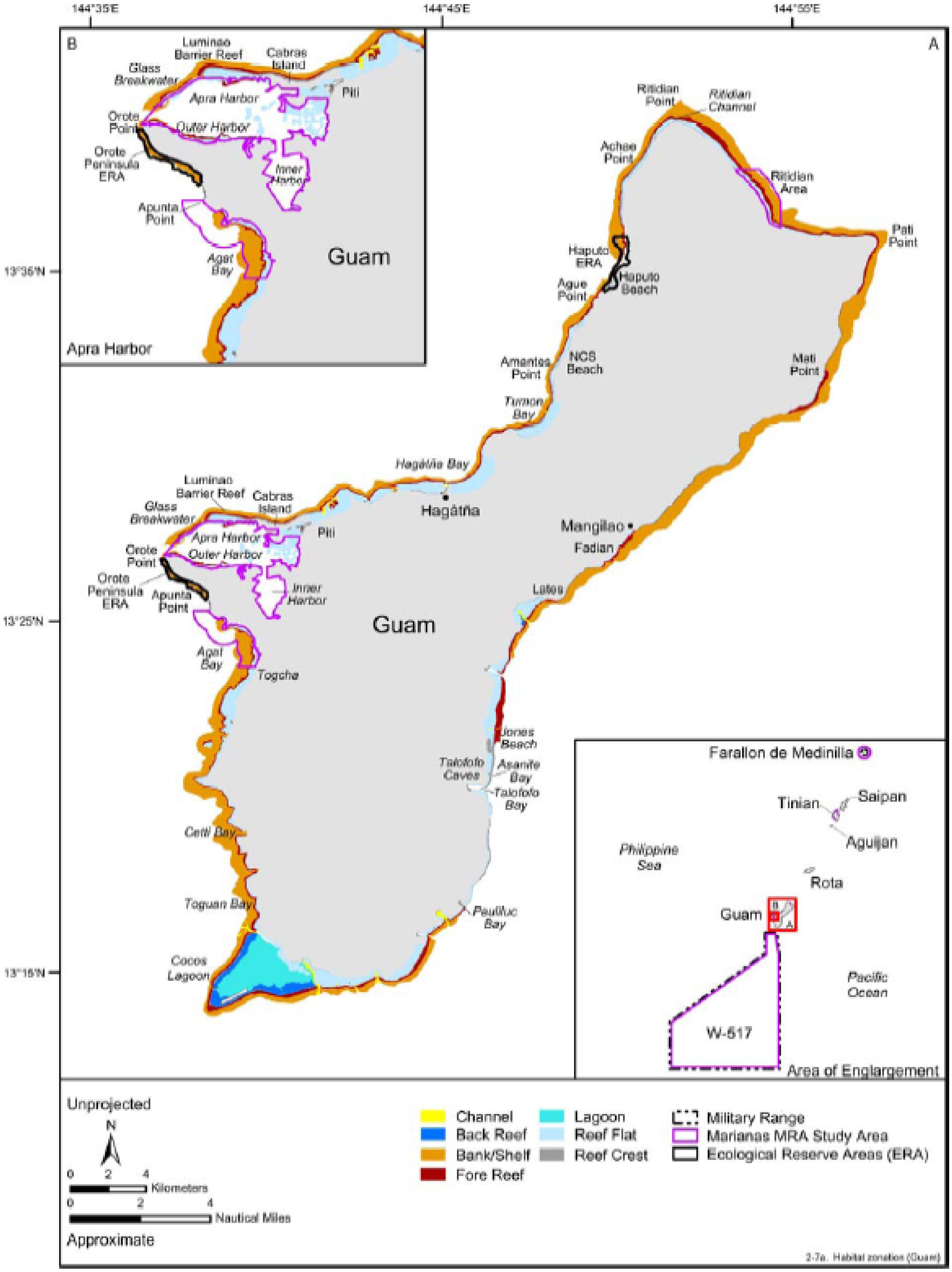


Figure 3-7a. Nearshore benthic habitats of the MIRC study area, Guam: Habitat zonation. Source data: NCCOS/NOAA (2005).

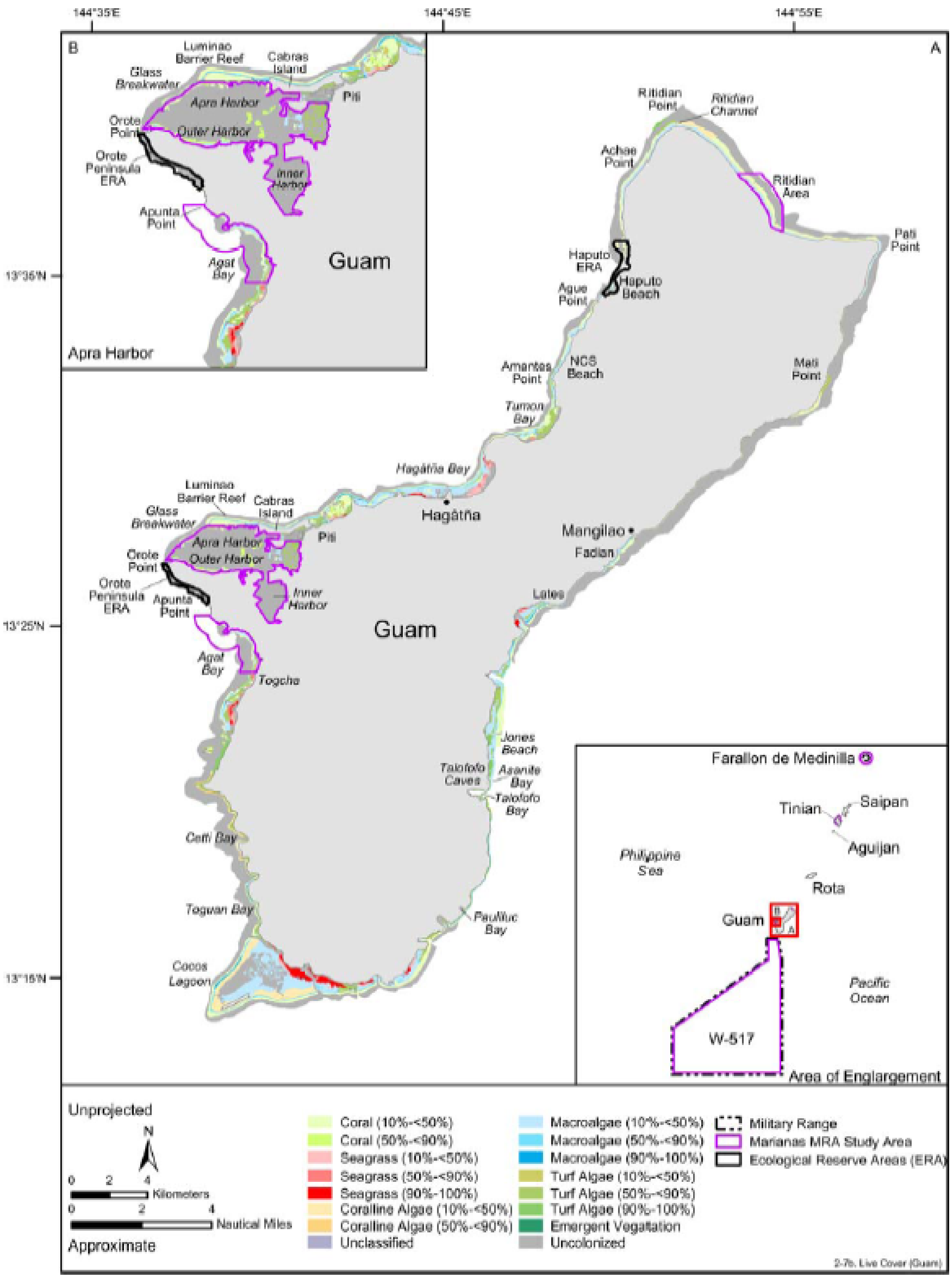


Figure 3-7b. Nearshore benthic habitats of the MIRC study area, Guam: Live cover. Source data: NCCOS/NOAA (2005).

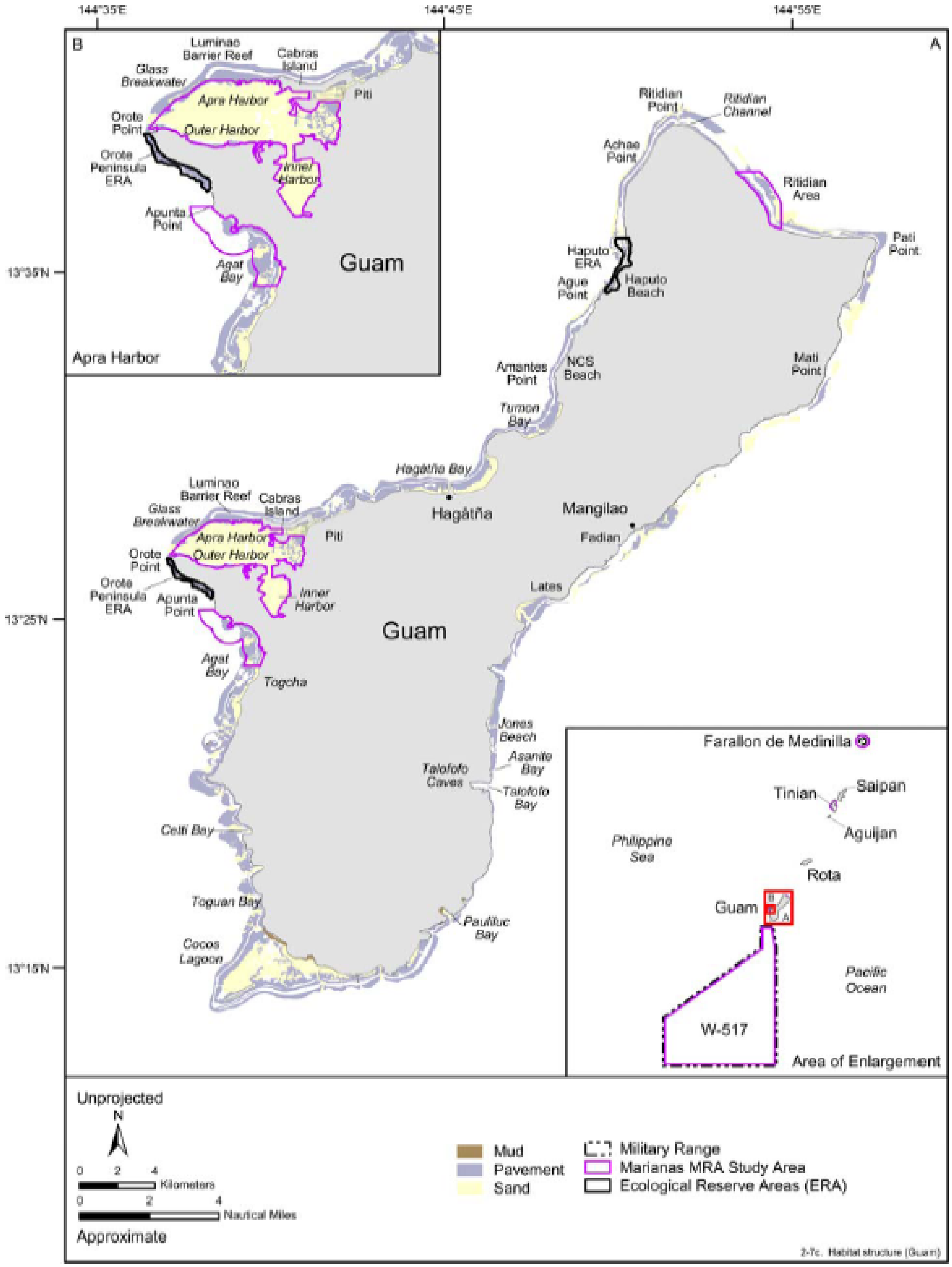


Figure 3-7c. Nearshore benthic habitats of the MIRC study area, Guam: Geomorphological structure. Source data: NCCOS/NOAA (2005).

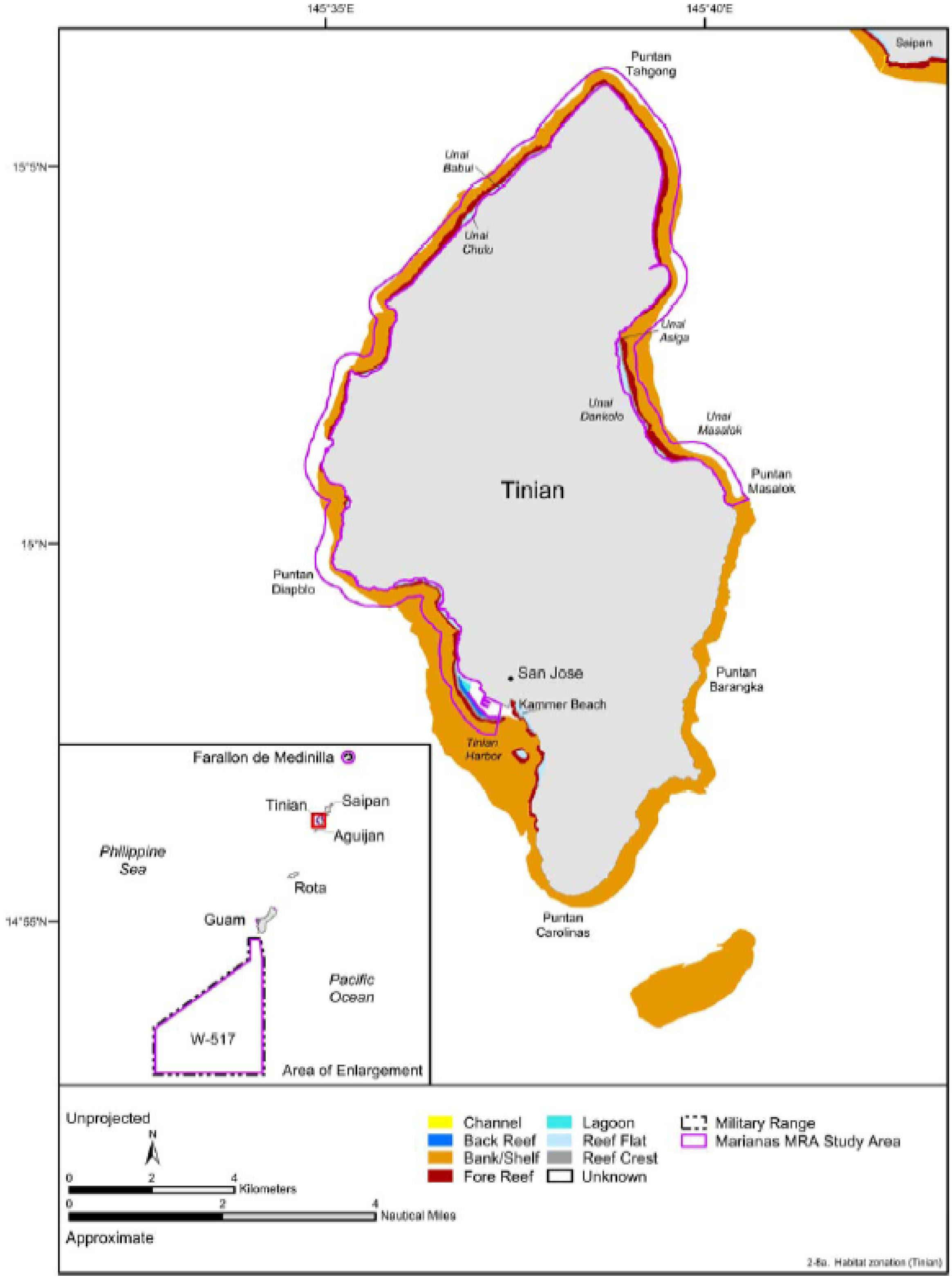


Figure 3-8a. Nearshore benthic habitats of the MIRC study area, Tinian: Habitat zonation. Source data: NCCOS/NOAA (2005).

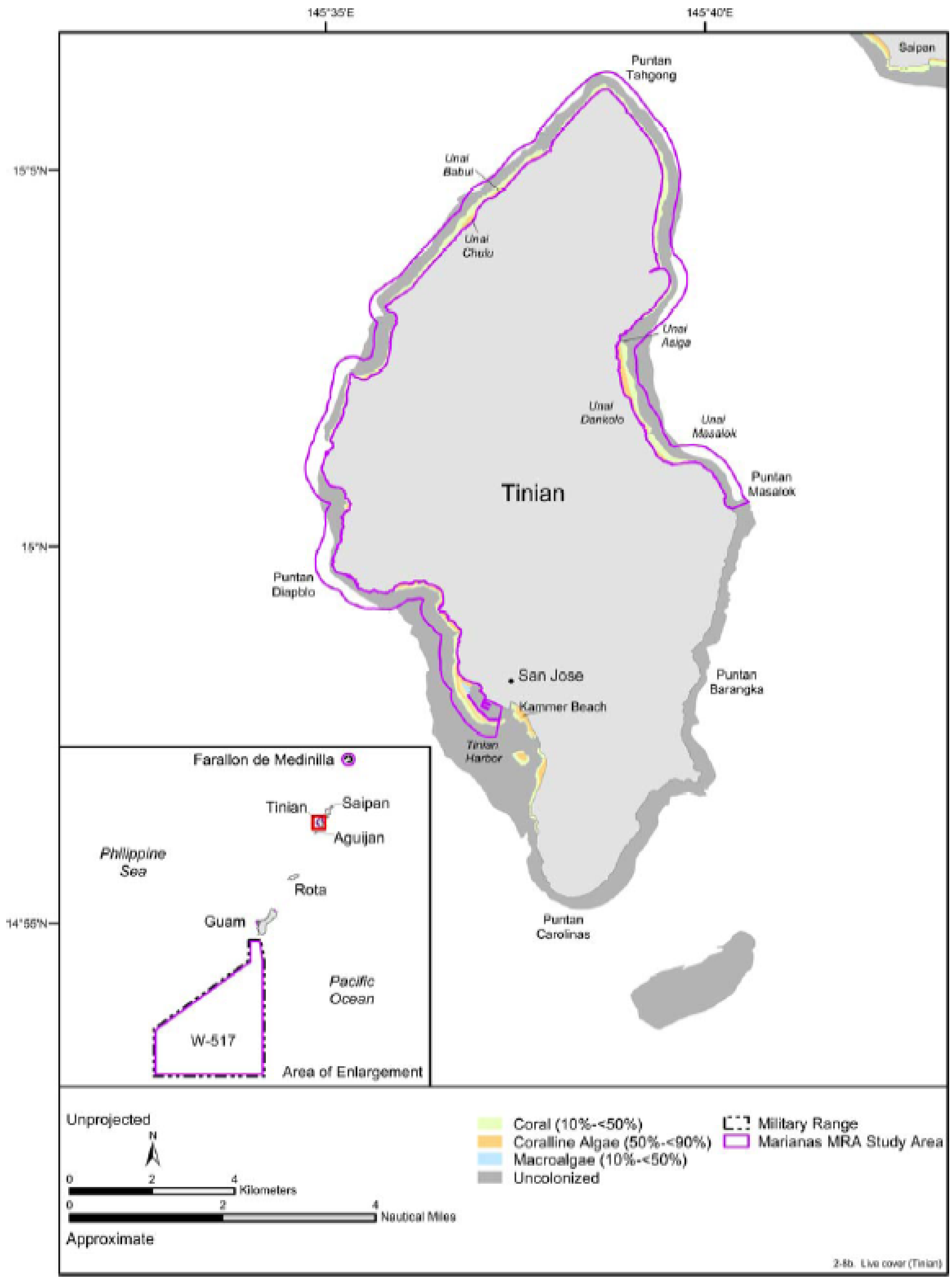


Figure 3-8b. Nearshore benthic habitats of the MIRC study area, Tinian: Live cover. Source data: NCCOS/NOAA (2005).

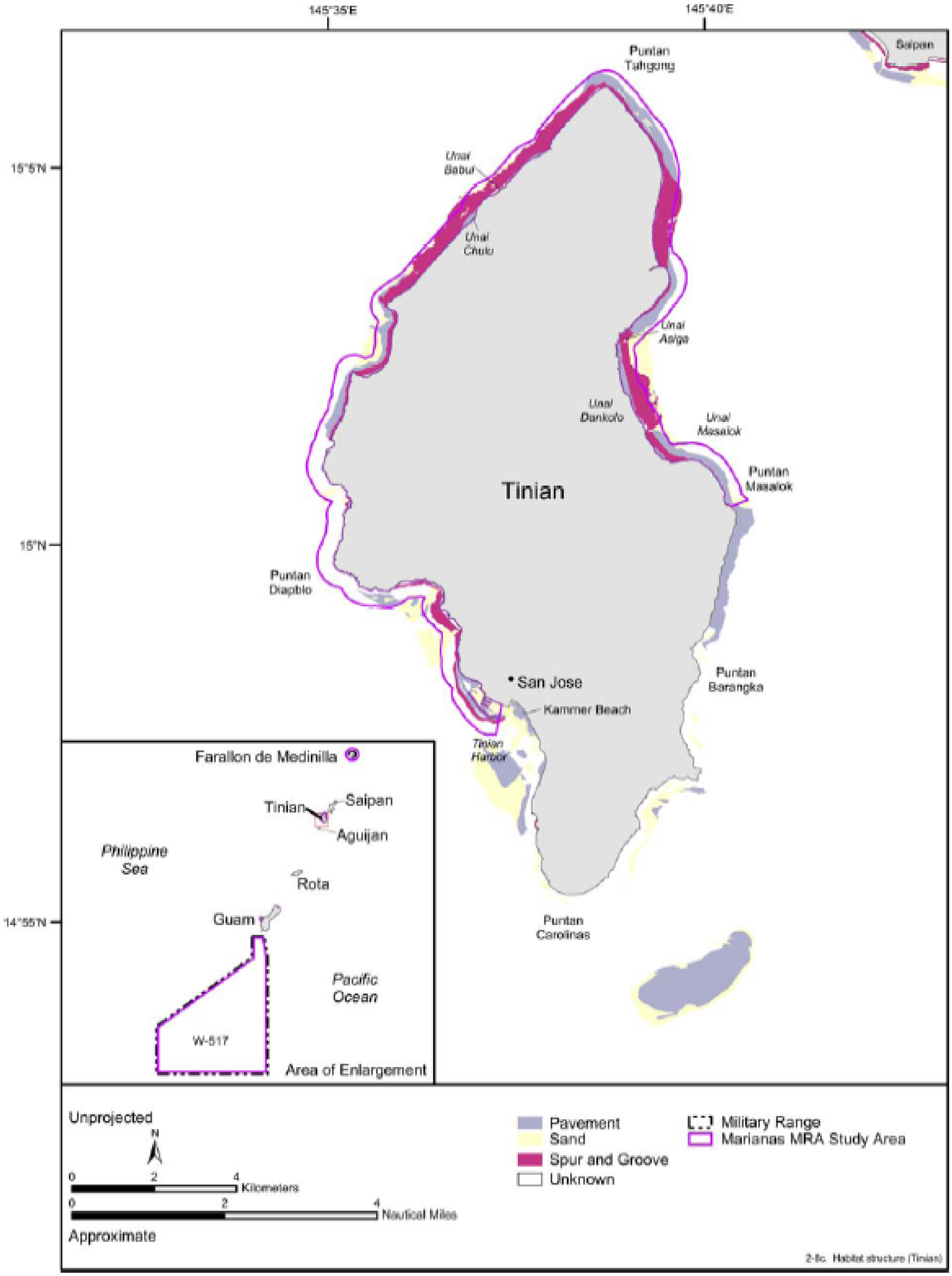


Figure 3-8c. Nearshore benthic habitats of the MIRC study area, Tinian: Geomorphological structure. Source data: NCCOS/NOAA (2005).

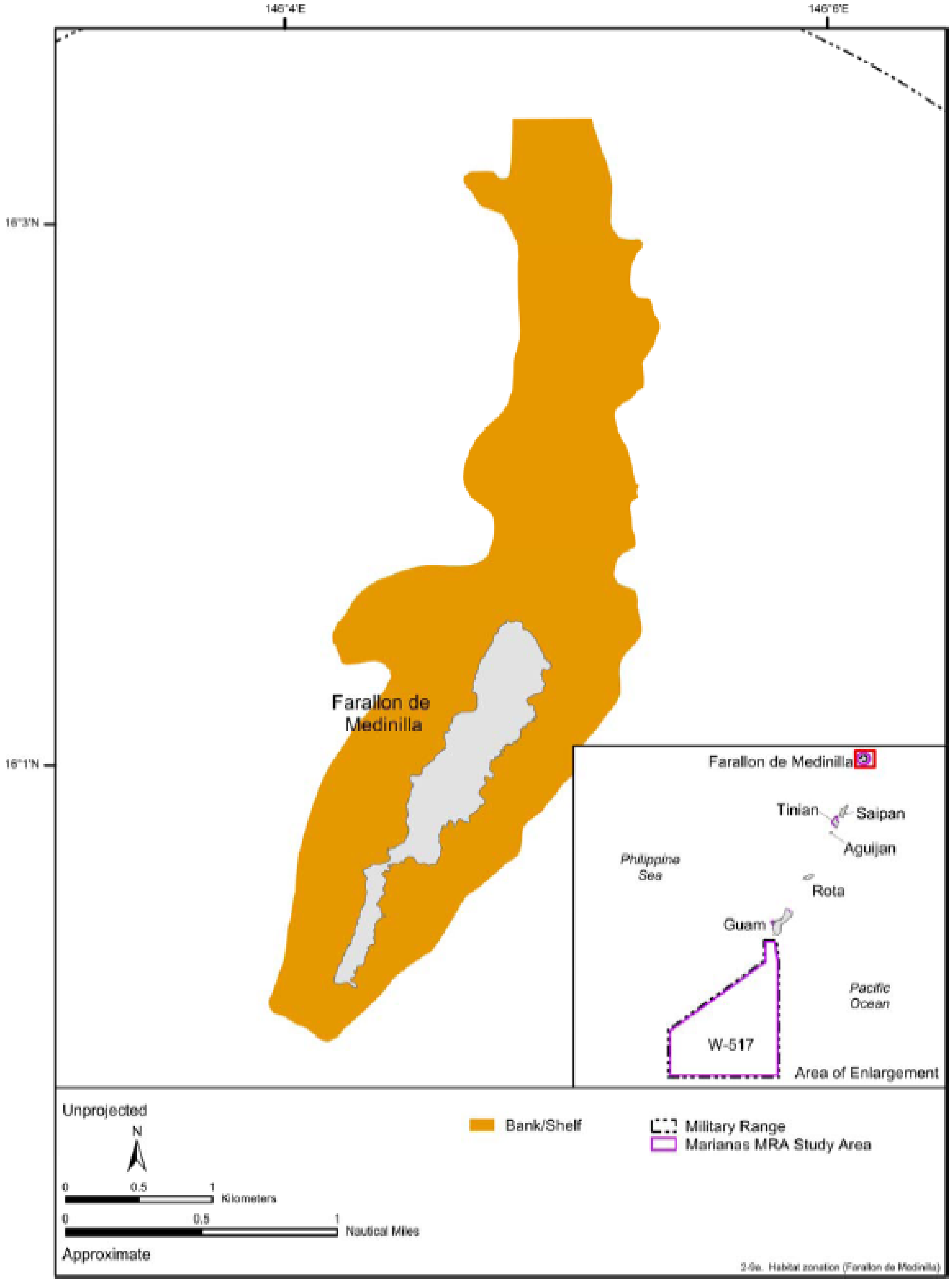


Figure 3-9a. Nearshore benthic habitats of the MIRC study area, Farallon de Medinilla: Habitat zonation. Source data: NCCOS/NOAA (2005).

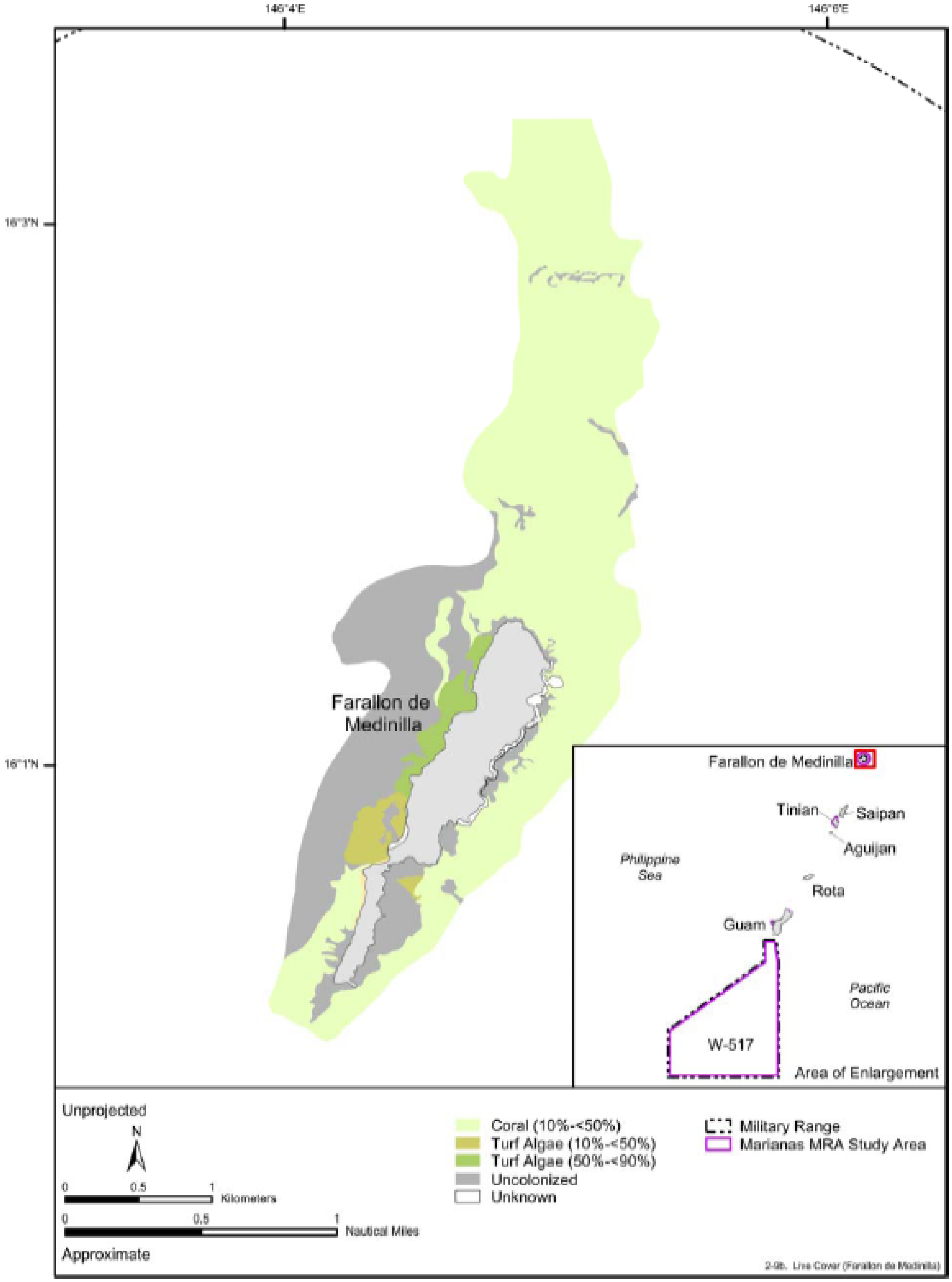


Figure 3-9b. Nearshore benthic habitats of the MIRC study area, Farallon de Medinilla: Live cover. Source data: NCCOS/NOAA (2005).

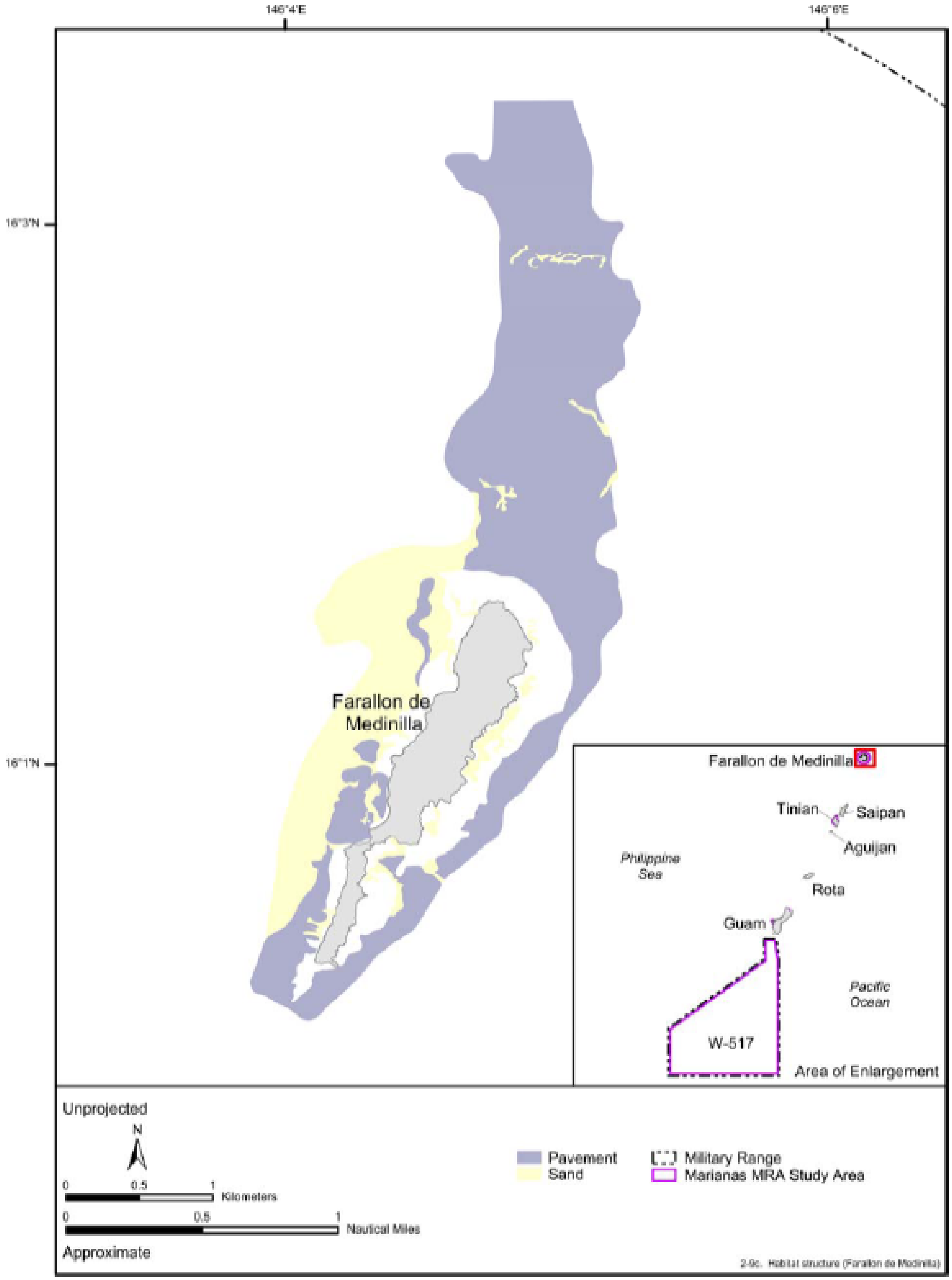


Figure 3-9c. Nearshore benthic habitats of the MIRC study area, Farallon de Medinilla: Geomorphological structure. Source data: NCCOS/NOAA (2005).

3.7.2.1 Regional Distribution, Composition, and Condition

Reefs located in the MIRC study area are found on Guam (Agat Bay, Apra Harbor, and Ritidian Point area), Tinian (along the upper two thirds of the island shoreline), and FDM. Reefs of the Orote Peninsula Ecological Reserve Area (ERA) and the Haputo ERA in Guam are not specifically within the MIRC study area but are nevertheless of interest here since the Orote ERA is within the boundaries of the U.S. Naval Station, Guam, and the Haputo ERA is under the control of the Commanding Officer, U.S. Naval Forces Marianas (COMNAVMARIANAS) (DoN 1984, 1986).

Coral communities and reefs are dynamic and changing ecosystems subject to natural and humaninduced disturbances. Natural disturbances that have had significant impacts on coral communities and reefs in the Mariana Islands include storm-related damage caused by frequent typhoons, ENSO events, outbreaks of the crown-of-thorns starfish (COTS) (*Acanthaster planci*, a corallivorous predator), freshwater runoff, recurrent earthquakes, and volcanic activity (Richmond 1994; Birkeland 1997; Paulay 2003; Abraham et al. 2004; Bonito and Richmond Submitted). Human-induced disturbances on reefs in the Mariana Islands include erosion, sedimentation, polluted runoff (input of nutrients), exposure to warm water (global warming and thermal effluents) leading to bleaching, overfishing, anchor damage, tourism related impacts, ship groundings, and certain military activities (Birkeland 1997; Houk 2001; Richmond and Davis 2002; Starmer et al. 2002; Paulay 2003; Quinn and Kojis 2003; DoN 2003a; Abraham et al. 2004).

<u>Natural Disturbances</u> - Coral communities and reefs on the eastern, windward side of the islands are exposed to dominant winds, strong wave action, and storms (including typhoons). Corals found above the 30 m isobath on windward coasts are conditioned to withstand heavy wave action and will recover if damaged (Randall 1985; Birkeland 1997; DoN 2005b). Typhoons can cause substantial damages to corals on windward coasts (DoN 2005b). Corals in this exposed area of the reef typically include encrusting or massive growth forms of corals as well as columnar, platy and branching growth forms. Exposed windward reef fronts are dominated by three growth forms of *Acropora*: corymbose (colonies are composed of horizontal branches and short to moderate vertical branchlets that terminate in a flat top), digitate (colonies are composed of short, nonanastomosing branches like the fingers of a hand), and caespitose (bushy, branching, possibly fused branches) (DoN 2005b). There are currently more acroporids on reefs at Unai Dankulo than in sheltered bays of Lau Lau Bay (southeastern Saipan) or Sasanhaya Bay (southwestern Rota) (DoN 2005b). Reef growth in the CNMI at wave exposed sites is more conditioned by the availability of a suitable habitat and an underlying substrate than by wave action (Randall 1985; DoN 2005b).

The disruption of the trade wind pattern during ENSO events has caused sea level to drop in the Mariana Islands and exposed shallow corals and other reef organisms over a prolonged time which has caused mass mortality (Birkeland 1997). Further, ENSO events have produced unusually high seawater temperature, which may have caused coral bleaching (Richmond and Davis 2002). The bleaching of corals has been recorded in the Marianas since 1994, and some bleaching events have caused coral mortality (Paulay and Benahayu 1999, Richmond and Davis 2002; Starmer et al. 2002). In 1994, corals bleached on all reefs of Guam (Paulay and Benahayu 1999). While pocilloporids and acroporids incurred severe bleaching on Guam in 1994, and in spite of the bleaching, Paulay and Benayahu (1999) observed no stony coral mortality during that bleaching event. In August and September 2007 a moderate regional bleaching event occurred, which extended from southern Japan to Palau. At FDM and in Apra Harbor, Guam, bleaching was almost entirely confined to two coral genera, *Pocillopora* and *Acropora*. Mortality of those taxa in Apra Harbor was high; nearly 100% on some *Acropora muricata* patch reefs. In contrast, at FDM, 2008 surveys showed that most bleached specimens recovered (Smith and Marx, 2009). Outbreaks and predation of COTS on corals (including *Acropora*, *Montipora*, and *Pocillopora*) have also caused coral mortality. In the fore reef zone in sheltered areas, massive corals (*Porites* and *Favia*) that are more resistant but not immune to *A. planci* have replaced the corals decimated by *A. planci* (Quinn and Kojis 2003; DoN 2005b). Weather and wave action-exposed reefs (e.g., Unai Dankulo, Tinian) appear to be more resilient to COTS outbreaks compared to reefs in sheltered bays (e.g., Lau Lau Bay, Saipan; Sasanhaya Bay, Rota) (DoN 2005b).

Other sources of coral mortality and degradation are freshwater runoff and seismic and volcanic activity. Freshwater runoff naturally affects reefs during the rainy season (Richmond and Davis 2002). Areas particularly affected by sedimentation following heavy rainfall include the Ugum River watershed (southeast Guam), the south coast of Guam, Lau Lau Bay (southeastern Saipan), and Opyan Beach (southern Saipan) (Houk 2001; Richmond and Davis 2002; Abraham et al. 2004). Reefs in the islands north of FDM are likely to have been impacted by frequent and recent seismic and volcanic activity (Birkeland 1997; USGS 2004, 2005b). The southern islands (Guam to FDM) have not been impacted by recent volcanic activity but by recurrent seismic activity as witnessed in 1993 in Guam (EE1997).

<u>Human-Induced Disturbances</u> - The increased land-clearing and construction of coastal roads, housing, and tourism-related facilities have caused the increased erosion, sedimentation and runoff (particularly during heavy rainfall) impacting coral cover and recruitment in Guam and the CNMI and is the main source of human-induced impacts on coral communities and reefs in the MIRC study area (Richmond 1994; Birkeland 1997; Houk 2001; Richmond and Davis 2002; Starmer et al. 2002; Paulay 2003; Abraham et al. 2004). Sedimentation affects both coral cover and diversity. Sedimentation-impacted sites can further be degraded by the compounding effects of overfishing of herbivorous fishes and starfish (Houk 2001; Abraham et al. 2004). Polluted runoff (nutrients from sewage, fertilizers, agriculture, and animal waste), sedimentation, and overfishing have impacted reefs off the most urbanized areas.

3.7.2.2 Coral Communities and Reefs of Guam

Guam is almost entirely surrounded by fringing reefs, is entirely surrounded by fore reefs, and has barrier reefs at Apra Harbor (Luminao Barrier Reef at the western end of Guam) and Cocos Lagoon (southern end of Guam) (Eldredge 1983; DoN 2005b). The depiction of benthic habitats (including reefs) of Guam presented in Figures 3-7a, 3-7b, and 3-7c is approximate and would benefit from higher resolution mapping and site-specific input on reef structure and coral coverage from local experts.

Reefs in the southern half of Guam have always been subject to more naturally-occurring sedimentation than in the northern half of the island because of the difference of erosional products (volcanic in the south versus limestone in the north) (Richmond and Davis 2002). Coral cover and diversity are currently higher on reefs located along the northeastern coast of Guam (Richmond and Davis 2002). Historical surveys suggest that diversity was actually higher in the south before anthropogenic impacts severely impacted those reefs (DoN 2005b). The NCCOS/NOAA (2005) survey of shallow water benthic habitats of Guam determined that the overall coral cover around Guam ranged from 10 to 90% (Figure 3-7b). Most the reefs surrounding Guam have a coral cover ranging 10 and 50%. NCCOS/NOAA (2005) delineates four of the areas of Guam where coral cover ranges from 50 to 90%: an area off Mergagan Point on the northeastern end of the island, an area off Pagat Point on the eastern side of the island, an area immediately south of Togacha Bay also on the eastern side of the island, and Apra Harbor.

The fringing reef is interrupted in several locations along the coastline by bays, channels, and areas where the insular shelf is colonized by seagrass (Figures 3-7a, 3-7b, and 3-7c). Along the northern coast of the island between Achae Point and the Ritidian Channel, the fringing reef and fore reef area transitions from a relatively wide swath of coral (less than 250 m wide) to an area populated by turf algae (200 to 500 m wide). Similarly, turf algae and macroalgae cover the insular shelf (up to a 500 m width) from Pati Point (northeastern tip of the island) to an area south of Mati Point on the eastern side of the island. Turf algae and macroalgae also cover the insular shelf from Fadian to Lates, Talofofo Caves to Paulicuc Bay, north of Toguan Bay to south of Cetti Bay, Apuntua Point to Orote Point, Amantes Point to NCS Beach, and from Ague Point to Haputo Beach (NCCOS/NOAA 2005). Small coral-populated reef areas (individual areas less than 1 ha occur within large stretches of turf algae and macroalgae cover off of Jones Beach near Camp Dealy (eastern side of the island), at Asanite Bay (south of Jones Beach), and in two areas off Togcha on the western end of the island south of Agat Bay (NCCOS/NOAA 2005).

Natural and human-induced disturbances affecting the reefs of Guam have caused a significant decline of coral cover and recruitment since the 1960s (Richmond 1994). Coral cover on many fore reef slopes on Guam has decreased from over 50% to less than 25% (Birkeland 1997). There are, however, several reefs of Guam where coral cover remains high, including Apra Harbor, Agat Bay, Orote ERA, and Haputo ERA.

Hagatna and Tumon Bays are centers for tourism and incur a high level of tourism-related impacts on water quality and marine resources. Polluted runoff has affected the inner areas of Hagatna, Tumon, and Piti Bays. Marine recreational sports (including SCUBA diving, snorkeling, fishing, underwater walking tours, and jet skis) can cause physical damages on reefs (Richmond and Davis 2002; Starmer et al. 2002; Abraham et al. 2004). Anchor damage on reefs occurs at popular dive and fishing sites (Abraham et al. 2004). It is estimated that over half a million SCUBA dives are done each year on Guam and concentrated in five main dive sites: Tokai Maru (Apra Harbor), the Cormoran (Apra Harbor), The Crevice (Orote peninsula), Blue Hole (Orote peninsula), and Hap's Reef (Agat Bay) (Birkeland 1997; Hanauer 2001). Vessel groundings (recreational and commercial vessels) are also a source of physical impacts on reefs in the Marianas (Richmond and Davis 2002; Starmer et al. 2002).

<u>Apra Harbor</u> - Apra Harbor is a deep lagoon located at the western end of Guam (Paulay et al. 1997; Figures 3-7a, 3-7b, and 3-7c). Before 1944, the lagoon of Apra Harbor was delimited to the north by Cabras Island, Luminao Reef, and Calalan Bank; to the east by the Piti area; and to the south by the Orote Peninsula (Paulay et al. 1997). In 1944, the construction of the Glass Breakwater (limestone boulders) on Calalan Bank altered the barrier reef system and restricted water exchange between Apra Harbor and the open ocean. In addition, dredging of the Inner Apra Harbor (formerly a silty embayment of the lagoon) and fill operations to develop Dry Dock Island, Polaris Point, and artificial shorelines of the northeastern and southeastern boundaries altered the lagoon (Paulay et al. 1997).

Because of its depth (51 m), the Apra Harbor lagoon is unique to the MIRC study area (Paulay et al. 1997). It provides habitat for unique and diverse benthic fauna; for example, most of the sponges and ascidians found in Apra Harbor; 48 species of sponges and 52 species of ascidians are unique to Apra Harbor. Many of these species unique to Apra Harbor are indigenous. Some of the species (1 sponge and 16 ascidians) were introduced via ship traffic. Indigenous species generally occupy natural substrates while introduced and cryptogenic species (species whose origins cannot be verified) generally occupy artificial substrata (e.g., wharf walls, concrete revetments, moorings, and navigational buoys) (Paulay et al. 1997).

Corals are found in the Outer Apra Harbor where they thrive on shoals and fringing reefs (Paulay et al. 1997; DoD 1999; DoN 2003b; Paulay 2003; DoN 2005b). Coral cover in the outer harbor is greater than what is depicted in Figure 3-7b. Figure 3-7b is based on the

NCCOS/NOAA (2005) delineation (DoN 2005b); whereas, Paulay et al. (1997) observed "well-developed reefs with some of the highest coral cover on Guam" within Apra Harbor. Further, there are numerous deeper reef shoals in Apra Harbor that are missing from Figure 3-7a (DoN 2005b). The bottom of Apra Harbor is a complex environment that includes substantially more reef than depicted in Figures 3-7b and 3-7c (DoN 2005b). More detailed surveys and benthic habitat maps for specific locations within Apra Harbor were produced for an artifical reef feasibility study (DoN 2007), and are depicted in Figures 3-10 to 3-13.

Porites rus is the dominant coral species on the shoals in the center of the harbor outside Sasa Bay (Western Shoals, Jade Shoals, and Middle Shoals) (Paulay et al. 1997, Figures 3-10 and 3-11). Other coral species associated with these shoals include *Porites lobata*, *P. annae*, *P. cylindrica*, *Millepora dichotoma*, *Acropora formosa*, and *P. damicornis* (Paulay et al. 1997). Coral cover on the shoals range from 50 to 90% (Paulay 2003, NCCOS/NOAA 2005). There are mounds at deeper depths in the outer harbor. Paulay et al. (1997) surveyed Sponge Mound located west-southwest of Western Shoals. They found that the top of the mound (within 20 m of the sea surface) supported the highest diversity of sponges in all of Guam.

Along the southern boundary of Apra Harbor between Orote Point and Gabgab Beach including east and west of ammunition pier or "Kilo Wharf", coral cover on fringing reefs is high (DoD 1999, Smith 2004, NCCOS/NOAA 2005, Smith and Marx 2006, Figure 3-12). The areas to the east and west of Kilo Wharf support high coral cover (close to 100% cover) consisting mainly of *P. rus* (>90% of the cover) and other stony corals including *P. lichen*, *P. lobata*, *Platygyra pini*, *Leptoseris* spp., *Lobophyllia corymbosa*, and *Acanthastrea echinata* (Smith 2004). Reefs located further in the harbor (excluding the Inner Apra Harbor) have been severely impacted by freshwater runoff, sedimentation, and polluted discharges (DoD 1999; Richmond and Davis 2002). Corals in the Inner Apra Harbor (including *P. rus* and *P. damicornis*) encrust sheet pilings, rocks, and concrete debris (DoD 1999; Smith 2007).

There are no corals on the seafloor of the Inner Apra Harbor or the inner portion of the Entrance Channel to the Inner Apra Harbor (DoN 2005b). The closest area to the Inner Apra Harbor where corals occur on the seafloor is in the outer reaches of the Entrance Channel of the Inner Apra Harbor. In this area, corals consist of *P. rus* and *P. cylindrica* (DoN 2005b). Corals are also found on sheet piles in the Entrance Channel of the Inner Apra Harbor and the outer reaches of the Inner Apra Harbor (Smith 2007).

Corals also occur on reefs off the tip of the Orote Peninsula (Paulay et al. 2001). Paulay et al. (2001) described two macrohabitats in this area, the Orote Point reef slope and the Orote Point fringing reef. The Orote Point reef slope is found at the tip of the peninsula and extends from Spanish Steps to the western end of Orote Island. This area supports higher coral and fish diversity and higher fish biomass compared to other locations of Guam. The submerged terrace slopes gently down to a water depth of 12 to 15 m followed by a steep fore reef slope that plunges down to 30+ m. The area of reef that is contiguous with Apra Harbor is populated by the biota commonly found in the harbor (e.g., *P. rus* and sponges). The *P. rus* dominated reef is limited to an area immediately adjacent to the harbor. Along the northern end of the Orote Peninsula west from the harbor, the coral community is more diverse. Paulay et al. (2001) observed 19 species of corals in this area and noted that this was the most diverse coral area of the coastline from Spanish Steps to Agat Bay. The diversity of fishes was also greatest in this area with 53 species observed. In addition, in this diverse area, Paulay et al. (2001) may have found a new *Acropora* species record for Guam. The coral species appeared to be similar to *Acropora nasuta*.

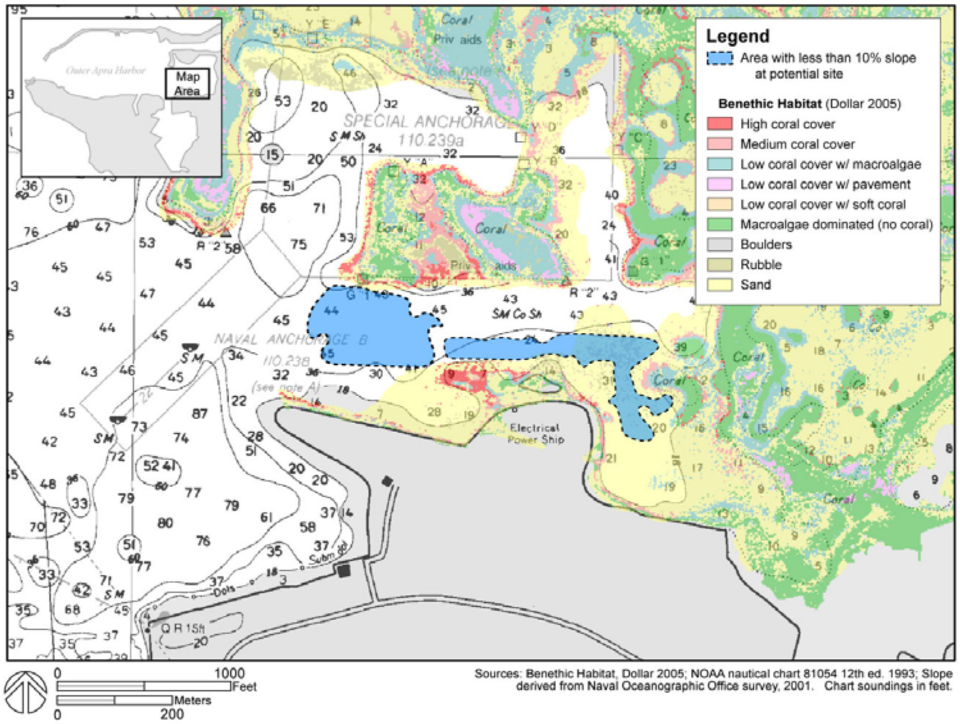


Figure 3-10. Benthic habitats of the Sasa Bay Artificial Reef Site. From DoN 2007.

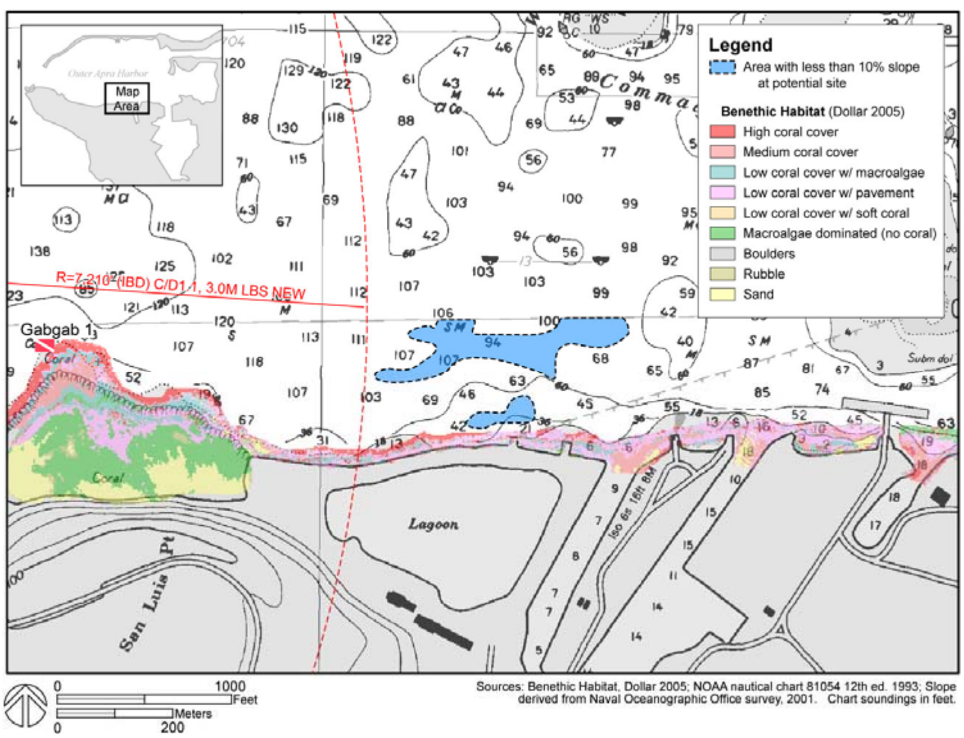


Figure 3-11. Benthic habitats of the San Luis Beach Artificial Reef Site. From DoN 2007.

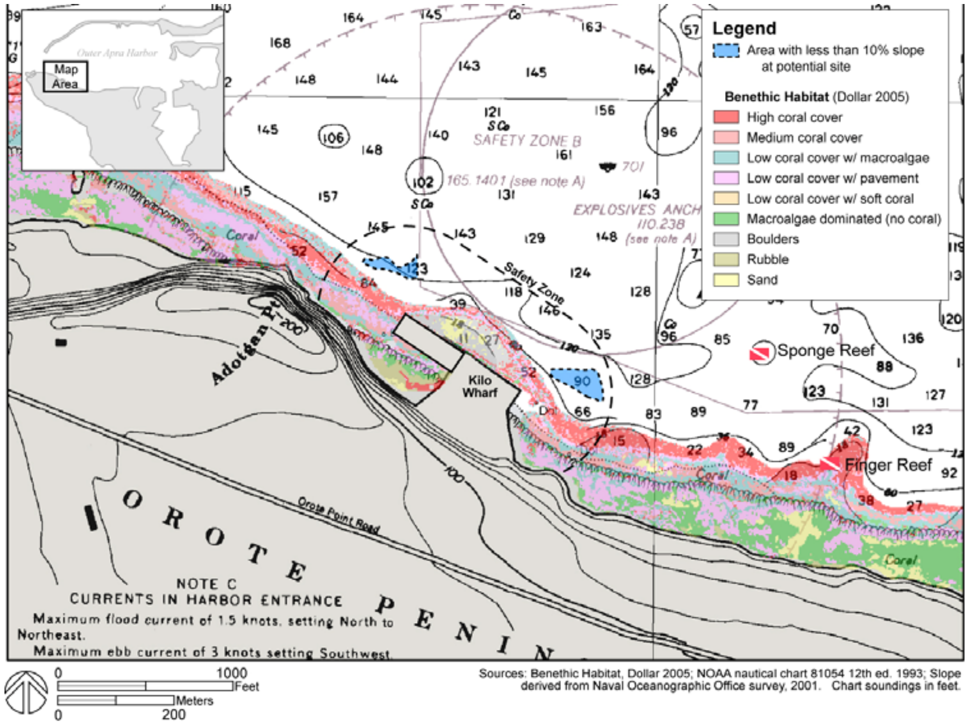


Figure 3-12. Benthic habitats of the Kilo Wharf Artificial Reef Site. From DoN 2007.

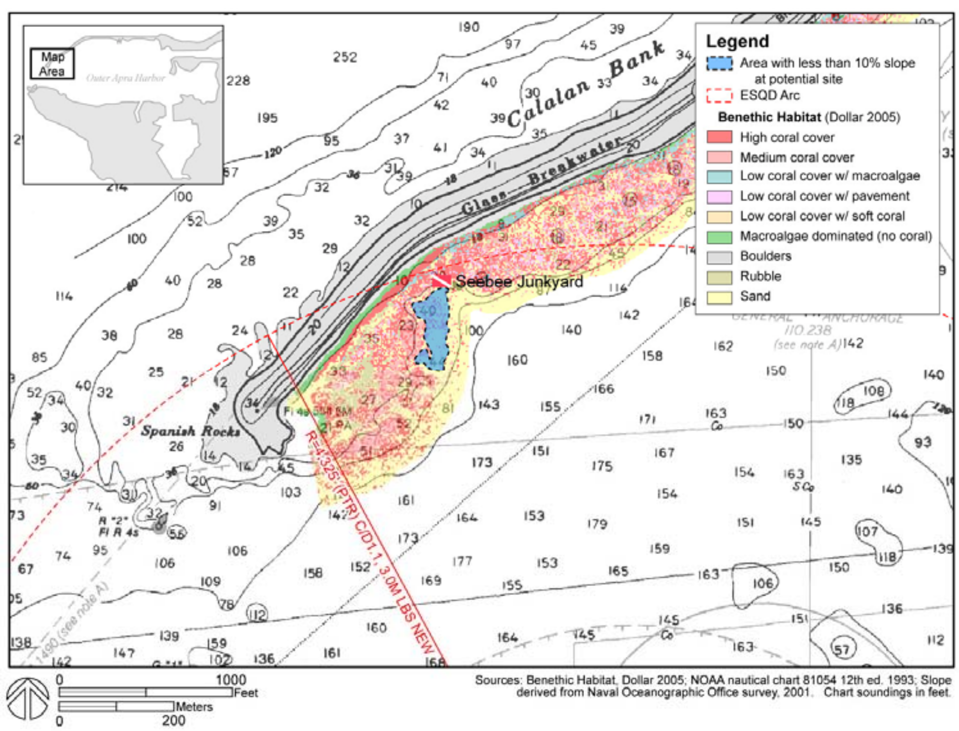


Figure 3-13. Benthic habitats of the Glass Breakwater Artificial Reef Site. From DoN 2007.

The Orote Point fringing reef is located between the tip of the Orote Peninsula and Orote Island. It has a reef front facing the southern coast of the Orote Peninsula and another facing the southwestern end of Apra Harbor (Paulay et al. 2001) intrinsically providing a connection between the north and south sides of the peninsula. Karstic shores flank the other two sides of the reef. Paulay et al. (2001) found a “strong gradient in species composition” on this reef. The middle and northern parts of the reef supported coral species that are typical of Apra Harbor (including *P. rus*, *P. cylindrica*, *Pavona venosa*, *Pavona divaricata*, *Psammocora contigua*, *P. damicornis*). Corals found on the southern end of the reef were characteristic of an oceanic, reef front community with corals including *A. digitifera*, *Galaxea fascicularis*, and an *Acropora* species similar to *Acropora valida*.

On the northern side of the harbor, the fringing reefs on either side of the Glass Breakwater, Luminao Barrier Reef, the fore reef off Cabras Island, and the fore reef of Piti Reef have 10 to 50% coral cover (NCCOS/NOAA 2005, Figure 3-13). Also, a narrow strip of seagrass borders the entire fore reef from the end of the breakwater to Piti Reef (NCCOS/NOAA 2005). In addition to this data from the National Centers for Coastal Ocean Science (NCCOS/NOAA 2005), Randall et al. (1982) surveyed three reef areas, the Luminao Barrier Reef on the seaward side of Glass Breakwater, the fringing reef on the seaward side of Cabras Island, and the Piti Reef (fringing reef east of Cabras Island). Randall et al. (1982) found that the reef flat and the reef front were areas of the reefs where corals were concentrated. However, considering the recent and severe impacts of corallivorous predators and storms on the corals of Guam, the surveys of 1980 and 1981 are probably not representative of current reef conditions (coral diversity and cover) (Birkeland 1997, Abraham et al. 2004). There is no new information to describe these reef areas; therefore the following description from Randall et al. (1982) is discussed. Luminao Barrier Reef is approximately 50 to 200 m long and less than 1 to 2 m deep. Coral cover on the reef flat ranged from 7 to 31% (Randall et al. 1982). Corals making up most of the cover were of the following genera: *Porites*, *Pocillopora*, *Leptastrea*, *Montipora*, *Millepora*, *Acropora*, *Psammocora*, *Leptoria*, and *Goniastrea*. Coral cover on the reef front slope ranged from 18 to 25% and was composed of the coral genera *Pocillopora*, *Acropora*, *Goniastrea*, and *Millepora*. The reef off Cabras Island consisted of a narrow and wave exposed reef pavement (0.6 m deep), a reef margin, and a reef slope. There were very few corals and coral cover on the reef pavement and reef margin was minute (0 to 1.1% coral cover) with coral cover on the reef pavement less than 0.3%. Coral genera on the reef pavement included *Porites* and *Pocillopora*. On the reef margin, there were more coral genera including *Goniastrea*, *Pocillopora*, *Acropora*, *Porites*, and *Favites*. Coral cover on the reef front (5 m water depth) ranged from 10 to 22% and was mostly composed of *Pocillopora*, *Goniastrea*, *Acropora*, *Millepora*, and *Montipora*. The Piti Reef was located seaward of the Tepungan Channel along the Piti shoreline. There were five physiographic zones on the Piti Reef: the inner reef moat (approximately 50 m wide and 1 m deep), the outer reef moat (approximately 150 m wide and 1.3 m deep), the outer reef flat pavement (approximately 60 m wide and less than 1 m deep), the reef margin (approximately 50 m wide and exposed at low tide), and the reef front slope (approximately 50 m wide and 5 m deep). Coral cover at Piti Reef ranged from 0.2 to 20% with coral cover greatest on the outer reef flat (20%) and the reef margin (12%). The exposed outer reef flat and the inner reef flat had the least amount of coral cover (0.2% and 0.4%, respectively). Corals on the outer reef flat were of the genera *Porites*, *Acropora*, *Pocillopora*, and *Millepora*. On the reef margin and reef front, the predominant coral genera were *Pocillopora*, *Acropora*, and *Montipora*. The little coral cover on the inner reef flat was composed of *Porites*, *Pocillopora*, and *Leptastrea* and on the outer reef flat, coral cover was composed of *Porites* and *Goniastrea* corals (Randall et al. 1982). As mentioned earlier, many environmental changes have occurred in Guam since the 1980-1981 Randall et al. survey, and an update is needed on the status of the coral populations of the Luminao Barrier Reef on the seaward side of Glass Breakwater, the fringing reef on the seaward side of Cabras Island, and the fringing reef east of Cabras Island.

Haputo ERA - The Haputo ERA is located along the northwestern karstic coast of Guam, between Haputo Beach and an area located approximately 840 m north of Double Reef (Pugua Patch Reef) (Figures 3-7a, 3-7b, and 3-7c). The marine portion of the Haputo ERA covers a 29 ha area (DoN 1986). The following information on the Haputo ERA marine community is taken from Amesbury et al. (2001).

The Haputo ERA coastline is characterized by exposed and narrow supratidal exposed benches (less than 5 m wide, raised 0.5 to 1.5 m above sea level) alternating with vertical cliffs. There are six main macrohabitats supporting corals in the Haputo ERA within the 1 to 18 m water depth range: exposed benches, protected reef flats, Double Reef Top, the back reef, the shallow fore reef, and the deep fore reef. Macrohabitats on the fore reef (1 to 18 m in depth) support more diverse assemblages of corals, macroinvertebrates, and fish than the three shallow macrohabitats. Corals, however, have the greatest diversity in shallow water on Double Reef. Coral cover ranged from 37 to 64% in the Haputo ERA. Coral cover is higher along transects taken at an 8 m depth compared to those taken at 15 m, and coral species with the highest coverage in the Haputo ERA include *Porites* (deep area), *Montipora* (shallow area), and *Leptastrea*.

Amesbury et al. (2001) found 21% of the known marine fauna of Guam within the Haputo ERA. These organisms consisted of 154 species of corals, 583 species of other macroinvertebrates (>1 cm), and 204 species of fish. The 154 coral species found in the Haputo ERA correspond to approximately one-third of the coral species known on Guam, and the 204 fish species, 22% of the fish known on Guam. The marine portion of the Haputo ERA is therefore an area of relatively high biodiversity, yet because of overfishing, the fish in the Haputo ERA are not very diverse or abundant.

Shallow splash pools found on the exposed benches support low diversities of corals, fishes, and cryptic organisms. Shoreward of the benches and at the base of the cliffs are erosional notches created by wave action on the rock face where habitat-specific species of limpets, chitons, slugs, and shore crabs can be found. The seaward edge of the benches is a steep subtidal face typically burrowed by echinoids that supports corals, macroinvertebrates and fishes.

Protected reef flats (fringing reefs) off Haputo Beach and shoreward of Double Reef are intertidal habitats supporting few species of corals (including *Pavona divaricata*), hermit crabs, crabs, sea slugs, and sea cucumbers that can withstand the rigors of an exposed habitat. Corals and fishes are more common and diverse at the seaward margin of these reef flats.

The Double Reef Top is a reef front environment that supports healthy corals and high coral cover (>75%) consisting of *Acropora valida*, *A. digitifera*, and *Pocillopora* species. The exposed reef pavement has been honeycombed by echinoids.

The shallow fore reef substrate within the Haputo ERA includes a steep reef front and gently sloping fore reef starting at a 4 to 8 m water depth. Numerous cuts and channels normal to the shoreline run through the fore reef and create abundant structural complexity. The highest coral cover (54 coral species) within the Haputo ERA is found between these cuts and channels. Amesbury et al. (2001) recorded three new sponges for Guam in this macrohabitat (*Neofibularia hartmani*, “yellow tough sponge,” and “puff sponge”). Branching corals (*Acropora*, *Pocillopora*) dominate the 1 to 3 m depth range on the fore reef. Coral composition within the 4 to 9 m depth range varies within the Haputo ERA, including several areas dominated by encrusting species of *Montipora* while other areas are dominated by the massive *Porites*. The reef front off Haputo

Beach contains very large corals of diverse faviid species (>0.5 m diameter) which makes it distinctive compared to other locations of Guam. Elsewhere on Guam, abundant large massive corals are largely of *Porites*. Coral cover on this reef front exceeds 80% consisting of faviid, mussid, and poritid species (*Leptoria phrygia*, *Goniastrea* spp., *Platygyra* spp., *Favia stelligera*, *Lobophyllia hemprichii*, and *Porites* spp.). Since this area contains slow growing coral heads that are healthy and large, Amesbury et al. (2001) believe that this site withstood the pressures of predation by *A. planci* and physical damage by storms. Crevices and caverns within the reef front create a favorable habitat for sponges.

On the deep fore reef (9 to 18 m depth range), Amesbury et al. (2001) found 52 species of corals, a species richness comparable to that found on the shallow fore reef. The coral community on the deep fore reef is healthy and *Porites*-dominated. Two faviids rare on Guam, *Favia helianthoides* and *Favia maritima*, are common along the deep fore reef. The soft corals *Sinularia leptoclados*, *S. racemosa*, *Lobophytum batarum*, and *Sarcophyton trocheliophorum* are also common on the reef slope.

The back reef to the east and south of Double Reef supports branching, platy, and massive corals including *Acropora palifera*, *Acropora acuminata*, *P. rus*, and *Porites* spp. (>2 m diameter). The soft coral *Asterospicularia randalli* is common and very abundant in this region of the reef. Dead coral skeleton is evidence of recent coral mortality having affected the back reef (Amesbury et al. 2001).

<u>Ritidian Area</u> - Located on the northern shore of Guam, the area between Tarague Cave and the Tarague Channel (Ritidian area) is bordered by a nearshore narrow fringing reef made of coralline algae (NCCOS/NOAA 2005, Figures 3-7a, 3-7b, and 3-7c). Landward of the fringing reef is a reef flat primarily populated by macroalgae and an intertidal area colonized by seagrass. Seaward of the fringing reef is a fore reef colonized by corals (10 to 50% cover) (NCCOS/NOAA 2005).

<u>Orote Peninsula ERA</u> - The Orote Peninsula ERA is located at the eastern end of Guam (Figures 3- 7a, 3-7b, and 3-7c). As per Paulay et al. (2001), the following is a description of the coral and reef communities found within the Orote peninsula. The Orote peninsula ERA is characterized by steep karstic cliffs plunging abruptly onto a steep fore reef macrohabitat. Erosional processes and seismic events caused large boulders to become detached from the karstic cliffs and land on the fore reef pavement. There are strong currents along this area of the Guam coastline. Paulay et al. (2001) identified four macrohabitats in this area: the Orote Point fringing reef, the Orote cliff reef, the Orote reef slope, and the Orote dropoff.

The Orote Point fringing reef is located between the tip of the Orote peninsula and Orote Island. There are two fringing reefs, one facing the southwestern tip of Apra Harbor and the other facing the southern coast of the Orote peninsula. Corals that populate these fringing reefs are more Apra Harbor-like to the north end of the reef and more Orote-like toward the southern end. The northern and middle parts of the reef support high coral cover composed mainly of *P. rus* and *P. cylindrica*. Corals on the southern end consist of *Acropora valida*, *A. digitifera*, and *Galaxea fascicularis*.

The Orote cliff reef was surveyed on the southern face of Orote peninsula. The fore reef slope of the cliff reef is the continuation of the cliff face. At sea level, wave action has undercut notches and caverns into the cliff, and at the base, there are accumulations of large boulders originating from the cliff. The cliff reef substrate is highly bioeroded by boring echinoids (*Echinometra*), and there is a low diversity of corals in this macrohabitat comprised primarily of *Montipora*, *Pocillopora*, and *Millepora platyphylla*. The sessile benthos here is primarily composed of sponges. The abundance of sponges at this location is substantially higher than many other places on Guam (DoN 2005b).

The Orote Point reef slope (from Spanish Steps to western tip of Orote Island) is characterized by higher coral diversity and higher fish biomass and diversity compared to most locations of Guam. For the majority, the western tip of Orote Island can be considered a high energy environment. The eastern end of the Orote Point reef slope abuts the Apra Harbor southern reef slope. West of the *P. rus* dominated Apra Harbor, the Orote Point reef slope is more diverse and includes 19 species of corals. The reef slope is heavily bioeroded ("deeply honeycombed") and supports a diverse cryptofauna (including shrimp, lobster, and crab) and abundant crinoids. Sharks, tuna, groupers, snappers, parrotfish, and emperors are abundant at this location. In total, 53 species of fishes were recorded on the Orote Point reef slope. This area once supported a large aggregation of Bumphead parrotfish (*Bulbometopon muricatum*) (DoN 2005b).

Paulay et al. (2001) defined the Orote reef slope as a depth zone between the Orote cliff reef and the Orote drop-off. This is the largest macrohabitat of the Orote peninsula ERA. The pavement of Orote reef slope has a gentle slope, is barren, and supports a low diversity biota including clumped macroalgae, corals (*Montipora foveolata*, *Leptastrea*, *Astreopora*, *Pocillopora*), and the large boring sponge *Spirastrella vagabunda*. Yet, there are three microhabitats that support unusual biota: boulder fields, rubble fields, and the Blue Hole.

Boulders detached from and clustered along cliffs provide habitat for highly diverse reef communities. Individual boulders are up to 15 m in diameter. Large clusters of boulders are located off Neye Island, Apuntua Point, and Barracuda Rock and support higher coral diversity, higher fish diversity and biomass compared to typical locations of Guam, and many soft corals rarely observed on Guam. In this microhabitat, Paulay et al. (2001) found the largest population of *Plerogyra sinuosa* (bubble coral) and the only sighting of *Madracis kirbyi* known on Guam.

The fore reef pavement on the western half of the Orote peninsula is covered with large areas of rubble (10 to 100 cm in size). The rubble fields contain diverse cryptofauna including a new species of lobster (*Paraxiopsis* sp.), a new species of a swimming crab (*Carupa* sp.), a rare crab (*Aethra edentata*), the only observation of a spider crab (*Acheus lacertosus*), and many species of pagurid hermit crabs.

The other microhabitat on the reef slope is the Blue Hole, a cave formed during low sea stands. The bottom of the cave is 91 m deep with a collapsed roof at 18 m and a "window" at 37 m. The Blue Hole is the most popular dive spot on Guam (Hanauer 2001). This cave contains sessile species and fishes known only to this location on Guam. In the 1970s, the Blue Hole contained many more gorgonians and much more macrofauna than it does today. Since then, recreational divers have taken much of the gorgonians as souvenirs (Birkeland 1997). The cave contains the gorgonians *Viminella* sp., *Keroides* sp., *Heliania spiniescens*, and *Briareum excavatum* which have only been observed around the lip of the cave and on the Orote Drop Off (Paulay et al. 2001). Other significant observations include the undescribed minute false oyster (*Dimyella* sp.) and an undescribed hard coral (*Leptoseris* sp.).

The Orote dropoff on the southwestern margin of the Orote peninsula is a steep vertical face that begins at 25 to 35 m and extends down to >100 m. This region of the reef is exposed to strong currents, and large gorgonians and black corals can be found on the reef face (*Annella mollis*, *Annella reticulata*, *Astrogorgia* sp., *Subergorgia suberosa*, *Antipathes* sp., and *Cirripathes* sp.). The rare encrusting gorgonian *B. excavatum* and the hard coral *Favia rotumana* inhabit the drop off. Paulay et al. (2001) has also identified an undescribed sponge *Callyspongia* aff. *carens*.

<u>Agat Bay</u> - Agat Bay is located at the eastern end of Guam (Figures 3-7a, 3-7b, and 3-7c). Paulay et al. (2001) recently surveyed coral reefs from Orote Point to the northern half of Agat Bay. The Agat Bay shoreline is characterized by sandy beaches and small limestone outcrops.

The sand on Agat Bay consists of dredge spoils from the Inner Apra Harbor deposited on the shore here following World War II (WWII). As a result, the sand contains abundant shells of *Timoclea* sp., a bivalve specific to Apra Harbor.

There is a silty sand plain found in the middle of Agat Bay at water depths ranging from 5 to 30 m (Paulay et al 2001; NCCOS/NOAA 2005). Sand channels and reef substrate interdigitate with patch reefs and reef substrate rising more than 2 m above the sand channels. At 30 m, few patch reefs are found on the dominant sand cover. The epifauna on the sand substrate has a low diversity.

The reef flat from Tipalao Bay through Dadi Beach contains silty intertidal and nearshore areas covered with macroalgae and some seagrass. Paulay et al. (2001) found that the silt cover and macroalgae and seagrass cover decreased with increasing distance from shore. Meanwhile, the diversity of corals, macroinvertebrates, and fish were directly related to the distance from shore. Corals found along the inner reef flat include *Porites australiensis*, *Porites lutea*, and *Leptastrea purpurea*. The coral along the outer reef flat is more diverse than the inner reef flat and includes the species *Pocillopora damicornis*, *Acropora valida*, *Acropora abrotanoides*, *Pavona venosa*, and a new record for Guam, *Pavona bipartita*.

The reef flat between Neye Island and the main island is swept by strong currents and is less subject to siltation. There is a high biodiversity of marine fauna at Neye Island with the coral cover and diversity high on this particular reef flat. Coral cover is dominated by large *Porites* microatolls and eleven *Acropora* species. There is low algal cover and high coralline algae cover, and 34 species of echinoderms have been identified.

3.7.2.3Coral Communities and Reefs of Tinian

Barrier reefs, fringing reefs, and a broad shelf area (1,000 m wide) are found off the Tinian Harbor (Eldredge 1983, NCCOS/NOAA 2005, Figures 3-8a, 3-8b, and 3-8c). The largest amount of coral cover is probably found along the outer edges of the reef (fore reef and terrace) (Starmer et al. 2002). Fringing and fore reefs (less than 200 m wide) occur immediately next to the western shoreline of Tinian (NCCOS/NOAA 2005). Corals are found on the fore reef and insular shelf seaward of the fore reef. From Puntan Tahgong, the northeastern tip of the island, to north of Unai Asiga, coralline algae populate the fringing and fore reefs, and the insular shelf seaward of the fore reef. From Unai Asiga to south of Unai Masalok, coralline algae occupies the reef crest and corals are found along the fore reef and a large portion of the seaward shelf.

From Unai Masalok to Puntan Masalok, no fringing reefs are found and the shelf is composed of coralline algae. Furthermore, there are no fringing reefs from Puntan Masalok to Puntan Carolinas (southernmost point of Tinian). Coralline algae occupy the entire shelf from Puntan Masalok to an area north of Puntan Barangka where coral cover begins to dominate (Figures 3-8a, 3-8b, and 3-8c). Fringing reefs reoccur past Puntan Carolinas (NCCOS/NOAA 2005). An oval-shaped, offshore, submerged reef (3.5 km by 1 km) composed primarily of coralline algae is located approximately 2.7 km southeast off the southern most point of Tinian (NCCOS/NOAA 2005). NCCOS/NOAA (2005) determined that the overall coral cover around Tinian ranged from 10 to 50%.

Coral cover ranges from 14 to 59% on coral reefs at Kammer Beach and Two Coral Head, respectively (Quinn and Kojis 2003). Dominant coral species in terms of cover are *Goniastrea retiformis* at Kammer Beach, and *P. rus* at Two Coral Head. Coral cover is much higher at Two Coral Head compared to Kammer Beach due to fewer coral predator-resistant species (Quinn and Kojis 2003).

Unai Chulu, Unai Babui, and Unai Dankulo are three beach areas and nearshore reefs within the MIRC study area that have been evaluated for amphibious training landing exercises

(Marine Research Consultants 1999). Unai Chulu and Unai Babui are located on the northwestern side of Tinian and Unai Dankulo on the east side of the island, north of Puntan Masalok. A narrow fringing reef composed of coralline algae (50 to 90% cover) borders the carbonate sand beaches of Unai Chulu and Unai Babui (NCCOS/NOAA 2005). Landward of the fringing reef is a reef flat in a water depth of 0.5 m (Marine Research Consultants 1999). At Unai Chulu, within 20 m seaward of the shoreline, the reef flat substrate includes sand, rubble, and outcrops of a fossil reef. Live cover in the inner reef flat is mostly composed of turf algae. The few coral specimens of the genus *Porites* located in this area of the reef form circular, flattopped, and lobate colonies. In the middle of the reef flat, echinoids have bioeroded the reef substrate, and corals (small branching and encrusting colonies) are more abundant when compared to the inner reef flat. The fringing reef is exposed to wave action, resulting in few coral colonies. Seaward of the fringing reef, the reef front forms a spur-and-groove system (alternating channels and ridges that are perpendicular to the fringing reef). Spurs are 1 to 2 m wide and the grooves are approximately 5 m wide. Abundant coral cover was observed within the spurs. Seaward of the spur-and-groove system is a deep reef front terrace (Marine Research Consultants 1999). The reef morphology off Unai Babui is similar to that of Unai Chulu except that the spur-and-groove system was more developed at Unai Babui.

A fringing reef borders the Unai Dankulo white carbonate beach (NCCOS/NOAA 2005). Macroalgae (10 to 50% cover) populate the reef flat while the fringing reef is composed of coralline algae. Corals (10 to 50% cover) are a main constituent of the fore reef and insular shelf (NCCOS/NOAA 2005). Surveys conducted in 1994, however, report that the inner reef flat supports an extensive (50 to 70% coral cover) and diverse reef community (25 coral species) (Marine Research Consultants 1999). On the reef front, there is a spur-and-groove system down to a depth of 10 m, seaward of which the benthos is comprised of carbonate pavement. Both the spur-and-groove system and the fore reef pavement are densely populated by corals (36 species of corals). The passage of a typhoon in December 1997 severely altered the reef flat coral community diversity and cover. Coral cover on the reef flat was reduced from an original 50 to 70% cover to 2% cover. No branching corals remained on the reef flat following the typhoon (Marine Research Consultants 1999). The recent benthic habitat mapping of the CNMI by NCCOS/NOAA (2005) reflects the change in reef flat composition. Since NCCOS/NOAA (2005) show relatively abundant coral cover on the reef front, the fore reef has possibly retained some of its pre-December 1997 characteristics. The impacts of corallivorous predators on corals have most likely altered the coral composition and cover on the fore reef (Quinn and Kojis 2003).

3.7.2.4 Coral Communities and Reefs of Farallon de Medinilla

In contrast with the other southern Mariana Islands, FDM does not include fringing or fore reefs (Figures 3-9a, 3-9b, and 3-9c). Rather, it has a relatively wide insular shelf (400 to 1,800 m wide) that supports limited coral cover along all sides except the western side of the island (NCCOS/NOAA 2005; DoN 2005). In 2004, 81 species of corals were observed on reefs at FDM (DoN 2005). Overall, the northwestern nearshore area (eroded submerged cliff face and reef terrace) of the island supports the highest diversity of marine invertebrates and fishes on FDM (DoN 2005). Most of the coastline of FDM is bordered by steep karstic cliffs which for the most part extend 6 to 9 m below the waterline (DoN 2005, 2006). Cliffs on the western shoreline extend more than 20 m below the waterline. There are numerous underwater caves along the FDM shoreline. Boulders dislodged from the cliffs border the base of the cliffs. Seaward of the cliff face is a reef terrace that is 30 to 50 m wide and 10 to 25 m deep beyond which is a sandy slope zone. On parts of the western side of the island, a vertical wall undercut by caves and ledges delimits the seaward edge of the reef terrace and intersects with the sandy slope habitat. At the southern end of the island, a narrow rocky spur reef extends several hundred meters southward. The shallowest portions of the spur are less than 3 m deep; the sides of the spur are steep, 45 to 90 degrees and extend deeper than 30 m. Between depths of about 7 and 25 m, stony coral cover exceeds 50% in some areas, comprised primarily of pocilloporids. The densest fish populations on the island are found along this spur and at the north west end of FDM.

Near the cliff edge on the reef terrace of the eastern side of FDM, there is estimated to be less than 5% coral cover (DoN 2005). Further offshore, there is estimated to be 10 to 20% coral cover composed of encrusting *Porites* and head coral forming *Pocillopora*. Coral cover on the boulders is estimated to be 25 to 30% and comprised of *Pocillopora*, *Porites*, *Montipora*, and *Millepora*. Coral cover on the ridges of the spur-and-groove system off the island isthmus on the windward side ranges are estimated to be from 15 to 25%, and is composed of *Porites* and *Pocillopora*. Sea urchin populations have fluctuated dramatically during the survey years. All species of urchins were sparse during the 2005, 2006 and 2007 surveys. In 2008, urchin levels were high and probably comparable to those noted in 2004. Stony coral cover is greatest below 7 m on the tops of boulders/cliff blocks, on submerged cliff faces and on the plateau off the isthmus. Based upon percent sea floor cover and frequency of occurrence *Pocillopora meandrina* and *Pocillopora eydouxi* are the dominant corals at FDM, followed by head forming species of *Porites*.

Since 1971, FDM has been a target site for live-fire military exercises (ship-to-shore gunfire, aerial gunnery and bombing) (DoN 2005). FDM is divided into four areas: Areas 2 and 4 are designated "no fire /no drop." While some ordnance items and ordnance fragments have been observed underwater, offshore all four areas, the vast majority have been sighted off Area 1 and the southern half of Area 3 (Appendix A, Figure A-3).

Yearly assessments of the near shore marine and fisheries resources at FDM have been conducted since 1999. The surveys conducted through 2004 were performed by a Navy contract biologist, with assistance from a NOAA, USFWS, and CNMI representative. Support was also provided by Navy EOD personnel. The 2005, 2006, 2007, and 2008 surveys were performed by Navy marine ecologists, with support from Navy EOD personnel. Based upon the observations made between 1999 and 2008, fish stocks around FDM are robust and healthy. In fact, based upon subjective estimates of size, total numbers and health, the fish stocks around FDM are probably among the best in the entire archipelago (DoN 2009). Sea turtle sightings have remained relatively stable between 1999 and 2008; both green sea turtles and hawksbill turtles have been regularly sighted. With the exception of the 2004 survey, there has never been any evidence that the range activities have had an adverse impact to the coral community, or other near shore marine natural resources. During the 2004 survey, it was noted that many of the corals with branching or plating type growth forms sustained significant breakage. Some members of the 2004 survey team suggested this could be the result of bombing/training activities. However, based upon observations at other locations, bombing levels in previous and subsequent years, plus observations made during the 2005, 2006, 2007, and 2008 surveys, it is clear that the damage observed in 2004 was a result of a direct hit on FDM by Typhoon Ting Ting shortly before the 2004 survey was conducted (DoN 2006). In conclusion, the near shore marine natural resources at FDM are thriving; the island in fact, is serving as a de-facto preserve due to the restricted fishing access (DoN 2009; also see Riegl et al. 2008 for comparable results at Vieques, Puerto Rico).

3.7.3 SOFTBOTTOM HABITATS

Softbottom habitats are those habitats in which the benthos is covered with a layer of fine sediment (Nybakken 1997). Commonly identified habitats are beaches, sand flats, and mudflats (Figures 3-7 through 3-9). Sand flats differ from sand beaches in that beaches are intertidal pile-ups along coasts, while sandflats can be found anywhere away from the coasts. Softbottom habitats can occur on a sloped seafloor and not only on a flat, horizontal surface (DoN 2005b).

The topography of a mud flat is flatter than that of a sand flat, as mudflats require less wave energy to form (Nybakken 1997). Mud flats are also more stable than their sand counterparts, and are more conducive to the establishment of permanent infaunal burrowing communities (Nybakken 1997). The Puerto Rico Mudflats of Saipan (15°13'N, 145°43'E) and mudflats in and around the Apra Harbor mangrove system are substantial (Scott 1993; Stinson et al. 1997; DoN 2005b) and are important feeding grounds for migratory shorebirds (Scott 1993, Figures 3-7 through 3-9).

Softbottom substrates in coastal regions of the MIRC study area are not common. This is due to the fact that the intertidal and subtidal regions are often characterized by limestone pavement interspersed with coral colonies and submerged boulders (Kolinski et al. 2001). Shorelines are often rocky with interspersed sand beaches or mud flats (Eldredge 1983; PBEC 1985).

On the island of Guam, the majority of the coastline is comprised of rocky intertidal regions. Interspersed among this rocky shoreline are 58 beaches composed of calcareous or volcanic sands (Eldredge 1983). On Rota, the rare beaches are found scattered among limestone patches and are composed of rubble and sand (Eldredge 1983). The submarine topography surrounding Tinian and Aguijan can be described as limestone pavement with interspersed coral colonies and submarine boulders (Kolinski et al. 2001). While the island of Aguijan contains no beaches (Kolinski et al. 2001), the island of Tinian contains 13 beaches (10 located on the west coast and 3 on the east coast). These beaches are not well developed (except Tinian Harbor on the southwest coast, and Unai Dankulu along the east coast, Figure 3-7c) and are comprised mainly of medium to course grain calcareous sands, gravel, and coral rubble ("coral-algal-mollusk rubble") (Eldredge 1983; Kolinski et al. 2001). The west coast of Saipan contains well developed fine-sand beaches protected by the Saigon and Tanapag Lagoons (Scott 1993). All other beaches of Saipan consist of coral-algal-mollusk rubble. The coastal area of FDM contains two small intertidal beaches that are inundated by high tide on the northeastern and western coastlines. Offshore of FDM, at approximately 20 m, a softbottom, sandy slope extends downward onto the abyssal plain (DoN 2003a). Most of the other islands in the Marianas also have sandy slopes below the fore reef, typically starting at 30 to 40 m, with some variation (DoN 2005b).

3.7.4 ESTUARINE HABITATS

Estuaries are bodies of water along coasts and are formed where there is an interaction between freshwater, saltwater, land, and the atmosphere (Day et al. 1989). Estuaries are among the most productive natural systems on earth, producing more food per acre than the richest farmland (RAE/ERF 1999). A minority of fish and shellfish species depend on estuaries, although these are often very abundant and economically important species. Estuaries provide a vital buffer between land and open water, filtering pollution and protecting surrounding lands from flooding (RAE/ERF 1999). The dominant feature of the estuarine environment is the fluctuating salinity. By definition, a salinity gradient (from fresh to saline) exists at some time in an estuary (Nybakken 1997).

There are many types of estuaries in the world. The most common type is the coastal plain estuary which is formed when rising sea levels invade low-lying coastal river valleys. Examples of coastal plain estuaries are the Chesapeake Bay and the mouths of the Hudson and Delaware Rivers on the east coast of the U.S. (Nybakken 1997). Tectonic estuaries are formed when land subsides, allowing water to flood coastal regions. One example of a tectonic estuary is San Francisco Bay (Nybakken 1997). Fjords, a third type of estuary, are formed when a valley that has been deepened by a glacier is submerged by oceanic waters. Fjords are characterized by a shallow sill that restricts water exchange with the ocean and the deeper waters of the fjord. Finally, the lagoon is an estuarine habitat formed along a coastline behind a sandbar or reef. Within the MIRC study area, estuarine habitats are found in lagoons, embayments, and river mouths.

Steep slopes and complex shorelines of the Mariana Islands (Guam to FDM) form relatively sheltered coastal bays characterized by silty sediments and turbid waters. Often, these bays are associated with riverine freshwater discharge (Myers 1999). Bordering estuaries and coastal embayments throughout the world are unique plant associations. In temperate and subpolar regions, this association is found in the form of a salt marsh. A salt marsh develops wherever sediment has accumulated to form a transition area between aquatic and terrestrial ecosystems (Nybakken 1997). They are composed of beds of intertidal rooted vegetation which are alternately inundated and drained by the tides (Day et al. 1989). While salt marshes can occasionally form in tropical regions along salt flats, they are not known to occur in the MIRC study area (Day et al. 1999). Rather, mangroves, the tropical equivalent of salt marshes, occur within the MIRC study area. Mangroves often line the shores of coastal embayments and the banks of rivers to the upper tidal limits in tropical environments, especially where the slope is gentle (Myers 1999). Mangroves possess large roots that spread laterally and consolidate sediments, eventually transforming local mudflats into dry land (Myers 1999). The extensive root system and nutrient rich waters found in mangroves make them among the richest of nursery grounds for marine life (Scott 1993, Myers 1999).

On Guam, estuarine habitats occur in areas of tidal intrusion or brackish water, and consist primarily of mangroves and the lower channels of rivers that are inundated by tides ranging from 75 to 90 cm in amplitude (Scott 1993). Nine of the Guam's 46 rivers that empty into the ocean have true estuarine habitats with elevated salinity levels extending upstream (Scott 1993). While estuarine habitats in the CNMI are not as widely studied, there are a number of bays and lagoons that probably function as estuarine habitats. Further discussion of the estuarine environments located within the MIRC study area including sand flats, mud flats, lagoons, and mangroves can be found within this section.

3.7.5 LAGOONS

A lagoon can be described as a semi-enclosed bay found between the shoreline and the landward edge of a fringing reef or barrier reef (NCCOS/NOAA 2005). By geomorphological definition, true lagoons lie only behind barrier reefs, while moats (a shallow analogue of lagoons) can lie behind fringing reefs (DoN 2005b). A lagoon is formed when a sandbar (or barrier reef) is built up parallel to the coastline and cuts off the inland waters to the sea, creating a shallow region of water. A lagoon typically contains three distinct zones: freshwater zone, transitional zone, and saltwater zone (Thurman 1997). Yet, most tropical reef-associated lagoons are not brackish and lack significant freshwater influence (DoN 2005b).

The MIRC study area contains numerous relatively shallow lagoons (depth ranging from 1 to 15 m) and one deep lagoon, Apra Harbor (PBEC 1985; Paulay et al. 1997; NCCOS/NOAA 2005, Figures 3-7 through 3-9). The bottoms of the lagoons are mostly sandy and flat or undulatory. Coral rubble, coral mounds (patch reefs), seagrass, and algae are found within the lagoons. Coral mounds tend to be more abundant in the outer lagoons and are widely scattered or absent in the inner lagoons (PBEC 1985; NCCOS/NOAA 2005).

Apra Harbor, the only deep lagoon on Guam and the busiest port in the Mariana Islands, is enclosed by the Glass Breakwater (Figure 3-7a). The Inner Apra Harbor is a lagoon created by dredging in the 1940s. Cocos Lagoon, a shallow lagoon (12 m water depth) located on the southern tip of the island is also encompassed by a series of barrier reefs (Paulay et al. 2002).

Sasa Bay, also located on Guam, is a shallow coastal lagoon populated with patchy corals (Scott 1993). Embayments along the entire western coastline except for the small regions spanning from Oca Point to Ypao Point and from Orote Point to Apuntua Point have developed behind fringing reefs and may possess physical characteristics similar to a lagoon (USGS 1978; Paulay et al. 2002; Figure 3-7a). A similar situation occurs on the eastern coastline with fringing reefs occurring along the eastern coastline from Fadian Point to Cocos Lagoon (USGS 1978; Figure 3-7a).

The western coastline of Saipan is lined with sandy beaches protected by a barrier reef which forms Tanapag and Saipan Lagoons (Scott 1993). Tanapag Lagoon is a typical high-island barrier reef lagoon. Tanapag Lagoon is located on the northwestern coast of Saipan. Also, on the western coastline of Saipan, the barrier reefs form two additional lagoons, creating the largest lagoonal system in the Mariana Islands, Garapan Lagoon and Chalan Kanoa Lagoon (Chandron 1988, Duenas and Associates 1997, Trianni and Kessler 2002). The maximum width of Saipan Lagoon is 100 m, and the maximum depth is 14 m in the Tanapag Harbor channel, although average depth is only 3 m (PBEC 1985; Trianni and Kessler 2002).

The islands of Tinian and Rota lack complex lagoon systems. The island of Tinian is surrounded by reefs, but lacks a true lagoon complex. The lagoons of Tinian, save two (off of the Leprosarium at the southwestern edge of the leaseback area (LBA; see Figure 3-8a), and the northern region of the Tinian Harbor area), are all adjacent to military leases (USGS 1980; NCCOS/NOAA 2005).

Saipan has five small lagoons located on the western side of the island and two lagoons along the eastern coastline (USGS 1980; PBEC 1985; NCCOS/NOAA 2005). On the island of Rota, a small "semilagoon" is located along the entire western coast, and the only true lagoon on Rota can be found at the extreme southern tip of the island (PBEC 1985; NCCOS/NOAA 2005).

3.7.6 SEAGRASS BEDS

Seagrasses are vascular (flowering) plants adapted to living in a saline environment and grow completely submerged (Phillips and Menez 1988). Seagrasses are unique as they are land plants that spend their entire life cycle underwater. Seagrasses grow in muddy or sandy substrates and can develop into extensive undersea meadows (Phillips and Menez 1988). Seagrass beds are among the most highly productive ecosystems in the world and are an important ecosystem of shallow-water tropical regions (Nybakken 1997). Beds are often used as protective habitats or nursery grounds for many organisms that live in/on sandy or muddy bottoms, in the surrounding waters, or on the plants themselves (Phillips and Menez 1988, Daniel and Minton 2004). While seagrasses are consumed by only a few species (including dugongs, sea turtles, mollusks, and some urchins), many organisms feed on the epiphytic algae growing on the plant structure (Nybakken 1997).

Seagrass beds are widely distributed within the study area. Both Guam and Saipan have extensive seagrass meadows surrounding the coastlines (NCCOS/NOAA 2005; Figure 3-14), including extensive beds in Agat Bay (including the Agat Unit of the War in the Pacific National Historical Park; Daniel and Minton 2004), south of Apra Harbor, and Cocos Lagoon on Guam (Eldredge et al. 1977, Daniel and Minton 2004). Rota is known to posses a small seagrass bed off its southern shore (Abraham et al. 2004). Tinian possesses seagrass beds along the northwestern, the northeastern, the southwestern and the eastern coastlines (DoN 2003a). Seagrasses are more scattered on the island of Saipan, with seagrass beds reported along Tanapag Beach (along the northwest coast) and in the Puerto Rico Mudflats (northwest shoreline, south of Tanapag Beach) (Tsuda et al. 1977, Scott 1993). Seagrasses have vanished off the southern coast of Saipan (Abraham et al. 2004). There is no record of seagrass beds occurring on the islands north of Saipan (Tsuda 2003).

Currently, three species of seagrasses (*Enhalus acoroides*, *Halodule uninervis*, and *Halophila minor*) are known to occur in the Mariana Islands (Tsuda et al. 1977). *Enhalus acoroides*, also referred to as tape grass, possesses long leaves (30 to 150 cm long and 1 to 2 cm wide), white flowers, forms clumps, and grows best on sheltered coastlines in sandy or muddy substrate in a range from the mean low water to 4 m deep (Phillips and Menez 1988; Daniel and Minton 2004). *Halodule uninervis* possesses leaves ranging from 6 to 15 cm long (0.25 to 3.5 mm wide), grows from the intertidal zone to 30 m deep on firm sand and soft mud, and can survive in a range of environments including highly sheltered bays and along coral reefs. *Halophila minor* has small wide leaf blades (0.7 to 1.4 cm long, 3 to 5 mm wide) and is found in sheltered areas on muddy or sandy substrate in the upper subtidal zone (Phillips and Menez 1988).

3.7.7 MANGROVES

Mangroves are a type of wetland that borders estuaries or shores protected from the open ocean (Scott 1993). They are composed of salt-tolerant trees and other plant species and they provide critical habitat for both marine and terrestrial life. Species diversity is usually high in mangroves, and like seagrasses, can act as a filter to remove sediments before they can be transported onto an adjacent coral reef (Scott 1993; Nybakken 1997; Thurman 1997).

Mangrove forests are native to the MIRC study area, however, are only present on the islands of Guam and Saipan (Figure 3-14), with the mangroves of Guam being the most extensive and diverse, totaling approximately 70 ha (Scott 1993). There are 50.7 ha of mangrove forests on ten sites within the Navy lands on Guam (DoN 1999b, Figure 3-14). The largest of these mangrove sites (35.9 ha) is site R, located along the eastern shoreline of the Apra Inner Harbor (DoN 1999b). This site mainly consists of *Rhizophora mucronata*. Four sites near Abo Cove atthe southern tip of the Inner Apra Harbor (Sites H, O, P, and Q) amount to 12.4 ha of mangrove forests (Figure 3-14). Site H contains *R. mucronata* and *Avicennia alba*. Sites O, P and Q contain *R. mucronata*. There are two mangrove sites near Dry Dock Island (Sites V and W) and two more sites near Polaris Point (Sites S and T) (Figure 3-14). Mangrove site S (0.6 ha) consists of *Rhizophora* sp., and site T (0.4 ha) of *Rhizophora* sp. and *A. marina*. Mangroves species found at site V (1.2 ha) are *A. marina*, *Rhizophora* sp., and *Bruguiera gymnorrhiza*. Site W is populated by *A. marina*, *Xylocarpus moluccensis*, and *B. gymnorrhiza* (DoN 1999b). Along the southern shore of the Apra Harbor, there is a mangrove area at site D which consists of *R. mucronata* and *A. alba* and covers a 0.7 ha area (DoN 1999b). Achang Bay Mangroves is centered on Achang Bay at the southern end of Guam. This area is the only sizable area of mangrove forest in southern Guam (*R. mucronata*, *B. gymnorrhiza*, *A. marina*, *R. apiculata*) (Wilder 1976). The forest is owned by the government of Guam and is a 20 to 60 m wide strip lining the shore.

Mangroves in the CNMI are restricted to Saipan. These mangroves are comprised of a single species (*Bruguiera gymnorrhiza*) and can only be found in a few small stands (Scott 1993) in two locations: Puerto Rico Mudflats and American Memorial Park. Puerto Rico Mudflats (15°13'N, 145°43'E) is a series of mudflats bounded by a national park (American Memorial Park; NPS 2004) and a landfill. Within these mudflats is a broken fringe of mangrove trees. The largest stands of mangroves are found north of the landfill.

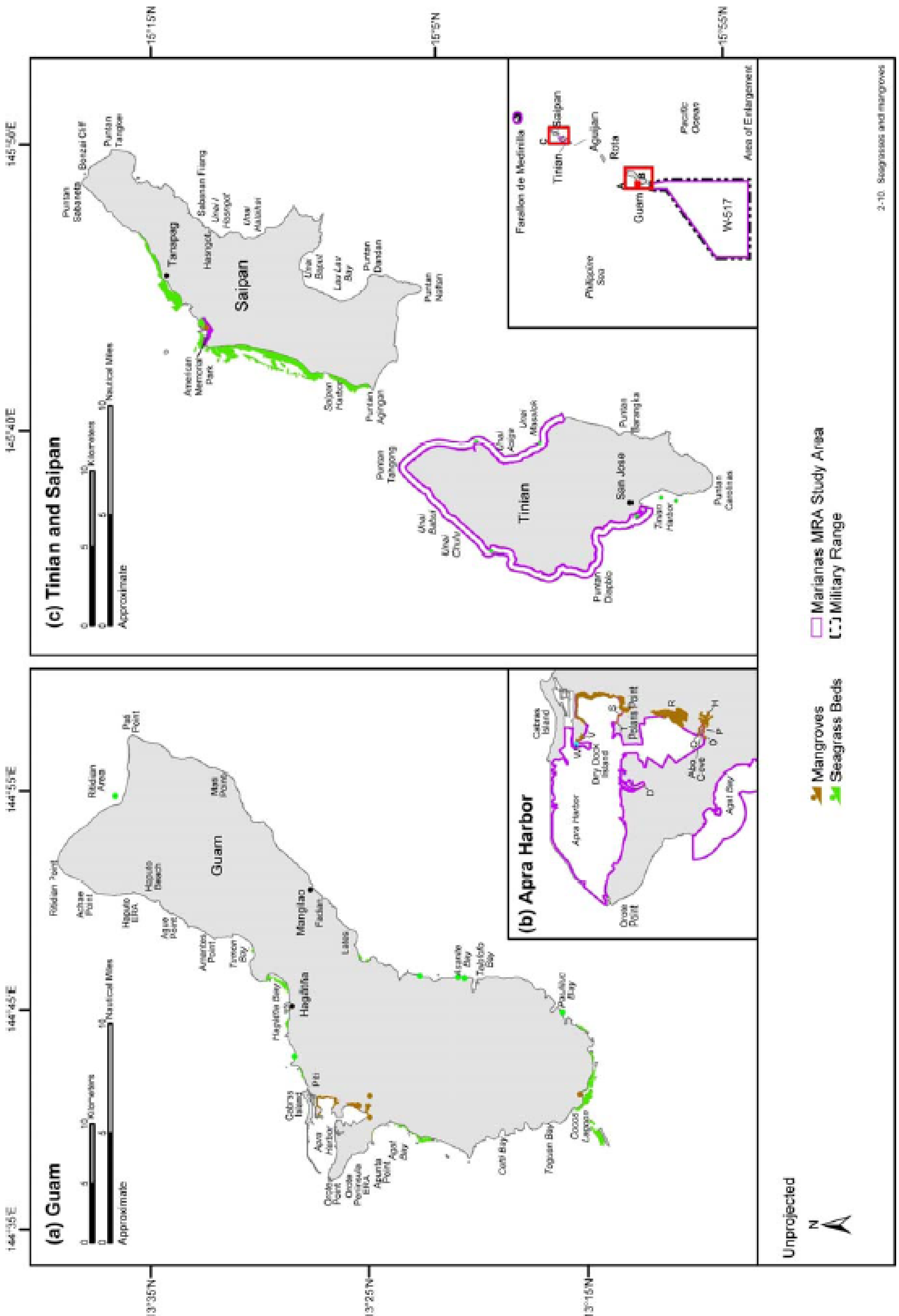


Figure 3-14. Distribution of seagrass and mangrove communities in the MIRC study area (a) Guam, (b) Apra Harbor, (c) Tinian and Saipan. Source data: Jones et al. (1974), Scott (1993), DoN (1999, 2003), and NCCOS/NOAA (2005).

3.7.8 ARTIFICIAL HABITATS

Artificial habitats (shipwrecks, artificial reefs, jetties, pontoons, docks, and other man-made structures) are physical alterations to the naturally-occurring marine environment. In addition to artificial structures intentionally or accidentally placed on the seafloor, Fish Aggregating Devices (FADs) are suspended in the water column and anchored on the seafloor to attract fish. FADs have come to be referred to as any floating object physically placed in the water column solely intended to attract fish (Klima and Wickham 1971, Bohnsack et al. 1991, Blue Water 2002). Artificial structures provide a substrate upon which a marine community can develop (Fager 1971). Navigational, meteorological, and oceanographic buoys suspended in the water column potentially function like artificial habitats. Epibenthic organisms will settle on artificial substrates (including algae, sponges, corals, barnacles, anemones, and hydroids) to eventually provide a biotope suitable for large motile invertebrates (e.g., starfish, lobster, crabs) and demersal and pelagic fishes (Fager 1971, Bohnsack et al. 1991).

3.7.8.1 Artificial Reefs

An artificial reef consists of one or more submerged structures of natural or man-made origin that are purposefully deployed on the seabed to influence the physical, biological, or socioeconomic processes related to living marine resources (Baine 2001). Artificial reefs are defined both physically, by the design and arrangement of materials used in construction, and functionally according to their purpose (Seaman and Jensen 2000). A large number of items are used for the creation of artificial reefs including natural objects, such as wood (weighted tree trunks) and shells; quarry rock; or man-made objects, like vehicles (automobile bodies, railroad cars, and military tanks), aircraft, steel-hulled vessels (Liberty ships, landing ship tanks, barges, and tug boats), home appliances, discarded construction materials (concrete culverts), scrap vehicle tires, oil/gas platforms, ash byproducts (solid municipal incineration, and coal/oil combustion), and prefabricated concrete structures (reef balls) (Artificial Reef Subcommittee 1997). The purpose of deploying artificial reefs in the marine environment is to: (1) enhance commercial fishery production/harvest; (2) enhance recreational activities (fishing, SCUBA diving, and tourism); (3) restore/enhance water and habitat quality; (4) provide habitat protection and aquaculture production sites; and (5) control fish mortality (Seaman and Jensen 2000).

Dedicated artificial reefs are currently found in two locations within the MIRC study area: Agat Bay, Guam and Apra Harbor, Guam (Figure 3-15). In 1969, 357 tires were tied together and scattered over a 465 m^2 area in Cocos Lagoon (Eldredge 1979). In the early 1970s, a second reef consisting of 2,500 tires was also placed in Cocos lagoon (Eldredge 1979). These tire reefs disintegrated and no longer serve as artificial reefs (DoN 2005b). In 1977, a 16 m barge was modified to enhance fish habitat and was sunk in 18 m of water in Agat Bay. Fish abundance has increased with time, and herbivorous and carnivorous communities have thrived (Eldredge 1979). In Apra Harbor, the “American Tanker,” a 90+ m long concrete barge, was sunk in 1944 at the entrance of the Apra Harbor to act as a breakwater (Micronesian Divers Association, Inc. 2005). In 1944, the 76th Naval Construction Battalion (SEABEES) built the Glass Breakwater which forms the north and northwest sides of Apra Harbor (Thompson 2005). The enormous seawall is made of 1.5 million m^3 of soil and coral extracted from Cabras Island (Thompson 2005). The Glass Breakwater is the largest artificial substrate in the Marianas.

To date, no additional artificial reefs have been established in the MIRC study area. The passage of tropical cyclones and typhoons have probably damaged and/or displaced the reefs placed in Cocos Lagoon (DoN 2005b). The installation of artificial reefs around Guam is currently prohibited (DoN 2005b).

3.7.8.2 Shipwrecks

Many shipwrecks are found within the MIRC study area including grounded vessels and military wreckage (Figure 3-15). Vessels have probably wrecked upon the shores of the Mariana Islands since Spanish galleons sailed to these islands during the seventeenth century. There is abundant WWII-era wreckage (including sunken ships, airplanes, and tanks) along the shores of the Marianas that resulted from the battles of Guam, Tinian, and Saipan (Commonwealth of the Northern Mariana Islands Coastal Resources Management 2001). Many of the shipwrecks along the shorelines of the MIRC study area have become popular dive sites. The groundings of ships can also create numerous hazards for navigation or the environment including the formation of large scars through seagrass beds or coral reefs, blockage of entry into ports or harbors, and the release of engine oil and fuel into the surrounding waters (NOAA 2004b).

As of October 2003, Lord et al. (2003) documented 117 abandoned vessels along the coast of Guam. Most of the vessels (80) were found in water depths greater than 12 m; the other vessels were abandoned in water depths shallower than 12 m. There are seven general locations where vessels were documented in shallow water (12 m or less) along the coast of Guam: Piti Channel (two longliners, six sailing vessels, three landing crafts, one tug, and one barge), Outer Piti Channel (three barges, one freighter, one landing craft), Outer Apra Harbor (four barges), Inner harbor of Piti Channel (one sailboat), Sasa Bay (one sailboat), Hagatna Boat Basin (six sailing vessels), and Cocos Lagoon (1 sailboat) (Lord et al. 2003). Shipwrecks of interest along Guam include the Cormoran, a German gunboat scuttled in Apra Harbor during World War I (WWI) to prevent it from falling into enemy hands (Rock 1999; Hanauer 2001). Lying next to the Cormoran in Apra Harbor is the Tokai Maru, a 134 m long Japanese freighter sunk by a Navy submarine during WWII. Also located in Apra Harbor are a tanker and a "junkyard" comprised of bulldozers, pieces of the oceanliner Cariba, and other scrap (Rock 1999, Hanauer 2001). Located off of Cocos Island at the southern tip of Guam is the wreck site of a seventeenth century Spanish galleon (Hanauer 2001).

A total of 55 abandoned vessels are known along the coasts of Saipan, Rota, and Tinian (Lord et al. 2003). Ten of the vessels are found in water depths greater than 12 m. At Saipan, Lord et al. (2003) documented nearshore abandoned vessels in the general area off Tanapag (two longliners, 27 barges, one cabin cruiser, one cargo vessel, one trawler, one freighter). Lord et al. (2003) found four abandoned vessels in the Tinian Harbor: two freighters, one fishing boat, and one yacht. At Rota Island, there were five abandoned vessels along the western coast (one fishing vessel, three U.S. military M-boats, and one tugboat) (Lord et al. 2003). Forty-five percent of the abandoned vessels encountered in shallow water (less than 12 m water depth) were potential navigation threats (Lord et al. 2003). Fourteen of the abandoned vessels documented in the Piti Channel and the Hagatna Boat Basin were potential navigation hazards, particularly those located in the center of the Piti Channel. Potential threats to navigation in the CNMI are for the most part WWII era barges located in sheltered and nearshore areas (Lord et al. 2003). A Japanese military freighter (possibly the Shoan Maru) is partially awash southeast of Mañagha Island, Saipan (15.24N; 145.72E) and is a threat to navigation. The steel freighter, Sin Long No. 8, located in Tinian is partially exposed and is a threat to navigation.

Coral growth, on the steel hulled vessels, causeways and other metallic items sunk in Apra Harbor and at other locations within the Mariana Archipelago, is highly variable. Some wrecks support diverse and robust coral growth, while other wrecks at the same depth and in close proximity support only meager coral growth. The reason for these differences is not known, but may be related to the type of steel and presence/absence of anti-fouling/anti-corrosion coatings on the steel (Smith, S.H. personal communication).

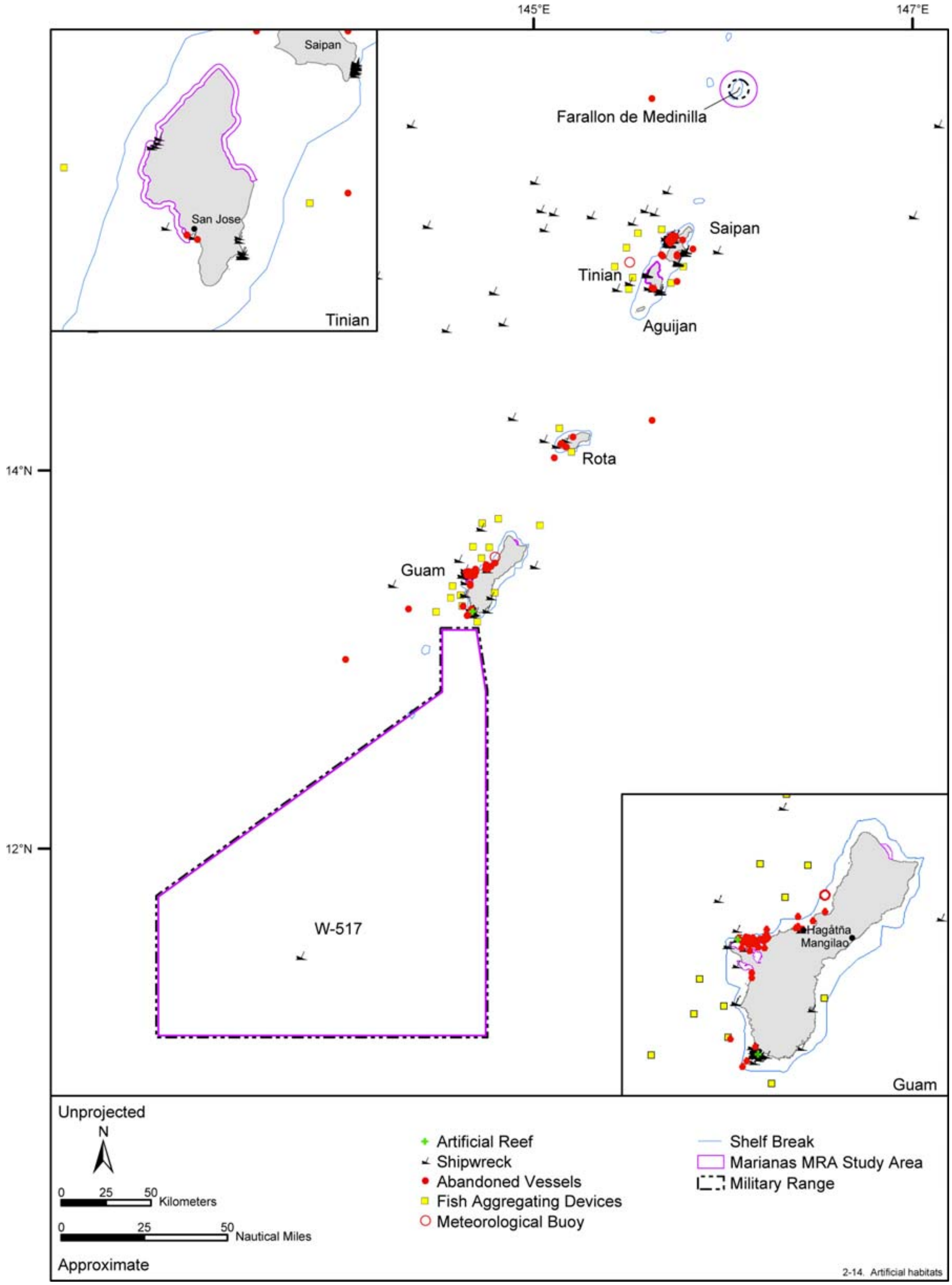


Figure 3-15. Distribution of artificial reefs, shipwrecks, and fish aggregating devices in the MIRC study area. Source data: Eldredge (1979), Veridian Corporation (2001), NOAA (2004c), DAWR (2004), and CNMI DFW (2005).

The majority of current small boat groundings are the result of operator error. However, most major groundings of larger ships (greater than 15 m in length) are typhoon related (Commonwealth of the Northern Mariana Islands Coastal Resources Management 2001).

3.7.8.3 Fish Aggregating Devices

FADs consist of single or multiple floating devices (Samples and Hollyer 1989) connected to the ocean floor by ballast or anchors. Usually prefabricated, FADs are designed to attract fish species to them (Klima and Wickham 1971). Even though a naturally floating log attracts fish, it is not considered a FAD because humans did not intentionally place it in the ocean (Blue Water 2002). Two fundamentally different types of FADs have been employed since the 1970s: large floating FADs and small mid-water FADs. Large FADs have been deployed in water depths exceeding 1,800 m for ocean pelagic commercial and recreational fisheries. Small FADs have been used in more nearshore and coastal environments for recreational fisheries in water depths ranging from 15 to 30 m (Rountree 1990).

The first FADs deployed within the MIRC study area were constructed by connecting three 55-gallon drums together (Chapman 2004). Four of these FADs were deployed between 1979 and 1980. All were lost within five months of deployment. The Northern Marianas Islands first deployed five FADs in conjunction with the Pacific Tuna Development Foundation in 1980. Four of the five were lost within the first six months (Chapman 2004). Currently, Guam maintains 16 FADs within 20 nm of the shoreline (Chapman 2004; DAWR 2004; Figure 3-15). Lost FADs are replaced within two weeks (Chapman 2004). The Northern Marianas Islands has turned over deployment of FADs to a private contractor and currently maintains 10 FADs deployed (three remaining) between the islands of Rota and Saipan (Chapman 2004; CNMI DFW 2005).

<u>Buoys</u> - A buoy is a floating platform used for navigational purposes or supporting scientific instruments that measure environmental conditions. Currently two meteorological buoys capable of measuring wave energy, wave direction, and sea surface temperature are active and located in the MIRC study area (Figure 3- 15). One of these buoys supports oceanographic instruments and is owned by the Scripps Institution of Oceanography (La Jolla, California), and is located off of Guam at 13°21'15" N, 144°47'20" E in 200 m of water depth (CDIP 2005; NDBC 2005; StormSurf 2005). The other buoy is located off the coast of Saipan (15°06'N, 145°30'E) and serves a meteorological purpose (StormSurf 2005; Figure 3-15). CRED (Coral Reef Ecosystem Division – NOAA Pacific Islands Fisheries Science Center) has deployed and currently maintains subsurface instrument arrays on all of the islands in the MIRC study area, and has surface buoys on Rota, Saipan, Pagan, Maug (DoN 2005b).

4.0 ESSENTIAL FISH HABITAT

EFH information and citations provided below come from the *Marine Resources Assessment for the Marianas Operating Area* (DoN 2005b), with additional technical information and changes incorporated throughout this section. Life history information for manged species is provided in Appendix B.

4.1 FISH AND FISHERIES

Distribution and abundance of fishery species depends greatly on the physical and biological factors associated with the ecosystem, as well as the individual species. Physical parameters include habitat quality variables such as salinity, temperature, dissolved oxygen, and large-scale environmental perturbations (e.g., ENSO). Biological factors affecting distribution are complex and include variables such as population dynamics, predator/prey oscillations, seasonal movements, reproductive/life cycles, and recruitment success (Helfman et al. 1999). Rarely is one factor responsible for the distribution of fishery species, but is a combination of factors. For example, pelagic species optimize their growth, reproduction and survival by tracking gradients of temperature, oxygen, or salinity (Helfman et al. 1999). Additionally, the spatial distribution of food resources is variable and changes with prevailing physical habitat parameters. Another major component in understanding species distribution is the location of highly productive regions such as frontal zones. These areas concentrate higher trophic-level predators such as tuna and provide visual clues for the location of target species for commercial fisheries (NMFSPIR 2001).

Environmental variations, such as ENSO events, change the normal characteristics of water temperature, thereby changing the patterns of water flow. The NEC (westward) and the Subtropical Countercurrent (eastward) are major influences on distribution of fishes and invertebrates in the MIRC study area (Eldredge 1983). ENSO events alter normal current patterns, alter productivity, and have dramatic effects on distribution, habitat range and movement of pelagic species (NMFS 2003a).

In the northern hemisphere, El Niño events typically result in tropical, warm-water species moving north (extending species range), and cold-water species moving north or into deeper water (restricting their range). Surface-oriented, schooling fish often disperse and move into deeper waters. Fishes that remain in an affected region experience reduced growth, reproduction, and survival (NOAA 2002). El Niño events have caused fisheries such as the skipjack tuna fishery to shift over 1,000 km (NMFS-PIR 2001).

Coral reef communities surrounding the MIRC study area have a reputation for year-round uniformity and stability (Amesbury et al. 1986). While this is true for most species in the area, there are exceptions. Seasonal variations in pelagic species distributions in the area are understood. Several of the reef fish species (juvenile rabbitfish, juvenile jacks, juvenile goatfish, and bigeye scad, *Selar crumenophthalmus*) targeted in the MIRC study area show strong seasonal fluctuation, usually related to juvenile recruitment (Amesbury et al. 1986).

Fish species composition within the MIRC study area is typical of what you find in most Indo-Pacific insular, coral reef-bordered coastal areas. Seventy-three percent of the total number of species found belongs to 20 families (Myers and Donaldson 2003). The geographic location of the MIRC study area suggests a more diverse ichthyofauna than areas such as the Hawaiian Islands. Recorded species diversity in the Guam/Marianas island chain is lower than that of the Hawaiian archipelago. Actual diversity may be higher and the recorded diversity may be an artifact of insufficient sampling (Paulay 2003a). However, many other factors, such as larval recruitment and frequent natural disturbances, have dramatic impacts on species diversity (Randall 1995). Myers and Donaldson (2003) noted the occurrence of 1,019 fish species (epipelagic and demersal species found to 200 m) within the MIRC study area. Inshore species are composed primarily of widespread Indo-Pacific species (58%) with the remainder consisting of circumtropical species (3.6%) and nearly equal numbers of species with widespread distributions primarily to the west, south, and east of the islands (Myers and Donaldson 2003). Ten species of inshore and epipelagic fishes are currently considered endemic to the Marianas. However, this number is probably too high due to the observations of transient species in the area (Myers and Donaldson 2003). Additionally, Myers and Donaldson (2003) identified 1,106 species of fish known from the Mariana Islands and adjacent territorial waters. Extensive studies have been done on the biogeography of inshore and epipelagic fauna found in the Marianas from 0 to 100 m. Currently, occurrence and distribution of benthic and mesopelagic species from 100 m to greater than 200 m are incomplete and poorly understood (Myers and Donaldson 2003). Lack of adequate data has made it difficult to identify and interpret other sources of variation in the distribution and/or decline of the fisheries resources of these islands. Declining fisheries resources is a major problem facing Guam; however, CNMI has adopted some of the strictest fishing regulations in the Pacific banning gears such as SCUBA/hookah spear fishing, gill nets, drag nets, and surround nets.

According to the Guam DAWR, fish populations have declined 70% over the past 15 years. Finfish harvest dropped from 151,700 kg in 1985 to 62,689 kg in 1999 (Richmond and Davis 2002). Catch-per-unit-effort has dropped over 50% since 1985, and landings of large reef fish are rare (Richmond and Davis 2002). Seasonal harvest of juvenile rabbitfish has also declined in recent years. Currently, there is little data assessing the health of fish resources in the MIRC study area but it is believed that populations increase as you travel north due to decreased fishing pressure (Starmer et al. 2002). Regulations such as the ban of spearfishing with SCUBA and gill netting have been proposed to aid in the relief of fishing pressure in the area (Richmond and Davis 2002).

4.1.1 ESSENTIAL FISH HABITAT: MANAGEMENT JURISDICTION

The Western Pacific Regional Fishery Management Council (WPRFMC) manages major fisheries within the Exclusive Economic Zone (EEZ) around Hawaii and the territories and possessions of the U.S. in the Pacific Ocean (WPRFMC 1998, 2001). The WPRFMC (3 to 200 nm), in conjunction with the Guam Division of Aquatic and Wildlife Resources (0 to 3 nm) and the CNMI Division of Fish and Wildlife manages the fishery resources in the MIRC study area. The WPRFMC has also proposed to defer fisheries management from 0 to 3 nm to the CNMI DFW (WPRFMC 2001). The WPRFMC focuses on the major fisheries in the MIRC study area that require regional management. The WPRFMC currently oversees five major Fishery Management Plans (FMPs) and their associated amendments for bottomfish, pelagics, crustaceans, precious corals, and coral reef ecosystems.

The MSFCMA, as amended by the Sustainable Fisheries Act (SFA), contains provisions for the identification and protection of habitat essential to production of federally managed species. The act requires NOAA Fisheries to assist regional fishery management councils in including EFH in their respective FMP.

EFH provisions impose procedural requirements on both councils and federal agencies. Councils must identify adverse impacts on EFH resulting from both fish and non-fishing activities, and describe measures to minimize or mitigate these impacts. Councils can also provide comments and make recommendations to federal or state agencies that propose actions that may affect habitat, including EFH, of a managed species. Agencies must then decide how they intend to minimize or mitigate the identified adverse impacts. Fishing activities that may adversely impact EFH include but are not limited to the following: anchor damage from vessels attempting to maintain position over productive fishing habitat, heavy weights and line entanglement occurring during normal hook-and-line fishing operations, lost gear from lobster fishing operations, and remotely operated vehicle tether damage to precious coral during harvesting operations. Seven non-fishing activities have been identified that directly or indirectly affect habitat used by management unit species and are as follows: invasive infaunal and bottom-dwelling organisms, turbidity plumes, biological availability of toxic substances, damage to sensitive habitat, current patterns/water circulation modification, loss of habitat function, contaminant runoff, sediment runoff, and shoreline stabilization projects (WPRFMC 2001).

The FMPs developed for federally managed species under the jurisdiction of these fishery management councils should include identification and description of the EFH, description of non-fishing and fishing threats, and suggested measures to conserve and enhance the EFH. Each of these councils may also identify the EFH-HAPC where one or more of the following criteria are demonstrated: (a) ecological function, (b) sensitivity to human-induced environmental degradation, (c) development activities stressing habitat type, or (d) rarity of habitat. In addition to the EFH status, some of these species are assigned status categories in conjunction with the ESA and various federal or international agencies. These status categories will be discussed in the “status” section of the EFH descriptions.

EFH species, as designated by the WPRFMC (2004a), are listed in Table 4-1 and discussed in Appendix B. These species have been divided into management units according to their ecological relationships and preferred habitats. Management units include bottomfish management unit species (BMUS), pelagic management unit species (PMUS), crustacean management unit species (CMUS), and coral reef ecosystem management unit species (CRE MUS). For each management unit, the status, distribution (including range), habitat preference (depth, bottom substrate), life history (migration, spawning), and EFH/HAPC designations are provided in the following sections with figures provided in Appendix B.

4.2 MANAGEMENT UNITS

4.2.1 BOTTOMFISH MANAGEMENT UNIT SPECIES

Status - Seventeen species are currently managed as BMUS by the WPRFMC through the Bottomfish and Seamount Groundfish Fishery Management Plan (WPRFMC 1986a) and subsequent amendments (Table 4-2; WPRFMC 1998, 2004a). In the Northern Marianas, Guam, and American Samoa, the BMUS are divided into a shallow-water complex and a deep-water complex based on depth and species composition. Under Draft Amendment 8, 30 bottomfish species from both the shallow-water and deepwater complexes have been proposed by WPRFMC for incorporation into the existing BMUS (NMFS 2003b). All 17 species have viable recreational, subsistence, and commercial fisheries (WPRFMC 2004b) with none of the BMUS approaching an overfished condition (NMFS 2004a). The BMUS found in the MIRC study area are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The shallow-water (0 to 100 m) and the deep-water (100 to 400 m) complexes are distributed throughout the tropical and subtropical waters of the insular and coral reef-bordered coastal areas of Pacific islands (Myers and Donaldson 2003).

Habitat Preferences - Bottomfish comprising the shallow-water and deep-water complexes concentrate around the 183 m contour (index of bottomfish habitat) that surrounds Guam and the Northern Marianas Islands (WPRFMC 1998). Juvenile and adult bottomfish are usually found in habitats characterized by a mosaic of sandy bottoms and rocky areas of high structural complexity (WPRFMC 1998). Habitats encompassing the shallow-water complex consist of shelf and slope areas (Spalding et al. 2001). The shelf area includes various habitats such as mangrove swamps, seagrass beds, shallow lagoons, hard, flat coarse sandy bottoms, coral and rocky substrate, sandy inshore reef flats, and deep channels. Seaward reefs, outer deep reef slopes, banks, and deeper waters of coral reefs comprise the slope areas (Heemstra and Randall 1993, Allen 1985, Myers 1999, Amesbury and Myers 2001, Allen and Adrim 2003). The deep-water complex inhabits areas of high relief with hard rocky bottoms such as steep slopes, pinnacles, headlands, rocky outcrops, and coral reefs (Allen 1985, Parrish 1987, Haight et al. 1993).

Life History - Very little is known about the ecology (life history, habitat, feeding, and spawning) of the bottomfish species managed in the area (WPRFMC 1998). However, limited information is available for various larval, juvenile, and adult bottomfish genera of the shallow-water and deep-water complexes.

Within the shallow-water complex, snappers form large aggregations and groupers/jacks occur in pairs within large aggregations near areas of prominent relief. Spawning coincides with lunar periodicity corresponding with new/full moon events (Grimes 1987, Myers 1999, Amesbury and Myers 2001). Groupers have been shown to undergo small, localized migrations of several kilometers to spawn (Heemstra and Randall 1993). Large jacks are highly mobile, wide-ranging predators that inhabit the open waters above the reef or swim in upper levels of the open sea (Sudekum et al. 1991) and spawn at temperatures of 18° to 30°C (Miller et al. 1979).

Within the deep-water complex, snappers aggregate near areas of bottom relief as individuals or in small groups (Allen 1985). Snappers may be batch or serial spawners, spawning multiple times over the course of the spawning season (spring and summer peaking in November and December), exhibit a shorter, more well-defined spawning period (July to September), or have a protracted spawning period (June through December peaking in August) (Allen 1985, Parrish 1987, Moffitt 1993). Some snappers display a crepuscular periodicity and migrate diurnally from areas of high relief during the day at depths of 100 to 200 m to shallow (30 to 80 m), flat shelf areas at night (Moffitt and Parrish 1996). Other snapper species exhibit higher densities on up-current side islands, banks, and atolls (Moffitt 1993).

EFH Designations - (WPRFMC 1998; Figures B-1, B-2, B-3, and B-4; Table 4-2)

Eggs and Larvae - EFH for these life stages is the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m and encompasses both the shallow-water and deep-water complexes.

Juveniles and Adults - For these life stages, EFH encompasses the water column and all bottom habitat extending from the shoreline to a depth of 400 and includes the shallow-water and deepwater complexes.

HAPC Designations - (WPRFMC 1998; Figures B-1, B-2, B-3, and B-4). Based on the known distribution and habitat requirements, all life stages of the BMUS have HAPC designated in the MIRC study area that includes all slopes and escarpments between 40 and 280 m.

Table 4-1. The fish and invertebrate species with essential fish habitat (EFH) designated in the MIRC study area.

[[1]Species not listed under the Currently Harvested Coral Reef Taxa; [2]Species not managed under Bottomfish FMP or included in proposed Bottomfish Amendment 8 (35 additional species); [3]Species not listed under Currently Harvested Coral Reef Taxa, managed under Bottomfish FMP, or included in proposed Bottomfish Amendment 8; [4]Excluding hogo (*Pontinus macrocephela*) which is included in proposed Bottomfish Amendment 8 (emperors/snappers); [5]Species not managed under Crustacean FMP; *Includes all other coral reef ecosystem management unit species that are marine plants, invertebrates, and fishes that are not listed under the Currently Harvested Coral Reef Taxa or are not bottomfish management unit species, crustacean management unit species, Pacific pelagic management unit species, precious coral or seamount groundfish]

Bottomfish Management Unit Species

Shallow-water Species Complex (0-100 m):
Gray jobfish (*Aprion virescens*)
Lunartail grouper (*Variola louti*)
Blacktip grouper (*Epinephelus fasciatus*)
Ambon emperor (*Lethrinus amboinensis*)
Redgill emperor (*Lethrinus rubrioperculatus*)
Giant trevally (*Caranx ignobilis*)
Black jack (*Caranx lugubris*)
Amberjack (*Seriola dumerili)*
Blue stripe snapper (*Lutjanus kasmira*)

Deep-water Species Complex (100-400 m):

Squirrelfish snapper (*Etelis carbunculus*)
Longtail snapper (*Etelis coruscans*)
Pink snapper (*Pristipomoides filamentosus*)
Yellowtail snapper (*Pristipomoides auricilla*)
Yelloweye snapper (*Pristipomoides flavipinnis*)
Pink snapper (*Pristipomoides sieboldii*)
Yellow-barred snapper (*Pristipomoides zonatus*)
Silver jaw jobfish (*Aphareus rutilansi*)

Pelagic Management Unit Species

Marketable Species Complex:

Temperate Species
Striped marlin (*Tetrapurus audax*)
Broadbill swordfish (*Xiphias gladius*)
Northern bluefin tuna (*Thunnus thynnus)*
Albacore *(Thunnus alalunga*)
Bigeye tuna (*Thunnus obesus*)
Mackerel (*Scomber* spp.)
Pomfret (Bramidae)
  Sickle pomfret (*Taractichthys steindachneri*)
  Lustrous pomfret (*Eumegistus illustris*)

Tropical Species
Yellowfin tuna (*Thunnus albacares*)
Kawakawa (*Euthynnus affinis*)
Skipjack tuna (*Katsuwonus pelamis*)
Frigate and bullet tunas (*Auxis thazard, Auxis rochei*)
Slender tunas (*Allothunnus fallai*)
Indo-Pacific blue marlin (*Makaira nigricans*)
Black marlin (*Makaira indica*)
Shortbill spearfish (*Tetrapturus angustirostris*)
Sailfish (*Istiophorus platypterus*)
Dolphinfishes (Coryphaenidae)
  Dolphinfish (*Coryphaena hippurus*)
  Pompano dolphinfish *(Coryphaena equiselas*)
Wahoo (*Acanthocybium solandri*)
Moonfish (*Lampris guttatus)*

Non-marketable Species Complex:
Snake mackerels or oilfish (Gempylidae)
  Escolar (*Lepidocybium flavobrunneum*)
  Oilfish (*Ruvettus pretiosus*)

Shark Species Complex

Common thresher shark (*Alopias vulpinus*)
Pelagic thresher shark (*Alopias pelagicus)*
Bigeye thresher shark (*Alopias superciliousus*)
Shortfin mako shark (*Isurus oxyrinchus*)
Longfin mako shark (*Isurus paucus*)
Salmon shark (*Lamna ditropis*)
Silky shark (*Carcharhinus falciformis*)
Oceanic whitetip shark (*Carcharhinus longimanus*)
Blue shark (*Prionace glauca*)

Crustacean Management Unit Species

Spiny and Slipper Lobster Complex
Spiny lobster (*Panulirus penicillatus, Panulirus* sp.)
Chinese slipper lobster (*Parribacus antarticus*)

Coral Reef Ecosystem *

Currently Harvested Coral Reef Taxa (CHCRT):
Surgeonfishes (Acanthuridae)
  Orange-spot surgeonfish (*Acanthurus olivaceus*)
  Yellowfin surgeonfish (*Acanthurus xanthopterus*)
  Convict tang (*Acanthurus triostegus*)
  Eye-striped surgeonfish (*Acanthurus dussumieri*)
  Blue-lined surgeonfish (*Acanthurus* nigroris)
  Blue-banded surgeonfish (*Acanthurus lineatus*)
  Blackstreak surgeonfish (*Acanthurus nigricauda*)
  White-spotted surgeonfish (*Acanthurus guttatus*)
  Ringtail surgeonfish (*Acanthurus blochii*)
  Brown surgeonfish (*Acanthurus nigrofuscus*)
  Elongate surgeonfish (*Acanthurus mata*)
  Mimic surgeonfish (*Acanthurus pyroferus*)
  Striped bristletooth (*Ctenochaetus striatus*)
  Twospot bristletooth (*Ctenochaetus binotatus*)
  Bluespine unicornfish (*Naso unicornus*)
  Orangespine unicornfish (*Naso lituratus*)
  Humpnose unicornfish (*Naso tuberosus*)

Table 4-1. The fish and invertebrate species with EFH designated in the MIRC study area (continued).

Surgeonfishes (Acanthuridae) (continued)
- Blacktongue unicornfish (*Naso hexacanthus*)
- Bignose unicornfish (*Naso vlamingii*)
- Whitemargin unicornfish (*Naso annulatus*)
- Spotted unicornfish (*Naso brevirostris*)
- Humpback unicornfish (*Naso brachycentron*)
- Barred unicornfish (*Naso thynnoides*)
- Gray unicornfish (*Naso caesius*)

Triggerfishes (Balistidae)
- Titan triggerfish (*Balistapus viridescens*)
- Clown triggerfish (*Balistoides conspicillum*)
- Orangestripped triggerfish (*Balistapus undulatus*)
- Pinktail triggerfish (*Melichtys vidua*)
- Black triggerfish (*Melichtys niger*)
- Blue triggerfish (*Pseudobalistes fuscus*)
- Picassofish (*Rhinecanthus aculeatus*)
- Wedged picassofish (*Rhinecanthus rectangulus*)
- Bridled triggerfish (*Sufflamen fraenatus*)

Jacks (Carangidae)
- Bigeye scad (*Selar crumenophthalmus*)
- Mackerel scad (*Decapterus macarellus*)

Requiem Sharks (Carcharhinidae)
- Grey reef shark (*Carcharhinus amblyrhynchos*)
- Silvertip shark (*Carcharhinus albimarginatus*)
- Galapagos shark (*Carcharhinus galapagenis*)
- Blacktip reef shark (*Carcharhinus melanopterus*)
- Whitetip reef shark (*Triaenodon obesus*)

Soldierfishes/Squirrelfishes (Holocentridae)
- Bigscale soldierfish (*Myripistris berndti*)
- Bronze soldierfish (*Myripristis adusta*)
- *Blotcheye soldierfish (Myripristis* murdjan)
- Brick soldierfish (*Myripristis amaena*)
- Scarlet soldierfish (*Myripristis pralinia*)
- Violet soldierfish (*Myripristis violacea*)
- Whitetip soldierfish (*Myripristis vittata*)
- Yellowfin soldierfish (*Myripristis chryseres*)
- Pearly soldierfish (*Myripristis kuntee*)
- Tailspot squirrelfish (*Sargocentron caudimaculatum*)
- File-lined squirrelfish (*Sargocentron microstoma*)
- Pink squirrelfish (*Sargocentron tieroides*)
- Crown squirrelfish (*Sargocentron diadema*)
- Peppered squirrelfish (*Sargocentron punctatissimum*)
- Blue-lined squirrelfish (*Sargocentron tiere*)
- Long jaw squirrelfish (*Sargocentron spiniferum*)
- Spotfin squirrelfish (*Neoniphon* spp.)

Flagtails (Kuhliidae)
- Barred flagtail (*Kuhlia mugil*)

Rudderfishes (Kyphosidae*)*
- Grey rudderfish *(Kyphosus bigibbus*)
- Highfin rudderfish (*Kyphosus cinerascens*)
- Lowfin rudderfish (*Kyphosus vaigensis*)

Wrasses (Labridae)
- Napoleon wrasse (*Cheilinus undulatus*)
- Triple-tail wrasse (*Cheilinus trilobatus*)
- Floral wrasse (*Cheilinus chlorourus*)
- Harlequin tuskfish (*Cheilinus fasciatus*)
- Ring-tailed wrasse (*Oxycheilinus unifasciatus*)
- Bandcheek wrasse (*Oxycheilinus digrammus*)
- Arenatus wrasse (*Oxycheilinus arenatus*)
- Razor wrasse (*Xyricthys pavo*)
- Whitepatch wrasse (*Xyrichtes aneitensis*)
- Cigar wrasse (*Cheilio inermis*)
- Saddleback hogfish (*Bodianus bilunulatus*)
- Blackeye thicklip (*Hemigymnus melapterus*)
- Barred thicklip (*Hemigymnus fasciatus*)
- Three-spot wrasse (*Halichoeres trimaculatus*)
- Checkerboard wrasse (*Halichoeres hortulanus*)
- Weedy surge wrasse (*Halichoeres margaritaceus*)
- Surge wrasse (*Thalassoma purpureum*)
- Redribbon wrasse (*Thalassoma quinquevittatum*)
- Sunset wrasse (*Thalassoma lutescens*)
- Longface wrasse (*Hologynmosus doliatus*)
- Rockmover wrasse (*Novaculichthys taeniourus*)

Goatfishes (Mullidae)
- Yellow goatfish (*Mulloidichthys* spp.)
- Yellowfin goatfish (*Mulloidichthys vanicolensis*)
- Yellowstripe goatfish (*Mulloidichthys flaviolineatus*)
- Banded goatfish (*Parupeneus* spp.)
- Dash-dot goatfish (*Parupeneus barberinus*)
- Redspot goatfish (*Parupeneus heptacanthus*)
- White-lined goatfish (*Parupeneus ciliatus*)
- Yellowsaddle goatfish (*Parupeneus cyclostomus*)
- Side-spot goatfish (*Parupeneus pleurostigma*)
- Multi-barred goatfish (*Parupeneus multifaciatus*)
- Bantail goatfish (*Upeneus arge*)

Mullets (Mugilidae)
- Engel's mullet (*Moolgarda engeli*)
- False mullet (Neomyxus leuciscus)
- Fringelip mullet (Crenimugil crenilabis)

Moray Eels (Muraenidae)
- Yellowmargin moray (*Gymnothorax flavimarginatus*)
- Giant moray (*Gymnothorax javanicus*)
- Undulated moray (*Gymnothorax undulatus*)

Octopuses (Octopodidae)
- Day squid (*Octopus cyanea*)
- Night squid (*Octopus ornatus*)

Threadfins (Polynemidae)
- Sixfeeler threadfin (*Polydactylus sexfilis*)

Bigeyes (Pricanthidae)
- Glasseye (*Heteropriacanthus cruentatus*)
- Bigeye (*Priacanthus hamrur*)

Mackerels (Scombridae)
- Dogtooth tuna (*Gymnosarda unicolor*)

Parrotfishes (Scaridae)
- Bumphead parrotfish (*Bolbometopon muricatum*)
- Parrotfish (*Scarus* spp.)
- Pacifc longnose parrotfish (*Hipposcarus longiceps*)
- Stareye parrotfish (*Catolomus carolinus*)

Table 4-1. The fish and invertebrate species with EFH designated in the MIRC study area (continued).

Rabbitfishes (Siganidae)
- Forktail rabbitfish (*Siganus aregentus*)
- Randall's rabbitfish (*Siganus randalli*)
- Scribbled rabbitfish (*Siganus spinus*)
- Vermiculate rabbitfish (*Siganus verimiculatus*)

Barracudas (Sphyraenidae)
- Heller's barracuda (*Sphyraena helleri*)
- Great barracuda (*Sphyraena barracuda*)

<u>Aquarium Taxa/Species</u>

Surgeonfishes (Acanhturidae)
- Yelow tang (*Zebrasoma flavescens*)
- Yellow-eyed surgeonfish (*Ctenochaetus strigosus*)
- Achilles tang (*Acanthurus achilles*)

Moorish Idols (Zanclidae)
- Moorish idol (*Zanclus cornutus*)

Angelfishes (Pomacanthidae)
- Shepard's angelfish (*Centropyge shepardi*)
- Lemonpeel angelfish (*Centropyge flavissimus*)

Hawkfishes (Cirrhitidae)
- Flame hawkfish (*Neocirrhitus armatus*)
- Longnose hawkfish (*Oxycirrhites typus*)

Butterflyfishes (Chaetodontidae)
- Threadfin butterflyfish (*Chaetodon auriga*)
- Raccoon butterflyfish (*Chaetodon lunula*)
- Black-backed butterflyfish (*Chaetodon melannotus*)
- Saddled butterflyfish (*Chaetodon ephippium*)

Damselfishes (Pomacentridae)
- Blue-green chromis (*Chromis viridis*)
- Humbug dascyllus (*Dascyllus aruanus*)
- Three-spot dascyllus (*Dascyllus trimaculatus*)

Scorpionfishes (Scorpaenidae)

Feather-duster Worms (Sabellidae)

<u>Potentially Harvested Coral Reef Taxa (PHCRT):</u>

<u>Fish Management Unit Species</u>

Other Wrasses (Labridae spp.) [1]
Requiem Sharks (Carcharhinidae spp.) [1]
Hammerhead Sharks (Sphyrnidae spp.) [1]
Whiptail Stingrays (Dasyatididae)
Eagle Rays (Myliobatidae)
Manta Rays (Mobulidae)
Other Groupers (Serranidae spp.) [2]
Jacks/Trevallies (Carangidae) [3]
Other Soldierfishes/Squirrelfishes (Holocentridae spp.) [1]
Other Goatfishes (Millidae) [1]
Other Surgeonfishes (Acanthuridae spp.) [1]
Other Emperor Fishes (Lethrinidae) [4]
False Moray Eels (Chlopsidae) [1]
Conger and Garden Eels (Congridae) [1]
Spaghetti Eels (Moringuidae) [1]
Snake Eels (Ophichthidae) [1]
Other Moray Eels (Muraenidae) [1]
Cardinalfishes (Apogonidae)
Bigeyes (Pricanhtidae)
Other Butterflyfishes (Chaetodontidae spp.) [1]
Other Angelfishes (Pomacanthidae spp.) [1]
Other Damselfishes (Pomacentridae) [1]
Turkeyfishes (Scorpaenidae) [3]
Blennies (Blenniidae)
Other Barracudas (Sphyraenidae spp.) [1]
Sandperches (Pinguipedidae)
Left-eye Flounderes (Bothidae)
Right-eye Flounderes (Pleuronectidae)
Soles (Soleidae)
Trunkfishes (Ostraciidae)
Pufferfishes (Teradontidae)
Porcupinefishes (Diodontidae)
Spadefishes/Batfishes (Ephippidae)
Monofishes (Monodactylidae)
Grunts (Haemulidae)
Remoras (Echineididae)
Tilefishes (Malacanthidae)
Dottybacks (Pseudochromidae)
Prettyfins (Plesiopidae)
Coral crouchers (Caracanthidae)
Soapfishes (Grammistidae)
Trumpetfishes (Aulostomidae)
- Chinese Trumpetfish (*Aulostomus chinensis*)

Cornetfishes (Fistularidae)
- Reef cornetfish (*Fistularia commersoni*)

Flashlightfishes (Anomalopidae)
Herrings and Sardines (Clupeidae)
Anchovies (Engraulidae)
Gobies (Gobiidae)
Other Snapperes (Lutjanidae) [2]
Other Triggerfishes (Balistidae spp.) [1]
Other Filefishes (Monocanthidae spp.) [1]
Other rabbitfishes (Siganidae) [1]
Rudderfishes (Kyphosidae) [1]
Fusiliers (Caesionidae)
Hawkfishes (Cirrhitidae) [1]
Frogfishes (Antennariidae)
Pipefishes and Seahorses (Syngnathidae)

<u>Invertebrate Management Unit Species</u>

Mollusks (Mollusca) [1]
- Sea Snails and Sea Slugs (Gastropods)
  - Trochus (*Trochus* spp.)
- Bivalve (Oysters and Clams)
  - Black-lipped pearl oyster (*Pinctada margaritifera*)
  - Giant clams (Tridacnidae)
  - Other Clams

Nautiluses, cuttlefishes, squids, and octopuses (Cephalopods)
Tunicates (Ascidians)
Moss Animals (Bryozoans)
Mantis Shrimps, Lobsters, Crabs, and Shrimps (Crustacean) [5]
Sea Cucumbers and Sea Urchins (Echinoderms)
Segmented Worms (Annelids)

Table 4-1. The fish and invertebrate species with EFH designated in the MIRC study area (continued).

<u>Sessile Benthos Management Unit Species</u>

- Algae (Seaweeds)
- Sponges (Porifera)
- Corals (Cnidaria)
  - Hydrozoans
    - Stinging or fire corals (Millepora)
    - Lace corals (Stylasteridae)
    - Hydroid fans (Solanderidae)
  - Scleractinian Anthozoans
    - Stony Corals (Scleractinia)
    - Ahermatypic Corals (Azooxanthellate)
  - Non-Scleractinian Anthozoans
    - Anemones (Actinaria)
    - Colonial Anemones or Soft Zoanthid Corals (Zoanthidae)
    - Soft Corals and Gorgonians (Alcyonaria)
    - Blue coral (*Heliopora coerulea*)
    - Organ-pipe corals or star polyps (*Tubipora musica*)
- Live Rocks

Table 4-2. Bottomfish Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
BOTTOMFISH											
Shallow-water Species Complex (0 to 100 m)											
Gray jobfish (*Aprion virescens*)		A		J	J	A,J	A,J		A	E,L	Adult depth of 3-180 m
Lunartail grouper (*Variola louti*)		A				A	A			E,L	Adult depth of 4-200 m
Blacktip grouper (*Epinephelus fasciatus*)				J		A,J	A		A	E,L	Adult depth of 0-160 m
Ambon emperor (*Lethrinus amboinensis*)						A,J	A,J		A,J	E,L	ND
Redgill emperor (*Lethrinus rubrioperculatus*)									A	E,L	Adult depth of 0-160 m
Giant trevally (*Caranx ignoblis*)			J		J					E,L	Adult depth of 80 m
Black jack (*Caranx lugubris*)									A	A,J,L,E	Adult depth of 12-354 m
Amberjack (*Seriola dumerili*)						J	A,J		A	A,J,L,E	Adult depth of 0-250 m
Blue stripe snapper (*Lutjanus kasmira*)		A		J		A,J			A	E,L	Adult depth of 0-265 m
Deep-water Species Complex (100 to 400 m)											
Squirrelfish snapper (*Etelis carbunculus*)						A			A	E,L	Adult depth of 90-350 m
Longtail snapper (*Etelis coruscans*)						A			A	E,L	Adult depth of 164-293 m
Pink snapper (*Pristipomoides filamentosus*)					J				A	E,L	Juvenile depth of 65-100 m; Adult depth of 100-200 m
Yellowtail snapper (*Pristipomoides auricilla*)									A	E,L	Adult depth of 180-270 m
Yelloweye snapper (*Pristipomoides flavipinnis*)									A	E,L	Adult depth of 180-270 m
Pink snapper (*Pristipomoides sieboldii*)									A	E,L	Adult depth of 180-360 m
Yellow-barred snapper (*Pristipomoides zonatus*)									A	E.L	Adult depth of 100-200 m
Silver jaw jobfish (*Aphareus rutilans*)						A			A	E,L	Adult depth of 6-100 m

Source: WPRFMC 1998, 2001
Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A).

4.2.2 PELAGIC MANAGEMENT UNIT SPECIES

Status - Thirty-three species are currently managed as PMUS by the WPRFMC through the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region (WPRFMC 1986b) and subsequent amendments (WPRFMC 1998). PMUS are divided into the following species complex designations: marketable species, non-marketable species, and sharks (Table 4-3). The designation of these complexes is based on the ecological relationships among the species and their preferred habitat (WPRFMC 1998). The marketable species complex has been further divided into temperate and tropical assemblages. The temperate species complex includes those PMUS that are found in greater abundance outside tropical waters at higher latitudes (e.g., broadbill swordfish, *Xiphias gladius*; bigeye tuna, *Thunnus obesus*; northern bluefin tuna, *T. thynnus*; and albacore tuna, *T. alalunga*). Additionally, a potential squid PMUS consisting of three flying squid species has been proposed by the WPRFMC for incorporation into the existing PMUS (NMFS-PIR 2004).

Currently, no data are available to determine if the PMUS are approaching an overfished condition (NMFS 2004a) except for the bigeye tuna. NMFS (2004b) determined that overfishing was occurring Pacific wide on this species. In addition, the shark species are afforded protection under the Shark Finning Prohibition Act (NMFS 2002).

The broadbill swordfish, albacore tuna, common thresher shark (*Alopias vulpinus*), and salmon shark (*Lamna ditropis*) have been listed as data deficient on the IUCN Red List of threatened species (Safina 1996, Uozumi 1996a, Goldman and Human 2000, Goldman et al. 2001). The shortfin mako shark (*Isurus oxyrinchus*), oceanic whitetip shark (*Caracharhinus longimanus*), and the blue shark (*Prionace glauca*) have been listed as near threatened (Smale 2000a, Stevens 2000a, 2000b). The bigeye tuna is listed as vulnerable (Uozumi 1996b).

Distribution - PMUS occur in tropical and temperate waters of the western Pacific Ocean. Geographical distribution among the PMUS is governed by seasonal changes in ocean temperature. These species range from as far north as Japan, to as far south as New Zealand. Albacore tuna, striped marlin (*Tetrapurus audax*), and broadbill swordfish have broader ranges and occur from 50°N to 50°S (WPRFMC 1998).

Habitat Preferences - PMUS are typically found in epipelagic to pelagic waters, however, shark species can be found in inshore benthic, neritic to epipelagic, and mesopelagic waters. Factors such as gradients in temperature, oxygen, or salinity can affect the suitability of a habitat for pelagic fishes. Skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*T. albacares*), and Indo-Pacific blue marlin (*Makaira nigricans*) prefer warm surface layers, where the water is well mixed and relatively uniform in temperature. Species such as albacore tuna, bigeye tuna, striped marlin, and broadbill swordfish, prefer cooler temperate waters associated with higher latitudes and greater depths. Certain species, such as broadbill swordfish and bigeye tuna are known to aggregate near the surface at night. However, during the day broadbill swordfish can be found at depths of 800 m and bigeye tuna around 275 to 550 m. Juvenile albacore tuna generally concentrate above 90 m with adults found in deeper waters (90 to 275 m) (WPRFMC 1998).

Life History - Migration and life history patterns of most PMUS are poorly understood in the Pacific Ocean. Additionally, very little is known about the distribution and habitat requirements of the juvenile lifestages of tuna and billfish prior to recruitment into fisheries. Seasonal movements of cooler-water tunas such as the northern bluefin and albacore are more predictable and better defined than billfish migrations. Tuna and related species tend to move toward the poles during the warmer months and return to the equator during cooler months. Most pelagic species make daily vertical migrations, inhabiting surface waters at night and deeper waters during the day. Spawning for pelagic species generally occurs in tropical waters

Table 4-3. Pelagic Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
PELAGIC											
Marketable Species Complex:											
Temperate Species											
Striped marlin (*Tetrapurus audax*)										A,J.L.E	Depth Distribution: governed by temperature stratification
Broadbill swordfish (*Xiphias gladius*)										A,J.L.E	Depth Distribution: surface to 1,000 m
Northern bluefin tuna (*Thunnus thynnus*)										A,J,L,E	No data
Albacore tuna (*Thunnus alalunga*)										A,J,L	Depth Distribution: surface to 380 m
Bigeye tuna (*Thunnus obesus*)										A,J,L,E	Depth Distribution: surface to 600 m
Mackerel (*Scomber* spp.)										A,J,L,E	No data
Promfet (Bramidae)											
Sickle pomfret (*Tatactichthys steindachneri*)										A,J,L,E	Depth Distribution: surface to 300 m
Lustrous pomfret (*Eumegistus illustris*)										A,J,L,E	Depth Distribution: surface to 549 m
Tropical Species											
Yellowfin tuna (*Thunnus albacares*)										A,J,L,E	Depth Distribution: upper 100 m with marked oxyclines
Kawakawa (*Euthynnus affinis*)										A,J,L,E	Depth Distribution: 36-200 m
Skipjack tuna (*Katsuwonus pelamis*)										A,J,L,E	Depth Distribution: surface to 263 m
Frigate tuna (*Auxis thazard*)										A,J,L,E	No data
Bullet tuna (*Auxis rochei*)										A,J,L,E	No data
Indo-Pacific blue marlin (*Makaira nigricans*)										A,J,L,E	Depth Distribution: 80-100 m
Black marlin (*Makaira indica*)										A,J,L,E	Depth Distribution: 457-914 m
Shortbill spearfish (*Tetrapturus angustirostris*)										A,J,L,E	Depth Distribution: 40-1,830 m
Sailfish (*Istiophorus platypterus*)										A,J,L,E	Depth Distribution: 10-20 to 200-250 m
Dolphinfishes (Coryphaenidae)											
Dolphinfish (*Coryphaena hippurus*)			A,J							A,J,L,E	No data
Pompano dolphinfish (*Coryphaena equiselas*)										A,J,L,E	No data
Wahoo (*Acanthocybium solandri*)										A,J,L,E	Adult depth <200 m
Moonfish (*Lampris guttatus*)										A,J	Depth Distribution: surface to 500 m
Non-marketable Species Complex:											
Snake mackerels/oilfish (Gempylidae)											
Escolar (*Lepidocybium flavobrunneum*)										A,J,L,E	Depth Distribution: surface to 200 m
Oilfish (*Ruvettus pretiosus*)										A,J,L,E	Depth Distribution: surface to 700 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S).

Table 4-3. Pelagic Management Unit Species EFH Designations (cont'd).

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Shark Species Complex											
Common thresher shark (*Alopias vulpinus*)		J								A,J	Depth Distribution: surface to 366 m
Pelagic thresher shark (*Alopias pelagicus*)		A				A				A,J	Depth Distribution: surface to 152 m
Bigeye thresher shark (*Alopias superciliosus*)										A,J	Depth Distribution: surface to 500 m
Shortfin mako shark (*Isurus oxyrinchus*)										A,J	Depth Distribution: surface to 500 m
Longfin mako shark (*Isurus paucus*)										A,J	No data
Salmon shark (*Lamna ditropis*)										A,J	Depth Distribution: surface to 152 m
Silky shark (*Carcharhinus falcirormis*)									A	A,J	Adult depth of 18-500 m
Oceanic whitetip shark (*Carcharhinus longimanus*)										A,J	Adult depth of 37-152 m
Blue shark (*Prionace glauca*)										A,J,L,E	Depth Distribution: surface to 152 m

Source: WPRFMC 1998, 2001

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S).

but may include temperate waters during warmer months. Very little is known about the life history stages of species that are not targeted by fisheries in the Pacific such as gempylids, sharks, and pomfrets (WPRFMC 1998).

EFH Designations - (WPRFMC 1998; Figures B-5; Table 4-3)

Eggs and Larvae - The (epipelagic zone) water column down to a depth of 200 m from the shoreline to the outer limit of the EEZ.

Juveniles and Adults - The water column down to a depth of 1,000 m from the shoreline to the outer limit of the EEZ.

HAPC Designations - HAPC for this group is the entire water column to a depth of 1,000 m above all seamounts and banks with summits shallower than 2,000 m within the EEZ.

4.2.3 CRUSTACEAN MANAGEMENT UNIT SPECIES

Status - Five species are currently managed as CMUS by the WPRFMC through the Fishery Management Plan of the Spiny Lobster Fisheries of the Western Pacific Region and the Final Combined Fishery Management Plan, Environmental Impact Statement, Regulatory Analysis, and Draft Regulations for the Spiny Lobster Fisheries of the Western Pacific Region (WPRFMC 1981, 1982) and subsequent amendments (WPRFMC 1998). CMUS is divided into the spiny and slipper lobster complex and the Kona crab (*Ranina ranina*) (WPRFMC 1998). Four species are managed as the spiny and slipper lobster complex by the CMUS and the PHCRT (WPRFMC 1998, 2001): spiny lobster (*Panulirus penicillatus* and *Panulirus* spp.), ridgeback spiny lobster (*Scyllarides haani*), and Chinese slipper lobster (*Parribacus antarcticus*). The Kona crab is managed as a single species under the CMUS and PHCRT (WPRFMC 1998; 2001). Currently, no data are available to determine if these lobster species or the Kona crab of the CMUS are approaching an overfished condition (NMFS 2004a). The spiny lobster is a main component of the inshore lobster catch (Hensley and Sherwood 1993) and it is overfished on Guam (DoN 2005). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004). The ridgeback slipper lobster and the Kona crab have not been recorded in the Marianas (DoN 2005b).

Distribution - Members of CMUS occur in the Indo-Pacific region (Holthuis 1991; WPRFMC 1998). There are 839 species of crustaceans in the Marianas (Paulay et al. 2003a). There are 13 species of spiny lobster that occur in the tropical and subtropical Pacific between 35°N and 35°S (Holthuis 1991; WPRFMC 1998). There are five species of *Panulirus* in the Marianas and *P. penicillatus* is the most common species (WPRFMC 2001, Paulay et al. 2003a).

Habitat Preferences - In general, adults of the CMUS favor sheltered areas with rocky substrates and/or sandy bottoms. There is a lack of published data pertaining to the preferred depth distribution of decapod larvae and juveniles in this region (WPRFMC 2001). The spiny lobster is mainly found in windward surf zones of oceanic reefs but some are also found on sheltered reefs (Pitcher 1993, DoN 2005). Adult spiny lobsters are typically found on rocky substrate in well-protected areas, such as crevices and under rocks (Holthuis 1991, Pitcher 1993). Some spiny lobsters prefer depths less than 10 m while others are found to depths of around 110 m (Holthuis 1991, Pitcher 1993, WPRFMC 2001, DoN 2005). Small juvenile spiny lobsters are found only in the same habitat as larger individuals (Pitcher 1993). The ridgeback spiny lobster likely occurs on rocky bottoms; it is known from depths between 10 and 135 m (Holthuis 1991). The depth distribution of the Chinese slipper lobster is 0 to 10 m and some are taken as incidental catch in the spiny lobster fishery (Polovina 1993). The Chinese slipper lobster prefers to live in coral or stone reefs with a sandy bottom (Holthuis 1991). The Kona crab is found in a number of environments, from sheltered bays and lagoons to surf zones, but prefers sandy habitat in depths of 24 to 115 m (Smith 1993, Poupin 1996, WPRFMC 1998).

Life History - Decapods exhibit a wide range of feeding behaviors, but most combine nocturnal predation with scavenging; large invertebrates are the typical prey items (WPRFMC 2001). Both lobsters and crabs are ovigerous—the females carry fertilized eggs on the outside of their body. The relationships between egg production, larval settlement, and stock recruitments are poorly understood (WPRFMC 1998, 2001). Spiny lobsters produce eggs in summer and fall. The larvae have a pelagic distribution of about one year and can be transported up to 3,704 km by prevailing ocean currents (WPRFMC 1998). This species is nocturnal, hiding during the daytime in crevices in rocks and coral reefs. At night, this lobster moves up through the surge channels to forage on the reef crest and reef flat (Pitcher 1993). The Kona crab spawns at least twice during the spawning season; there are insufficient data to define the exact spawning season in the MIRC study area (WPRFMC 1998). This species remains buried in the substratum during the day, emerging only at night to search for food (Bellwood 2002).

EFH Designations - (WPRFMC 1998; Figures B-6, B-7, B-8, and B-9; Table 4-4)

<u>Larvae</u> - EFH for this lifestage is the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m.

<u>Juveniles and Adults</u> - All bottom habitat from the shoreline to a depth of 100 m is designated as EFH.

HAPC Designations - No HAPC is designated for Guam and the Northern Mariana Islands.

Table 4-4. Crustaceans Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
CRUSTACEANS											
Spiny and Slipper Lobster Complex											
Spiny lobster (*Panulirus penicillatus, Panulirus* sp.)		All			A,J	All	All		All	L	Depth Distribution: 9 to 183 m
Chinese slipper lobster (*Parribacus antarticus*)						A					Depth Distribution: 0 to 20 m

Source: WPRFMC 1998, 2001
Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S)

4.2.4 CORAL REEF ECOSYSTEM MANAGEMENT UNIT SPECIES

4.2.4.1 Introduction to Coral Reef Ecosystem Management Unit Species

The Coral Reef Ecosystem Fishery Management Plan (CRE FMP) manages coral reef ecosystems surrounding the following U.S. Pacific Island areas: the State of Hawaii, the Territories of American Samoa and Guam, the CNMI, and the Pacific remote island areas of Johnston Atoll, Kingman Reef, Palmyra and Midway Atolls, and Jarvis, Howland, Baker and Wake Islands (WPRFMC 2001). For the purpose of this fishery management plan, these areas make up the Western Pacific Region, and Currently Harvested Coral Reef Taxa (CHCRT) and Potentially Harvested Coral Reef Taxa (PHCRT) will only be delineated by specific U.S. Pacific Island areas when information is available. While the MRA focused on the CNMI and Guam study area, all family information provided corresponds to the entire Western Pacific Region unless otherwise noted.

In addition to EFH, WPRFMC also identified HAPC that are specific areas within EFH that are essential to the life cycle of important coral reef species. HAPC for all life stages of the CRE MUS includes all hardbottom substrate between 0 and 100 m depth in the MIRC study area. Five individual HAPC sites have been identified for the island of Guam, one of which, Jade Shoals, occurs within Apra Harbor. Orote Point Ecological Reserve Area lies immediately outside of Apra Harbor. The remaining three occur in the northern (Ritidian Point), northwest (Haputo Ecological Preserve), and southern (Cocos Lagoon) areas of the island (Research Planning Inc. 1994, WPRFMC 2001, Figure B-11).

4.2.4.2 Currently Harvested Coral Taxa

The CHCRT are managed under the CRE FMP by the WPRFMC (2001). CHCRT are species that have been identified which: (1) are currently being harvested in state and federal waters and for which some fishery information is available, and (2) are likely to be targeted in the near future based on historical catch data. The WPRFMC has designated EFH for these MUS based on the ecological relationships among the species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual species (WPRFMC 2001). A complete list of managed species occurring in the MIRC study area and their respective fishery management units are found in Table 4-1.

Table 4-5. Coral Reef Ecosystem Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
CORAL REEF ECOSYSTEM											
Currently Harvested Coral Reef Taxa											
Surgeonfishes (Acanhthuridae)	J	A,J.S	A,J,S	J	A,J,S	A,J,S	A,J,S		A,J	E,L	Adult depth of 0-150 m
Unicornfishes (Nasinae)	J	A,J,S	J		A,S	A,J,S	A,J,S		A,S	All	Adult depth of 0-150 m
Triggerfishes (Balistidae)	J	A,J,S	J	J		A,J,S	A,J,S	A	A,S	E,L	Adult depth of 0-100 m
Jacks (Carangidae)	A,J,S	A,J,S	A,J,S	J	A,J,S	A,J,S	A,J,S		A,J,S	All	Adult depth of 0-350 m
Requiem Sharks (Carcharhinidae)	A,J	A,J	A,J	J	A,J	A,J	A,J		A,J	A,J	Adult depth of 1-300 m
Soldierfishes/Squirrelfishes (Holocentridae)		A,J,S	A,J,S	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 0-235 m
Flagtails (Kuhliidae)	A,J	A,J	A,J	A,J				A		E,L	Adult depth of 3-18 m
Rudderfishes (Kyphosidae)	J	A,J,S	A,J,S		A,J	A,J,S	A,J,S	A,J		All	Adult depth of 1-24 m
Wrasses (Labridae)											
Bodianus and Xyricthys spp.		J	J	J	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Juvenile depth of 2 m; Adult depth of 2-20 m
Cheilinus and *Choerodon* spp.		A,J	J		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-30 m
Oxycheilinus spp.		A,J			A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-160 m
Hemigymnus spp.		A,J		J	A,J,S	J	J,S		A,J,S	E,L	Adult depth of 1-40 m
Cheilio spp.											Adult depth of 1-30 m
Halichoeres spp.		A,J	J		A,J,S	A,J,S		A,J		E,L	Adult depth of 1-30 m
Thalassoma spp.		A,J		J	A,J,S	A,J,S	A,J,S			E,L	Adult depth of 1-30 m
Hologynmosus and *Novaculichthys* spp.		A,J			A,J,S	A,J,S		A,J			Adult depth of 1-30 m
Napoleon wrasse (*Cheilinus undulatus*)	J	J		J		A,J,S	A,J,S		A,S	E,L	Adult depth of 2-60 m
Goatfishes (Mullidae)		A,J	A	A,J	A,J	A,J	A,J			E,L	Adult depth of 1-10 m
Mullets (Mugilidae)	J	A,J,S	A,J,S	J		A,J		A		E,L	Adult depth of 0-20 m
Moray Eels (Muraenidae)	A,J,S	A,J,S	A,J,S	A,J	A,J,S	A,J,S	A,J,S	A,J,S	E,L		Adult depth of 0-150 m
Octopuses (Octopodidae)	A,J,S	All	A,J,S	All	All	All	All		All	L	Adult depth of 0-50 m
Threadfins (Polynemidae)	A,J	A,J,S	A,J,S		A,J,S			A,J		E,L	Juvenile depth of 0-100 m; Adult depth of 20-50 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S). Source: Colin and Arneson 1995, Sorokin 1995, Myers 1999, WPRFMC 2001

Table 4-5. Coral Reef Ecosystem Management Unit Species EFH Designations (cont'd)

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Bigeyes (Priacanthidae)						A,J	A,J		A,J	E,L	Adult depth of 5-400 m
Parrotfishes (Scaridae)	J	A,J,S		A,J		A,J,S	A,J,S			E,L	Adult depth of 1-30 m
Bumphead parrotfish (*Bolbometopon muricatum*)	J	J		J		A,J,S	A,J,S			E,L	Adult depth of 1-30 m
Mackerels (Scomberidae)											
Dogtooth tuna (*Gymnosarda unicolor*)		A,J,S			A,J	A,J,S	A,J		A,J	E,L	Adult depth of 0-100 m
Rabbitfishes (Siganidae)	A,J,S	A,J,S	A,J,S	J		A,J,S	A,J,S		E,L		Adult depth of 0-50 m
Barracudas (Sphyraenidae)	A,J	A,J,S	A,J,S	J		A,J,S	A,J,S		A,S	All	Adult depth of 0-100 m
Turban shells/green snails (Turbinidae)		A,J,S				A,J,S	A,J,S		A	E,L	Juvenile depth of 1-5 m; Adult depth of 1-20 m
Aquarium Taxa/Species											
Surgeonfishes (Acanthuridae)	J	A,J,S	A,J,S	J	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-113 m
Moorish Idols (Zanclidae)		A,J				A,J	A,J			E,L	Adult depth of 3-182 m
Angelfishes (Pomacanthidae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 2-100 m
Hawkfishes (Cirrhitidae)		A,J,S				A,J,S	A,J,S		A,J,S	All	Adult depth of 0-30 m
Butterflyfishes (Chaetodontidae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 0-30 m
Damselfishes (Pomacentirdae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 1-55 m
Scorpionfishes (Scorpaenidae)	J	A,J,S	A,J,S	J		A,J,S	A,J,S			E,L	Adult depth of 10-50 m
Feather-duster Worms (Sabellidae)	A,J,S	A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-30 m
Potentially Harvested Coral Reef Taxa											
FISH MANAGEMENT UNIT SPECIES											
Hammerhead Sharks (Sphyrnidae)	A,J	A,J	A,J		A,J	A,J	A,J		A,J	A,J	Adult depth of 1-275 m
Whiptail Stingrays, Eagle Rays, and Manta Rays (Dasyatidae, Myliobatidae, and Mobulidae)	A,J	A,J	A,J		A,J	A,J	A,J		A,J	A,J	Adult depth of 0-100 m
Groupers (Serranidae)	J	A,J		J	A,J,S	A,J,S	A,J,S		A,S	E,L	Adult depth of 0-400 m
Emperor Fishes (Lehtrinidae)	J	A,J,S	J	J	A,J,S	A,J,S	A,J,S		A,S	E,L	Adult depth of 0-350 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S). Source: Colin and Arneson 1995, Sorokin 1995, Myers 1999, WPRFMC 2001

Table 4-5. Coral Reef Ecosystem Management Unit Species EFH Designations (cont'd)

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
False Moray Eels, Conger and Garden Eels, and Snake Eels (Chlopsidae, Congridae, and Ophichthidae)	A,J,S	A,J,S	A,J,S	A,J	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-105 m
Cardinalfishes (Apogonidae)	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-80 m
Blennies (Blenniidae)		A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-40 m
Sandperches (Pinguipedidae)				A,J	A,J	A,J	A,J		A	E,L	Adult depth of 1-50 m
Flounders and Soles (Bothidae, Pleuronectidae, and Soleidae)		A,J				A,J	A,J		A,J	L	Adult depth of 1-100 m
Trunkfishes (Ostraciidae)		A	A	J	A,J	A			A	E,L	Adult depth of 1-100 m
Pufferfishes and Porcupinefishes (Tetradontidae and Diodontidae)	A,J	A,J	A,J		A,J	A,J	A,J		A,J	E,L	Adult depth of 0-100 m
Batfishes (Ephippidae)	J	A,J,S	J		A,S	A,J,S	A,J,S		A,S	All	Adult depth of 20-30 m
Monos (Monodactylidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S			E,L	Adult depth of 1-10 m
Sweetlips (Haemulidae)	J	A,J,S	A,J,S	J		A,J,S	A,J,S			E,L	Adult depth of 1-100 m
Remoras (Echineididae)						A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-50 m
Tilefishes (Malacanthidae)		A,J,S			A,J,S	A,J,S	A,J,S			E,L	Adult depth of 6-115 m
Dottybacks (Pseudochromidae)	J	J		J		A,J,S	A,J,S			E,L	Adult depth of 0-100 m
Prettyfins (Plesiopodae)	J	A,J,S				A,J,S	A,J,S			E,L	Adult depth of 3-45 m
Coral Crouchers (Caracanthidae)						A,J,S	A,J,S			E,L	Adult depth of 0-10 m
Soapfishes (Grammistidae)						A,J,S	A,J,S			E,L	Adult depth of 0-150 m
Trumpetfishes (Aulostomidae)	J	A,J,S		A,J	A	A,J,S	A,J,S			E,L	Adult depth of 0-122 m
Cornetfishes (Fistularidae)	J	A,J,S		A,J		A,J,S	A,J,S			E,L	Adult depth of 0-122 m
Flashlightfishes (Anomalopidae)						J	J		A,J,S	E,L	Adult depth of 2-400 m
Herrings and Sardines (Clupeidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,S	All	Adult depth of 0-20 m
Anchovies (Engraulidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,S	All	No data
Gobies (Gobiidae)	All	All	All	All	All	All	All		All	All	Adult depth of 1-48 m
Snappers (Lutjanidae)	A,J,S	A,J,S	A,J,S	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 0-400 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S). Source: Colin and Arneson 1995, Sorokin 1995, Myers 1999, WPRFMC 2001.

Table 4-5. Coral Reef Ecosystem Management Unit Species EFH Designations. (cont'd)

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Filefishes (Monocanthidae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 2-200 m
Fusiliers (Caesionidae)	J	A,J,S			A,S	A,J,S	A,J,S		A,S	All	Adult depth of 0-60 m
Hawkfishes (Cirrhitidae)		A,J,S				A,J,S	A,J,S		A,J,S	All	Adult depth of 0-30 m
Frogfishes (Antennariidae)		All		All		All	All			L	Adult depth of 0-20 m
Pipefishes and Seahorses (Syngnathidae)	All	All		All		All	All			L	Adult depth of 0-400 m
INVERTEBRATE MANAGEMENT UNIT SPECIES											
Mollusks (Mollusca)											
Gastropods	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adut depth of 1-24 m
Sea Snails (Prosobranchs)	A,J	A,J,S		A,J,S	A,J,S	A,J,S	A,J,S		A,J	E,L	Adult depth of 2-30 m
Trochus (Trochus spp.)		A,J,S				A,J,S	A,J,S			E,L	Adult depth of 7-25 m
Sea Slugs (Opisthobranchs)	A,J	A,J,S				A,J,S	A,J,S		A,J,S	E,L	Adult depth of 2-30 m
Bivalves (Oysters and Clams)											
Black-lipped pearl oyster (*Pinctada margartifera*)	A,J	A,J,S				A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: littoral/subtidal to 40 m
Giant clams (Tridacnidae)		A,J,S			A,J,S	A,J,S	A,J,S			E,L	Depth Distribution: 2-20 m
Other bivalves	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 1-27 m
Nautiluses, cuttlefishes, and squids (Cephalopods)		All	A,J,S	All	All	All	All		All	E,L	Adult depth from surface to 500 m
Octopuses (Octopodidae)	A,J,S	All	A,J,S	All	All	All	All		All	L	Adult depth of 1-1,000 m
Moss Animals (Bryozoans)	A,J,S	A,J,S	A,J,S	A,J		A,J,S	A.J,S		A,J,S	E,L	Adult depth of 20-80 m
Crustaceans (Crustacea)											
Lobster: Spiny and Slipper		All			A,J	All	All		All	L	Adult depth of 20-55 m
Shrimps and Mantis Shrimps		All	A,J	A,J	A,J	All	All		All	L	Adult depth of 3-70 m
Crabs: True and Hermit	A,J	All	A,J	A,J	A,J	All	All		All	L	Adult depth of 0-115 m
Sea Cucumbers and Sea Urchins (Echinoderms)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-2,000 m
Segmented Worms (Annelids)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 30-70 cm to 20 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S). Source: Colin and Arneson 1995, Sorokin 1995, Myers 1999, WPRFMC 2001.

Table 4-5. Coral Reef Ecosystem Management Unit Species EFH Designations. (cont'd)

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
SESSILE BENTHOS MANAGEMENT UNIT SPECIES											
Seaweeds (Algae)	All	All	All	All	All	All	All		All		Distribution: exposed shoreline, lagoon, bommies, inner/outer reef flat, reef crest, outer reef slope
Sponges (Porifera)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth from intertidal to 50 m
Corals (Cnidaria)											
Hydrozoans											
Stinging or fire corals (*Millepora*)		A,J,S				A,J,S	A,J,S		A,J,S	E,L	Depth distribution: 0-10 m reef edge, reef flat, outer reef slope
Lace corals (Stylasteridae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 10-20 m
Hydroid Fans (Solanderidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 0-100 m
Scleractinian Anthozoans											
Stony Corals (Scleractinia)		A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 0-60 m
Ahermatypic corals (Azooxanthellate)		A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: shallow water
Ahermatypic Corals (Azooxanthellate)		A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 44-1,761 m
Non-Scleractinian Anthozoans											
Anemones (Actinaria)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 0-40 m
Colonial Anemones or Soft Zoanthid Corals (Zoanthidae)	A,J,S	A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Distribution: lagoon floors, back reef flats, reef crests, shallow sub-littoral zone
Soft Corals and Gorgonians (Alcyonaria)		A,J,S			A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution - soft corals: 3-30 m and gorgonians: <30-400 m
Blue coral (*Heliopora coerulea*)		A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: <1 m to >30 m
Organ-pipe corals or star polyps (Tubipora musica)						A,J	A,J				Distribution: shallow lagoons, reef flats, reef slopes
Live Rocks		A,J	A,J			A,J	A,J		A,J	E,L	

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S). Source: Colin and Arneson 1995, Sorokin 1995, Myers 1999, WPRFMC 2001.

5.0 POTENTIAL ECOSYSTEM IMPACTS TO EFH AND MANAGED SPECIES

This section discusses potential ecosystem impacts as a result of implementation of the Proposed Action to EFH (including coral reef habitat) and managed species. Species within all FMPs may utilize both nearshore and offshore areas during their lives, as eggs and larvae for most species are planktonic and can occur in nearshore and offshore waters, while adults may be present in nearshore and/or offshore waters. Therefore, all project activities can potentially affect a lifestage of a managed species.

Pursuant to 50 CFR 600.910(a) (*Essential Fish Habitat Consultation Guidance*), an "adverse effect" on EFH is defined as any impact that reduces the quality and/or quantity of EFH. The Navy has determined that temporary or minimal impacts are not considered to adversely affect EFH – that is the Navy's policy, and the Navy used these criteria to determine if an effect would be temporary or minimal (Chief of Naval Operations Instruction [OPNAVINST] 5090.1C).

OPNAVINST] 5090.1C defines temporary impacts. To help identify Navy activities falling within the adverse effect definition, the Navy has determined that temporary or minimal impacts are not considered to "adversely affect" EFH. 50 CFR 600.815(a)(2)(ii) and the EFH Final Rule (67 Fed. Reg. 2354) were used as guidance for this determination, as they highlight activities with impacts that are more than minimal and not temporary in nature, as opposed to those activities resulting in inconsequential changes to habitat. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (67 Fed. Reg. 2354). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions (67 Fed. Reg. 2354). Factors that were considered in the ecosystem-based management analysis included the duration, frequency, intensity, and spatial extent of the impact; the sensitivity/vulnerability of the habitat; the habitat functions that might be altered by the impact; and the timing of the impact relative to when the species or life stages may use or need the habitat.

The proposed training activities in the MIRC have the potential to result in the following impacts:

- Physical disruption of open ocean habitat
- Physical destruction or adverse modification of benthic habitats
- Alteration of water or sediment quality from expended materials or discharge
- Cumulative ecosystem impacts

Due to the nature of each activity (i.e., various vessels, aircrafts, locations, ordnance), quantification of impacts for each activity is not possible. The assessment focuses on activities and impacts common to training activities (i.e., stressors), but also discusses individual exercises/training activities such as MISSILEX, BOMBEX, Expeditionary Assault, TORPEX, and SINKEX that have unique aspects. Each activity and associated ecosystem impacts are discussed in Sections 5.1 through 5.3, and a summary is provided in Table 5-6.

Permanent, adverse impacts to EFH components are not anticipated, as part of the Navy's commitment to sustainable use of resources and environmental stewardship, the Navy incorporates measures that are mitigation of the environment into all of its activities. These include employment of best management practice, standard operating procedures (SOPs), adoption of conservation recommendations, and other measures that mitigate the impacts of Navy activities on the environment. Some of these measures are generally applicable and others are designed to apply to certain geographic areas during certain times of year, for specific types of military training. Mitigation measures covering habitats and species occurring in the Mariana Islands Range Complex have been developed through various environmental analyses conducted by the Navy for land and sea ranges and adjacent coastal waters. However, there are temporary unavoidable impacts associated with several training activities that may result in localized impacts as discussed in Section 5.4. In addition, a single activity may potentially have multiple effects on EFH.

The following analyses are for activities under the No Action Alternative. Analyses for activities under Alternatives 1 and 2 are discussed in Section 5.4.

5.1 PHYSICAL DISRUPTION OF OPEN OCEAN HABITAT

The majority of the training activities in the MIRC occur in open ocean habitat or the pelagic zone. The pelagic zone encompasses the open ocean waters beyond the depth of approximately 200 m, and the pelagic environment in the Mariana Islands extend from the surface to water depths of more than 6,000 m. Pelagic biota live in the water column and have little or no association with the benthos, and consist of drifters (plankton) or swimmers (pelagic animals capable of swimming against currents).

Many of the training activities involve the use of bombs, munitions, missiles, or targets that fall or may fall into the waters of the MIRC producing shock waves, expended materials, and sound impacts. In addition, several training activities involve the use of live ordnance resulting in underwater explosions. Some examples include:

- Mine Neutralization
- Surface-to-Surface Gunnery Exercise
- Surface-to-Surface Missile Exercise
- Air-to-Surface Gunnery Exercise
- Air-to-Surface Missile Exercise
- Air to Ground Bombing Exercises
- Air to Ground Missile Exercises
- BOMBEX (Sea)
- SINKEX
- Antisubmarine Warfare Tracking Exercise
- Antisubmarine Warfare Torpedo Exercise

5.1.1 SHOCK WAVE

Bombs, and intact missiles and targets could impact the water surface with great force and produce a large shock wave (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). Impulses of this magnitude could injure or kill all life stages of fish, and larvae of other marine organisms within the immediate area. While many of the exercises are conducted with inert weapons, some exercises use live ordnance or explosives creating a larger area of impact and potentially injuring or killing an even greater number of fish and larvae.

Several factors determine a fish's susceptibility to injury and death from shock wave effects. Most blast injuries in fish and other marine animals involve damage to air- or gas-containing organs (Yelverton 1981). Many species of fish have a swim bladder, which is a gas-filled organ used to control buoyancy. Fish with swim bladders are vulnerable to effects of underwater explosions, whereas fish without swim bladders, like most species of invertebrates, are much more resistant (Yelverton 1981; Young 1991). During exposure to shock waves, the differential speed of shock waves through the body of the fish (which has a density close to water) versus the gas-filled space of the swim bladder causes the bladder to oscillate. If the swim bladder ruptures, it may cause hemorrhaging in nearby organs. In the extreme case, the oscillating swim bladder may rupture the body wall of the fish (Yelverton 1981). Some fish have a swim bladder that is ducted to the intestinal tract and some do not, but there is no difference in susceptibility between fish with these two types of bladders (Yelverton et al. 1975; Yelverton 1981). After a nearby underwater blast, most fish that die do so within 1–4 hours, and almost all do so within 24 hours (Yelverton et al. 1975; Yelverton 1981).

The rapid rise time of the shock wave resulting from detonation of high explosives causes most of the organ and tissue damage. Mortality of fish correlates better with impulse, measured in units of pressure time, than with other blast parameters (Yelverton 1981). The received impulse depends on the depth at which the fish is swimming, the depth of the charge, the mass of the charge, and the distance from charge to fish. Fish near the bottom or near a bank will receive a larger impulse (dicussed later in underwater detonations section). A fish on the bottom over a hard surface would receive a greater impulse than it would in open water (Yelverton et al. 1975; Yelverton 1981). Bottom reflection can also be enhanced if it is focused by bottom terrain.

Data from explosive blast studies indicate that very fast, high-level acoustic exposures can cause physical damage and/or mortally wound fishes (Hastings and Popper 2005). There is also reason to believe that lesser effects might also occur, but these have not been well documented. Just as in investigations testing the effects of sound, however, the number of species studied in tests of the effects of explosives is very limited, and there have been no investigations to determine whether blasts that do not kill fish have had any impact on short- or long-term hearing loss, or on other aspects of physiology (e.g., cell membrane permeability, metabolic rate, stress), and/or behavior (e.g., feeding or reproductive behavior, movement from preferred home sites).

5.1.2 EXPENDED MATERIALS FALL

In addition to impacts occurring near the ocean surface, there is also the possibility that falling fragments may injure or kill FMP species below the ocean surface. Accurate measurements of the size of the expended materials field from the underwater explosion of 5-inch shells are not available. However, the shells are typically fused to explode at the sea surface. This, combined with the high downward velocity of the shell at impact, suggests that the expended materials field from the exploding shell would be restricted in size. As with exploding bombs, the shell fragments rapidly decelerate through contact with the surrounding water. The possibility that the exploding shell fragments and expended materials would significantly affect EFH and fish populations is considered negligible. In addition, most missiles hit their target or are disabled before hitting the water. Therefore, most of these missiles and targets hit the water as fragments, which quickly dissipate their kinetic energy within a short distance from the surface. Similarly, expended small-arms rounds may also strike the water surface with sufficient force to cause injury, but most fish swim some distance below the surface of the water. Therefore, few fish would be injured or killed from falling fragments.

5.1.3 UNDERWATER EXPLOSIONS

Potential effects of explosive charge detonations on fish and EFH include: disruption of habitat (discussed later in section); exposure to chemical by-products (also discussed later in section); disturbance, injury, or death from the shock (pressure) wave; acoustic impacts; and indirect effects including those on prey species and other components of the food web. Concern about potential fish mortality associated with the use of underwater explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (e.g., Yelverton et al. 1975; Goertner 1982, Goertner et al. 1994).

Young's (1991) equations for 90 percent survivability were used to estimate fish mortality in the Seawolf Shipshock Trial EIS (DoN 1998b). In that document, Yelverton's (1981) equations were used to predict survival of fish with swim bladders, although the equations apply to simple explosives, and may not apply to all the explosives used in the MIRC. The impulse levels that kill or damage fish with swim bladders have been determined empirically to be as follows (from Yelverton 1981):

- 50 percent Mortality $\ln(I)=3.6136 + 0.3201 \ln(M)$
- 1 percent Mortality $\ln(I)=3.0158 + 0.3201 \ln(M)$
- No Injuries $\ln(I)=2.0042 + 0.3201 \ln(M)$

Where I = impulse (in Pascal•seconds or Pa•s) and M = body mass of a fish (g) with a swim bladder.

Yelverton (1981) cautioned against using these equations for fish weighing more than a few kg because fish used in the experiments from which these equations were derived did not weigh more than 2.2 lb (1 kg). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency). An example of such model predictions is shown in Table 5-1, which provides the radius of effect of various charges, depths, and fish size. The 10% mortality range is the distance beyond which 90% of the fish present would be expected to survive.

Table 5-1. Range of Effects for Underwater Demolition.

Charge	Charge Depth	Effect Criterion	Range of Effect
1-lb.	3 m	10% Mortality	103 m for 1 oz. fish 55 m for 1 lb. fish 27 m for 30 lb. fish
10-lb.	38 m	10% Mortality	200 m for 1 oz. fish 129 m for 1 lb. fish 79 m for 30 lb. fish
20-lb.	19 m	10% Mortality	261 m for 1 oz. fish 169 m for 1 lb. fish 106 m for 30 lb. fish
20-lb.	38 m	10% Mortality	283 m for 1 oz. fish 182 m for 1 lb. fish 111 m for 30 lb. fish

Notes: NAVSEA SW061-AA-MMA-010; Technical Manual; "Use of Explosives in Underwater Salvage," January 1994. Shallow water detonations are not covered in safety distances tables. Energy is lost to the atmosphere so reduced proportion of blast energy are propagated into underwater shock waves.

Fish kill data provided by Guam Environmental Protection Agency (GEPA) observations from four deepwater demolition training exercises indicated that a total of 3, 4, 765, and 103 fishes were killed, respectively (GEPA 1998). As exercises occur no more than once per month, the numbers recorded equated to a maximum of about 4 fish per day – well below the number caught daily by fisherman. The majority of the fish were less than 12 inches (30 cm) long, and mortality of fishes and other marine life following exercises was relatively low since the activities are conducted in areas where marine fauna are not abundant.

Typically, bombing exercises (BOMBEX) at sea involve one or more aircraft bombing a target simulating a hostile surface vessel. Practice bombs entering the water would be devoid of combustion chemicals found in the warheads of explosive bombs, and would generate physical shock entering the water, but would not explode. After sinking to the bottom, the physical structure of bombs would be incorporated into the marine environment by natural encrustation and/or sedimentation (discussed in Section 5.2). Air-to-ground bombing using explosive ordnance is mostly conducted at land ranges. However, some live bombs are dropped at sea, and exploding bombs are used in exercises such as SINKEX and in W-517.

As with underwater detonations, the range within which fish may sustain injury or death from an exploding bomb would depend on environmental parameters, the size, location, and species of the fish, and its internal anatomy (e.g., whether it has a swim bladder) (DoN 2005c). Fish without swim bladders are far more resistant to explosions than those with swim bladders (Keevin and Hempen 1997). Explosive bombs will be fused to detonate on contact with the water and it is estimated that 99 percent of them will explode within 5 ft (1.5 m) of the ocean surface (DoN 2005c). Table 5-2, based on Young's (1991) model, displays 10-percent mortality (90-percent survival) ranges for the largest explosive bombs that may be deployed during at-sea exercises.

Table 5-2. Estimated Fish-Effects Ranges for Explosive Bombs.

Warhead Weight NEW (lb-TNT)	10 % Mortality Range by Weight of Fish		
	1 ounce	1 pound	30 pounds
500-lb	1,289 ft (393 m)	899 ft (274 m)	578 ft (176 m)
1,000-lb	1,343 ft (409 m)	937 ft (286 m)	602 ft (184 m)
2,000-lb	1,900 ft (579 m)	1,325 ft (404 m)	852 ft (260 m)

Potential effects from the use of Naval gun systems have been analyzed in a variety of environmental documents (DoN 2000, 2001, 2002, 2004b, 2007). The 5-inch gun has the largest warhead fired during routine gunnery exercises. Most training uses non-explosive 5-inch rounds. The surface area of the ocean impacted by a non-explosive 5-in round has been estimated to be 129 cm^2 (20 in^2) (DoN 2007). Considering the vast expanse of the MIRC, few fish would be directly struck by a shell from a 5-inch gun.

Explosive rounds would have the greatest potential for impacts to fish in surface waters. As previously indicated, biological effects of an underwater explosion depend on many factors, including the size, type, and depth of both the animal and the explosive, the depth of the water column, the standoff distance from the charge to the animal, and the sound-propagation properties of the environment. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997).

Table 5-3 provides an estimation of the potential range of lethal effects on swim bladder fish based on Young's (1991) model for five-inch explosive projectiles. These rounds have a NEW of TNT of approximately 8 lbs (3.6 kg) and are assumed to detonate at a depth of 5 ft (1.3 m). Behavioral reactions of fish would extend over a substantially larger area. The overall impacts to water-column habitat would, however, be minor as fish would return following the activity.

The abundance and diversity of fish and the quality and quantity of fish habitat within the range is unlikely to decrease as a result of gun fire training.

Table 5-3. Estimated Fish-Effects Ranges for 5-in Naval Gunfire Rounds.

Weight of Fish	10% Mortality Range	
	ft	m
1 oz	405	123
1 lb	282	86
30 lbs	181	55

5.1.4 SOUND IMPACTS

Bombs, missiles, and targets could also produce a large noise/sound when impacting the water surface. In addition, exercises such as ASW exercises require the use of sonar or other acoustic transmitters, and Naval gunfire have acoustic effects from: 1) sound generated by firing the gun (muzzle blast), 2) vibration from the blast propagating through the ship's hull, 3) sonic-booms generated by the shell flying through the air, and 4) sound from the impact and explosion of the shell. Some exercises or activities that produce sound or use sonar include:

- Antisubmarine Warfare Tracking Exercise
- Antisubmarine Warfare Torpedo Exercise
- Surface-to-Surface Gunnery Exercise
- Naval Surface Fire Support (Land)

Studies of acoustic capabilities of fishes have been aimed at establishing the range of frequencies (or bandwidth) that a fish can hear, and the "threshold" (lowest level) of the sound detected at each frequency (Hastings and Popper 2005). If, following exposure to intense acoustic input, a higher level of sound is required to detect that frequency, a threshold shift has occurred. For humans, temporary threshold shifts may occur after loud concerts or following exposure to industrial sound. There are two kinds of threshold shifts: temporary threshold shift (TTS) or permanent threshold shift (PTS). A TTS may continue for minutes, hours or days, but the auditory deficit is eventually reversed. With PTS, however, hearing is permanently compromised and never recovers.

Based on current knowledge, all fish are able to perceive lower frequency sounds, from below 50 Hz to 1,500 Hz, whereas some fish have developed accessory hearing structures enabling them to detect higher frequencies over 3,000 Hz (Fay 1988; Ramcharitar and Popper 2004). A select few can even detect sounds over 120 kHz (Mann et al. 2001). Broadly, fishes can be categorized as hearing specialists or hearing generalists. Fishes in the hearing specialist category (e.g. carps, catfishes, and mormyrids) have a broad hearing frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels well above 1,000 Hz, whereas generalists are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). The best hearing sensitivity of many hearing generalists is at or around 300 Hz (Popper 2003).

Hearing specializations are most often found in freshwater species, while in marine species, specializations are quite rare (Amoser and Ladich 2005). It can be argued that the evolution of hearing specializations was facilitated by low ambient sound levels found in lakes, slowly flowing waters, and the deep sea (Amoser and Ladich 2005; Ladich and Bass 2003, Popper

1980). This evolution most likely came about due to the essential need to detect abiotic sound, avoid approaching predators and detect prey, and to a much lesser degree, communicate acoustically (Amoser and Ladich 2005; Fay and Popper 2000).

In summary, most marine fish are hearing generalists, however, a few have been shown to detect sounds in the mid-frequency and ultrasonic range. Species for which hearing above 1 kHz has been discovered are listed as specialists in Table 5-4, and include some clupeids, gadids, sciaenids, holocentrids, and pomacentrids. It should be noted that hearing ranges given pertain to pressure and not particle motion component of sound, which generalist species are most sensitive. It is also important to keep in mind that while these species can detect mid-frequency sounds, their best hearing sensitivities are not in the mid-frequency range. If a sound is at the edge of a fish's hearing range, the sound must be louder in order for it to be detected than if in the more sensitive range.

Table 5-4. Marine Fish Hearing Sensitivities.

Family	Description of Family	Common Name	Scientific Name	Hearing Range (Hz) Low	High	Best Sensitivity (Hz)	Reference
Albulidae	Bonefishes	Bonefish	*Albula vulpes*	100	700	300	Tavolga 1974a
Anguillidae	Eels	European eel	*Anguilla anguilla*	10	300	40-100	Jerkø et al. 1989
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis felis* [2]	50	1,000	100	Popper and Tavolga 1981
Batrachoididae	Toadfishes	Midshipman[3]	*Porichthys notatus*	65	385		Sisneros 2007
		Oyster toadfish	*Opsanus tau*	100	800	200	Fish and Offutt 1972
		Gulf toadfish	*Opsanus beta*			<1,000	Remage-Healy et al. 2006
Clupeidae	Herrings, shads, menhaden, sardines	Alewife	*Alosa pseudoharengus*		120+		Dunning et al. 1992
		Blueback herring	*Alosa aestivalis*		120+		Dunning et al. 1992
		American shad	*Alosa sapidissima*	0.1	180	200-800 and 25-150	Mann et al. 1997
		Gulf menhaden	*Brevoortia patronus*		100+		Mann et al. 2001
		Bay anchovy	*Anchoa mitchilli*		4,000		Mann et al. 2001
		Scaled sardine	*Harengula jaguana*		4,000		Mann et al. 2001
		Spanish sardine	*Sardinella aurita*		4,000		Mann et al. 2001
		Pacific herring	*Clupea pallasii*	100	5,000		Mann et al. 2005
Chondrichthyes [Class]	Rays, sharks, skates	Data are for several different species		200	1,000		See Fay 1988; Casper et al. 2003
Cottidae	Sculpins	Long-spined bullhead	*Taurulus bubalis*				Lovell et al. 2005

2 Formerly *Arius felis*
3 Data obtained using saccular potentials, a method that does not necessarily reveal the full bandwidth of hearing.

Table 5-4. Marine Fish Hearing Sensitivities (cont'd)

Gadidae	Cods, gadiforms, grenadiers, hakes	Atlantic Cod	*Gadus morhua*	2	500	20	Chapman and Hawkins 1973, Sand and Karlsen 1986
		Ling	*Molva molva*	60	550	200	Chapman 1973
		Pollack	*Pollachius pollachius*	40	470	60	Chapman 1973
		Haddock	*Melanogrammus aeglefinus*	40	470	110-300	Chapman 1973
Gobidae	Gobies	Black goby	*Gobius niger*	100	800		Dijkgraaf 1952
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish[4]	*Myripristis kuntee*	100	3,000	400-500	Coombs and Popper 1979
		Hawaiian squirrelfish	*Sargocentron xantherythrum**	100	800		Coombs and Popper 1979
		Squirrelfish	*Holocentrus adscensionis**	100	2,800	600-1,000	Tavolga and Wodinsky 1963
		Dusky squirrelfish	*Sargocentron vexillarium**	100	1,200	600	Tavolga and Wodinsky 1963
Labridae	Wrasses	Tautog	*Tautoga onitis*	10	500	37 - 50	Offutt 1971
		Blue-head wrasse	*Thalassoma bifasciatum*	100	1,300	300 – 600	Tavolga and Wodinksy 1963
Lutjanidae	Snappers	Schoolmaster snapper	*Lutjanus apodus*	100	1,000	300	Tavolga and Wodinksy 1963
Myctophidae[5]	Lanternfishes	Warming's lanternfish	*Ceratoscopelus warmingii*	Specialist			Popper 1977
Pleuronectidae	Flatfish[6]	Dab	*Limanda limanda*	30	270	100	Chapman and Sand 1974
		European plaice	*Pleuronectes platessa*	30	200	110	
Pomadasyidae	Grunts	Blue striped grunt	*Haemulon sciurus*	100	1,000		Tavolga and Wodinsky 1963
Pomacentridae	Damselfish[7]	Sergeant major damselfish	*Abudefduf saxatilis*	100	1,600	100-400	Egner and Mann 2005
		Bicolor damselfish	*Stegastes partitus*	100	1,000	500	Myrberg and Spires 1980
		Nagasaki damselfish[3]	*Pomacentrus nagasakiensis*	100	2,000	<300	Wright et al. 2005, 2007
		Threespot damselfish	*Stegatus planifrons**	100	1,200	500-600	Myrberg and Spires 1980
		Longfish damselfish	*Stegatus diencaeus**	100	1,200	500-600	Myrberg and Spires 1980
		Honey gregory	*Stegatus diencaeus**	100	1,200	500-600	Myrberg and Spires 1980

4 Present in MIRC.
5 Several other species in this family also showed saccular specializations suggesting that the fish would be a hearing specialist. However, no behavioral or physiological data are available.
6 Note, data for these species should be expressed in particle motion since it has no swim bladder. See Chapman and Sand, 1974 for discussion.
7 Formerly all members of this group were *Eupomocentrus*. Some have now been changed to *Stegatus* and are so indicated in this table (as per www.fishbase.org).

Table 5-4. Marine Fish Hearing Sensitivities (cont'd)

		Cocoa damselfish	*Stegastes variabilis**	100	1,200	500	Myrberg and Spires 1980
		Beau gregory[8]	*Stegastes leucostictus**	100	1,200	500-600	Myrberg and Spires 1980
		Dusky damselfish	*Stegastes adustus**[, 9]	100	1,200	400-600	Myrberg and Spires 1980
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<100	580		Hawkins and Johnstone 1978, Knudsen et al. 1994
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulatus*	100	1,000	300	Ramcharitar and Popper 2004
		Spotted seatrout	*Cynoscion nebulosus*	Generalist			Ramcharitar et al. 2001
		Southern kingcroaker	*Menticirrhus americanus*	Generalist			Ramcharitar et al. 2001
		Spot	*Leiostomus xanthurus*	200	700	400	Ramcharitar et al. 2006a
		Black drum	*Pogonias cromis*	100	800	100-500	Ramcharitar and Popper 2004
		Weakfish	*Cynoscion regalis*	200	2,000	500	Ramcharitar et al. 2006a
		Silver perch	*Bairdiella chrysoura*	100	4,000	600-800	Ramcharitar et al. 2004
		Cubbyu	*Pareques acuminatus*	100	2,000	400-1,000	Tavolga and Wodinsky 1963
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*	Generalist			Song et al. 2006
		Yellowfin tuna[3]	*Thunnus albacares*	500	1,100		Iversen 1967
		Kawakawa[3]	*Euthynnus affinis*	100	1,100	500	Iversen 1969
		Skipjack tuna[3]	*Katsuwonus pelamis*	Generalist			Popper 1977
Serranidae	Seabasses, groupers	Red hind	*Epinephelus guttatus*	100	1,100	200	Tavolga and Wodinsky 1963
Sparidae	Porgies	Pinfish	*Lagodon rhomboides*	100	1,000	300	Tavolga 1974b
Triglidae	Scorpionfishes, searobins, sculpins	Leopard searobin	*Prionotus scitulus*	100	~800	390	Tavolga and Wodinsky 1963

Data were compiled from reviews in Fay (1988) and Nedwell et al. (2004). See the very important caveats about the data in the text. For a number of additional species, we can only surmise about hearing capabilities from morphological data. These data are shown in gray, with a suggestion as to hearing capabilities based only on morphology. Scientific names marked with an asterisk have a different name in the literature. The updated names come from www.fishbase.org.

8 Similar results in Tavolga and Wodinsky 1963.
9 Formerly *Eupomacentrus dorsopunicans*.

5.1.4.1 Behavioral Effects

If the sound is loud enough and within the range of frequencies that a fish can hear, a sound will be detected by a fish at some distance from the source. Because of the variable hearing thresholds summarized above, this distance will vary among species. Theoretically, a yellowfin tuna would have to be much closer than an Atlantic cod to hear a low-frequency sound at a given energy level.

Underwater sounds have been used by fishermen to guide herring and other schooling fish to their nets (Yelverton 1981), or to exclude fish from water intakes (Haymes and Patrick 1986). The sounds made by fishing boats can scare some target fish. Sudden changes in sound level can cause fish to dive or to avoid the sound by changing direction. Time of year, whether the fish have eaten, and the nature of the sound signal may all influence how fish will respond to it.

Short, sharp sounds can startle herring. In one study, the fish changed direction and moved away from the 80–92 Hz source, but schooling behavior was not affected (Blaxter et al. 1981). Schwarz and Greer (1984) studied the responses of penned herring to sounds, with the experimental pen being 3.3 m long on each side. The following responses were noted by Schwarz and Greer (1984):

- *Avoidance* when the fish moved slowly away from the sound source.
- *Alarm* when the school packed, fled at high speed, dove repeatedly, and quickly changed directions.
- *Startle* when fish flexed their bodies powerfully and then swam at high speed without changing direction, or shuddered with each blast (the last noted by Pearson et al. 1992).

The low-frequency (<2 kHz) sounds of large vessels or accelerating small vessels usually caused an initial avoidance response among the herring. The startle response was observed occasionally. Avoidance ended within 10 seconds of the “departure” of the vessel. After the initial response, 25 percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound of the small boat. Chapman and Hawkins (1969) also noted that fish adjust rapidly to high underwater sound levels, and Schwartz and Greer (1984) found no reactions to an echosounder and playbacks of sonar signals which are much higher than that of medium-frequency active sonar (MFA). Pearson et al. (1992) conducted a controlled experiment to determine effects of low-frequency (mostly <500 Hz), strong sound pulses on several species of rockfish off the California coast. They used an air gun with a source level of 223 dB re 1 μPa. They noted:

- Startle responses at received levels 200–205 dB re 1 μPa and above for two sensitive fish species (olive and black rockfish), but not for two other species exposed to levels up to 207 dB.
- Alarm responses at 177–180 dB for the two sensitive species, and at 186–199 dB for other species.
- An overall threshold for the above behavioral response at ~180 dB.
- An extrapolated threshold of ~161 dB for subtle changes in the behavior of rockfish that included reduced catchability in a hook and line fishery (Skalski et al. 1992).
- A return to pre-exposure behavior types within the 20–60 minute exposure period.

Popper et al (2005) exposed three freshwater fish species (northern pike, broad whitefish, and lake chub) to 20 airgun shots over 15 min at peak received levels >205 dB re 1 μPa. There were no apparent physical effects, and TTS was found in only two of the species, with recovery within 24 h of exposure.

Experiments conducted by Skalski et al. (1992), Dalen and Raknes (1985), Dalen and Knutsen (1986), and Engas et al. (1996) demonstrated that some fish were forced to the bottom and others driven from the area in response to low-frequency airgun sound. The authors speculated that catch per unit effort would return to normal quickly in their experimental area because behavior of the fish returned to normal minutes after the sounds ceased.

In summary, fish often react to sounds, especially continuous strong and/or intermittent sounds of low frequency (<1 kHz) at received levels of 160 dB re 1 µPa and higher. Low-frequency pulses at levels of 180 dB may cause noticeable changes in behavior such as an alarm response and lowered catchability (Chapman and Hawkins 1973; Pearson et al. 1992; Skalski et al. 1992). These sounds are 80–100 dB over and above the fish's hearing threshold. It appears that fish often habituate to repeated strong sounds rather rapidly, on time scales of minutes to an hour or so. However, the habituation does not endure, and resumption of the disturbing activity may again elicit disturbance responses from the same fish.

5.1.4.2 Physiological Effects

Several studies have shown that underwater explosions or other loud, impulsive sounds can cause injury or mortality in fishes (Hastings and Popper 2005) if the animals are close enough to the explosion. Unlike MFA, impulsive sounds are low-frequency, broadband sounds that are probably within most fishes' hearing range. Experiments by Engas et al. (1996) and by Engas and Lokkeburg (2002) showed decreased catches of cod and haddock for several days after a seismic airgun was used in the area. Slotte et al. (2004) showed similar effects of airguns on blue whiting and Norwegian spring spawning herring; and Skalski et al. (1992) showed a 52% decrease in rockfish catch after a single airgun emission. Thus, fish have been shown to be affected by anthropogenic sounds however, these sounds were not in the frequency range of the operational sonars of the Proposed Action. Effects, are therefore, not anticipated to be similar, and explained in later in this section.

5.1.4.3 Examples and Effects of Sound Sources

5.1.4.3.1 Vessel Movement

The sound from Navy vessels could affect fish behavior. However, Navy vessels are quiet compared to commercial vessels.

Studies documenting behavioral responses of fish to vessels show that fish may exhibit avoidance responses to engine sound, sonar, depth finders, and fish finders . Avoidance reactions are quite variable depending on the type of fish, its life history stage, behavior, time of day, and, the sound propagation characteristics of the water (Schwartz 1985). Misund (1997) found that fish ahead of a ship, that showed avoidance reactions, did so at ranges of 160 to 490 ft (50 to 350 m). When the vessel passed over them, some species of fish responded with sudden escape responses that included lateral avoidance and/or downward compression of the school.

The low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses among the herring (Chapman and Hawkins 1973). Avoidance ended within 10 seconds after the vessel departed. Twenty five percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound small boats.

Fish are capable of active avoidance and ship strikes would be a rare event. Behavioral impacts would be transient with return to normal behavior after a ship passes. MIRC vessel movement would not have adverse effects on EFH.

5.1.4.3.2 Naval Gun Fire

Firing a deck gun produces a shock wave in air that propagates away from the muzzle in all directions, including toward the air/water surface. Direct measurements of shock wave pressures transferred through the air/water interface from the muzzle blast of a 5-inch gun are well below levels known to be harmful at shallow depths (DoN 2000, Yagla and Stiegler 2003). Navy watch standers would observe waters surrounding the ship to ensure significant biological aggregations are not in proximity to the ship during firing exercises. Sound produced during gunfire may disturb fish in the vicinity of the ship. Because the sound is brief, no extended disruption of fish behavior is expected.

Gun fire sends energy through the ship structure, into the water, and away from the ship. This effect was also investigated in conjunction with the measurement of 5-inch caliber gun blasts described above (DoN 2000, Yagla and Stiegler 2003). The energy transmitted through the ship to the water for a typical round was found to be about 6% of that from the air blast impinging on the water. Therefore, sound transmitted from the gun, through the hull into the water should have negligible impact on marine life.

The sound generated by a shell in its flight at supersonic speeds above the water is transmitted into the water in much the same way as a muzzle blast (Pater 1981). The region of underwater sound influence from a single traveling shell is relatively small, diminishes quickly as the shell gains altitude, and is of short duration. The penetration of sound through the air\water interface is relatively limited (Miller 1991, Yagla and Stiegler 2003). Studies reviewed in DoN 2007surfret indicate only a small number of submerged species would be exposed to the pressure waves from sonic booms from 5-inch shells fired during routine training exercises.

The potential exists for energy from multiple sonic booms to accumulate over time from multiple, possibly rapid firings of a gun. However, because the area directly below the shells' path, where the conditions are correct for energy to enter the ocean is small, it is highly unlikely that the energy from more than two or three shells would be additive.

Behavioral effects from the sound of Naval gunnery shells exploding would be similar to that already described for other types of underwater explosions. Although fish in the vicinity of the explosion may exhibit avoidance reactions, the sounds generated are relatively short-term and localized, and behavioral disruptions would not be expected to have lasting impacts on the survival, growth, or reproduction of fish populations.

5.1.4.3.3 Sonar

ASW and MIW exercises include training sonar operators to detect, classify, and track underwater objects and targets. There are two basic types of sonar: passive and active. Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment. Active sonars emit acoustic energy to obtain information about a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern, ultra-quiet submarines and sea mines in shallow water.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit acoustic pulses ("pings") and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonars emit a ping and then scan the received beam to provide directional as well as range information. Only about half of the U.S. Navy's ships are equipped with active sonar and their use is generally limited to training and maintenance activities - 90% of sonar activity by the Navy is passive (DoN 2007b).

Active sonars operate at different frequencies, depending on their purpose. High frequency sonar (>10 kHz) is mainly used for establishing water depth, detecting mines, and guiding torpedoes. At higher frequencies, sound energy is greatly attenuated by scattering and absorption as it travels through the water. This results in shorter ranges, typically less than five nautical miles. Mid frequency sonar is the primary tool for identifying and tracking submarines. Mid frequency sonar (1 kHz - 10 kHz) suffers moderate attenuation and has typical ranges of 1-10 nautical miles. Low frequency sonar (<1 kHz) has the least attenuation, achieving ranges over 100 nautical miles. Low frequency sonars are primarily used for long-range search and surveillance of submarines. Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) is the U.S. Navy's low frequency sonar system (DoN 2001b, 2005d). It employs a vertical array of 18 projectors using the 100-500 Hz frequency range.

Sonars used in ASW are predominantly in the mid frequency range (DoN 2007b). ASW sonar systems may be deployed from surface ships, submarines, and rotary and fixed wing aircraft. The surface ships are typically equipped with hull mounted sonar but may tow sonar arrays as well. Helicopters are equipped with dipping sonar (lowered into the water). Helicopters and fixed wing aircraft may also deploy both active and passive sonobuoys and towed sonar arrays to search for and track submarines.

Submarines also use sonars to detect and locate other subs and surface ships. A submarine's mission revolves around stealth, and therefore submarines use their active sonar very infrequently since the pinging of active sonar gives away their location. Submarines are also equipped with several types of auxiliary sonar systems for mine avoidance, for top and bottom soundings to determine the submarine's position in the water column, and for acoustic communications. ASW training targets simulating submarines may also emit sonic signals through acoustic projectors.

Sonars employed in MIW training are typically high frequency (greater than 10 kHz). They are used to detect, locate, and characterize mines that are moored, laid on the bottom, or buried (DoN 2002b, 2005e, 2005f). MIW sonars can be deployed from multiple platforms including towed systems, unmanned underwater vehicles (UUVs), surf zone crawlers, or surface ships.

Torpedoes use high-frequency, low-power, active sonar. Their guidance systems can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for tracking and targeting.

Military sonars for establishing depth and most commercial depth sounders and fish finders operate at high frequencies, typically between 24 and 200 kHz.

5.1.4.3.3.1 Low Frequency Sonar

Low frequency sound travels efficiently in the deep ocean and is used by whales for long-distance communication (Richardson et al. 1995, NRC 2003, 2005). Concern about the potential for low frequency sonar (<1 kHz) to interfere with cetacean behavior and communication has prompted extensive debate and research (DoN 2001b, 2005d, NRC 2000, 2003).

Some studies have shown that low frequency sound will alter the behavior of fish. For example, research on low frequency devices used to deter fish away from turbine inlets of hydroelectric power plants showed stronger avoidance responses from sounds in the infrasound range (5-10 Hz) than from 50 and 150 Hz sounds (Knudsen et al. 1992, 1994). In test pools, wild salmon exhibit an apparent avoidance response by swimming to a deeper section of the pool when exposed to low frequency sound (Knudsen et al. 1997).

Turnpenny et al. (1994) reviewed the risks to marine life, including fish, of high intensity, low frequency sonar. Their review focused on the effects of pure tones (sine waves) at frequencies between 50-1000 Hz. Johnson (2001) evaluated the potential for environmental impacts of employing the SURTASS LFA sonar system. While concentrating on the potential effects on whales, the analysis did consider the potential effects on fish, including bony fish and sharks. It appears that the swimbladders of most fish are too small to resonate at low frequencies and that only large pelagic species such as tunas have swimbladders big enough to resonate in the low frequency range. However, investigations by Sand and Hawkins (1973), and Sand and Karlsen (1986) revealed resonance frequencies of cod swim bladders from 2 kHz down to 100 Hz.

Hastings et al. (1996) studied the effects of low frequency underwater sound on fish hearing. More recently, Popper et al. (2005) investigated the impact of U. S. Navy SURTASS LFA sonar on hearing and on non-auditory tissues of several fish species. In this study, three species of fish in Plexiglas cages suspended in a freshwater lake were exposed to high intensity LFA sonar pulses for periods of time considerably longer than likely LFA exposure. Results showed no mortality and no damage to body tissues either at the gross or histological level. Some individuals exhibited temporary hearing loss but recovered within several days of exposure. The study suggests that SURTASS LFA sonar does not kill or damage fish even in a worst case scenario.

Although some behavioral modification might occur, adverse impacts from low frequency sonar on fish are not expected.

5.1.4.3.3.2 Mid Frequency Sonar

ASW training activities use mid frequency (1-10 kHz) sound sources. Most fish only detect sound within the 1-3 kHz range (Popper 2003, Hastings and Popper 2005). Thus, it is expected that most fish species would be able to detect the ASW mid frequency sonar at the lower end of its frequency range.

Some investigations have been conducted on the effect on fish of acoustic devices designed to deter marine mammals from gillnets (Gearin et al. 2000, Culik et al. 2001). These devices generally have a mid frequency range, similar to the sonar devices that would be used in ASW exercises. Adult sockeye salmon exhibited an initial startle response to the placement of inactive acoustic alarms designed to deter harbor porpoise. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not show any reaction or behavior change except for the initial startle response. This demonstrated that the alarms were either inaudible to the fish, or the fish were not disturbed by the mid frequency sound.

Jørgensen et al. (2005) carried out experiments examining the effects of mid frequency (1 to 6.5 kHz) sound on survival, development, and behavior of fish larvae and juveniles. Experiments were conducted on the larvae and juveniles of Atlantic herring, Atlantic cod, saithe *Pollachius virens*, and spotted wolfish *Anarhichas minor*. Swimbladder resonance experiments were attempted on juvenile Atlantic herring, saithe, and Atlantic cod. Sound exposure simulated Naval sonar signals. These experiments did not cause any significant direct mortality among the exposed fish larvae or juveniles, except in two (of a total of 42) experiments on juvenile herring where significant mortality (20-30%) was observed. Among fish kept in tanks one to four weeks after sound exposure, no significant differences in mortality or growth related parameters (length, weight and condition) between exposed groups and control groups were observed. Some incidents of behavioral reactions were observed during or after the sound exposure - ‘panic’ swimming or confused and irregular swimming behavior. Histological studies of organs, tissues, or neuromasts from selected Atlantic herring experiments did not reveal obvious differences between control and exposed groups.

The work of Jørgensen et al. (2005) was used in a study by Kvadsheim and Sevaldsen (2005) to examine the possible 'worse case' scenario of sonar use over a spawning ground. They conjectured that normal sonar activities would affect less than 0.06% of the total stock of a juvenile fish of a species, which would constitute less than 1% of natural daily mortality. However, these authors did find that the use of continuous-wave transmissions within the frequency band corresponding to swim bladder resonance will escalate this impact by an order of magnitude. The authors therefore suggested that modest restrictions on the use of continuous-wave transmissions at specific frequencies in areas and at time periods when there are high densities of Atlantic herring present would be appropriate.

Experiments on fish classified as hearing specialists (but not those classified as hearing generalists) have shown that exposure to loud sound can result in temporary hearing loss, but it is not evident that this may lead to long-term behavioral disruptions in fish that are biologically significant (Amoser and Ladich 2003, Smith et al. 2004 a,b). There is no information available that suggests that exposure to non-impulsive acoustic sources results in fish mortality.

In summary, most species of fish species would be expected to detect mid frequency sonar at the lower end of its frequency range. Behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected to occur. Sensitive life stages (juvenile fish, larvae and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

5.1.4.3.3.3 High Frequency Sonar

Although most fish cannot hear sound frequencies over 10 kHz, some shad and herring species can detect sounds in the ultrasonic range, i.e., over 20 kHz. (Mann 2001, Higgs et al. 2004). Ross et al. (1995, 1996) reviewed the use of high frequency sound to deter alewives from entering power station inlets. The alewife, a member of the herring family (Clupeidae) and shad subfamily (Alosinae) can hear sounds at ultrasonic frequencies (Mann et al., 2001), uses high frequency hearing to detect and avoid predation by cetaceans. Wilson and Dill (2002) demonstrated that exposure to broadband sonar-type sounds with high frequencies cause behavioral modification in Pacific herring.

Since high-frequency sound attenuates quickly in water, high levels of sound from mine hunting sonars would be restricted to within a few meters of the source. Even for fish able to hear sound at high frequencies, only short-term exposure would occur, thus high frequency military sonars are not expected to have significant effects on resident fish populations.

Because a torpedo emits sonar pulses intermittently and is traveling through the water at a high speed, individual fish would be exposed to sonar from a torpedo for a brief period. At most, an individual animal would hear one or two pings from a torpedo and would be unlikely to hear pings from multiple torpedoes over an exercise period. Most fish hear best in the low- to mid-frequency range and therefore are unlikely to be disturbed by torpedo pings.

Dipping sonar is also only active for short periods. Sonobuoys operate at relatively high frequencies, well beyond the hearing range of most fish. The area within which fish could hear the high frequency signals from active sonobuoys would be limited by the low signal strengths emitted.

The effects of high frequency sonar, on fish behavior, for species that can hear high frequency sonar, would be transitory and of little biological consequence. Most species would probably not hear these sounds and would therefore experience no disturbance.

5.1.4.4 Invertebrate Hearing and Sound Production

Very little is known about sound detection and use of sound by invertebrates (see Budelmann 1992a, b, Popper et al. 2001 for reviews). The limited data indicates that some crabs are able to detect sound, and there has been the suggestion that some other groups of invertebrates are also able to detect sounds. In addition, cephalopods (octopus and squid) and decapods (lobster, shrimp, and crab) are thought to sense low-frequency sound (Budelmann 1992b). Packard et al. (1990) reported sensitivity to sound vibrations between 1-100 Hz for three species of cephalopods. Lovell et al. (2005) concluded that at least one species from the invertebrate sub-phylum of crustacean (*Palaemon serratus*), is sensitive to the motion of water particles displaced by low frequency sounds ranging from 100 Hz up to 3000 Hz. Wilson et al. (2007) documents a lack of physical or behavioral response for squid exposed to experiments using high intensity sounds designed to mimic killer whale echolocation signals. In contrast, McCauley et al. (2000) reported that caged squid would show behavioral responses when exposed to sounds from a seismic airgun.

There has also been the suggestion that invertebrates do not detect pressure since few, if any, have air cavities that would function like the fish swim bladder in responding to pressure (URI 2007). It is important to note that some invertebrates, and particularly cephalopods, have specialized end organs, called statocysts, for determination of body and head motions that are similar in many ways to the otolithic end organs of fish. The similarity includes these invertebrates having sensory cells which have some morphological and physiological similarities to the vertebrate sensory hair cell, and the “hairs” from the invertebrate sensory cells are in contact with a structure that may bear some resemblance to vertebrate otolithic material (reviewed in Budelmann 1992a, b). As a consequence of having statocysts, it is possible that these species could be sensitive to particle displacement (Popper et al. 2001).

It is also important to note that invertebrates may have other organs that potentially detect the particle motion of sound, the best known of which are special water motion receptors known as chordotonal organs (e.g., Budelmann 1992a). These organs facilitate the detection of potential predators and prey and provide environmental information such as the movement of tides and currents. Indeed, fiddler crab (*Uca* sp.) and spiny lobster (*Panulirus* sp.) have both been shown to use chordotonal organs to respond to nearby predators and prey.

Like fish, some invertebrate species produce sound, with the possibility that it is used for communication. Sound is used in territorial behavior, to deter predators, to find a mate, and to pursue courtship (Popper et al. 2001). Well known sound producers include lobsters (*Panulirus* sp.) (Latha et al. 2005) and snapping shrimp (Alpheus heterochaelis) (Heberholz and Schmitz 2001). Of all marine invertebrates, perhaps the one best known to produce sound are the snapping shrimp (Heberholz and Schmitz 2001). Snapping shrimp are found in oceans all over the world and make up a significant portion of the ambient sound budget in many locales (Au and Banks 1998).

McCauley et al. (2000) found evidence that squid exposed to seismic airguns show a behavioral response including inking. However, these were caged animals, and it is not clear how unconfined animals may have responded to the same signal and at the same distances used. In another study, Wilson et al. (2007) played back echolocation clicks of killer whales to two groups of squid (*Loligo pealeii*) in a tank. The investigators observed no apparent behavioral effects or any acoustic debilitation from playback of signals up to 199 to 226 dB re 1 μPa. It should be noted, however, that the lack of behavioral response by the squid may have been because the animals were in a tank rather than being in the wild.

In another report on squid, Guerra et al. (2004) claimed that dead giant squid turned up around the time of seismic airgun operations off of Spain. The authors suggested, based on analysis of carcasses, that the damage to the squid was unusual when compared to other dead squid found at other times. However, the report presents conclusions based on a correlation to the time of finding of the carcasses and seismic testing, but the evidence in support of an effect of airgun activity was totally circumstantial. Moreover, the data presented showing damage to tissue is highly questionable since there was no way to differentiate between damage due to some external cause (e.g., the seismic airgun) and normal tissue degradation that takes place after death, or due to poor fixation and preparation of tissue. To date, this work has not been published in peer-reviewed literature, and detailed images of the reportedly damaged tissue are also not available.

There has been a recent and unpublished study in Canada that examined the effects of seismic airguns on snow crabs (DFO 2004). However, the results of the study were not at all definitive, and it is not clear whether there was an effect on physiology and reproduction of the animals.

There is also some evidence that an increased background sound (for up to three months) may affect at least some invertebrate species. Lagardère (1982) demonstrated that sand shrimp (*Crangon crangon*) exposed in a sound proof room to sound that was about 30 dB above ambient for three months demonstrated decreases in both growth rate and reproductive rate. In addition, Lagardère and Régnault (1980) showed changes in the physiology of the same species with increased sound, and that these changes continued for up to a month following the termination of the signal.

Finally, there was a recently published statistical analysis that attempted to correlate catch rate of rock lobster in Australia over a period of many years with seismic airgun activity (Parry and Gason 2006). The results, while not examining any aspects of rock lobster behavior or doing any experimental study, suggested that there was no effect on catch rate from seismic activity.

5.1.5 SUMMARY

Physical disruptions of the open ocean habitat from proposed activities, such as shock waves, expended materials, underwater detonations, and sound could result in temporary and localized impacts on FMP species due to the unavoidable direct loss of pelagic fishes and larvae, and potential prey items. However, given the random distribution of juvenile and adult pelagic fish species, planktonic eggs and larvae, and prey items, the relatively large area of the MIRC, and the relatively infrequent number of training activities in any given area, recovery is expected to occur quickly, and no long-term adverse impacts on ecosystem structure and function or ecosystem services are anticipated.

5.2 PHYSICAL DESTRUCTION OR ADVERSE MODIFICATION OF BENTHIC HABITATS

The majority of the training activities that use live munitions, bombs, or missiles occur in the open ocean away from sensitive nearshore habitats. However, some training activities involving the use of explosives, or traversing with vessels (e.g., LCAC, CRRC), vehicles, and troops in nearshore waters may damage EFH or HAPC, such as rocky substrate or coral reef habitat. Some examples of exercises that may result in temporary impacts to benthic habitats include:

- Ship to Objective Maneuver
- Sink Exercise
- Air to Ground Bombing Exercises
- Air to Ground Missile Exercises
- Insertion/Extraction
- Direct Action
- Over the Beach
- Naval Surface Fire Support

- Expeditionary Raid
- Underwater Demolition

Rocky substrate can support extensive communities and provides habitat for a diverse ecosystem of fish, invertebrates, and algae. Live bottoms, as defined by the Bureau of Land Management, are areas "containing biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, and hard corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and whose lithotope favors accumulation of turtles, pelagic and demersal fish."

In the MIRC, colonized hardbottom, macroalgae, invertebrates, and deep-slope terraces are found on every island (Figures 3-7, 3-8, 3-9). Subtidal colonized hardbottom habitats in the Mariana Islands include coral reefs and communities and deep-slope terrace, and the marine benthic invertebrate assemblages are extremely diverse and include representatives of nearly all phyla.

The WPRFMC identifies HAPC, which are specific habitats within EFH that are of greater importance to the life cycle of federally managed species. For example, HAPC for all life stages of the CRE MUS includes all hardbottom substrate between 0 and 100 m depth in the study area. Five individual HAPC sites have been identified for the island of Guam, one of which, Jade Shoals, occurs within Apra Harbor. Orote Point Ecological Reserve Area lies immediately outside of Apra Harbor. The remaining three occur in the northern (Ritidian Point), northwest (Haputo Ecological Preserve), and southern (Cocos Lagoon) areas of Guam (WPRFMC 2001). Another example of HAPC designated in the MIRC study area includes all slopes and escarpments between 40 and 280 m for all life stages of the BMUS.

5.2.1 DETONATIONS IN NEARSHORE WATERS

Training activities using live ordnance in nearshore waters may have direct effects on EFH (see Section 5.1), and additionally, may directly affect sensitive EFH and/or HAPC due to the greater likelihood of encountering rocky substrate that may support managed species. Training activities, such as BOMBEX (Land), MISSILEX (A-G), and FIREX (Land) have occurred at FDM since 1971, and although there are designated targets on land, short shots may damage rocky intertidal and subtidal habitat that support managed species (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). Existing habitat data indicates that the nearshore waters of FDM are predominantly ephemeral or opportunistic turf species, with relatively low coral densities (Figure 5-1); however, the data do not allow a detailed analysis due to the lack of resolution. It is likely that these training activities may have temporary, localized impacts to EFH, although annual surveys suggest the near shore marine natural resources at FDM are thriving, and that the island is serving as a de-facto preserve due to the restricted fishing access (DoN 2006, DoN 2009).

EOD training activities involve the locating and neutralizing of a deepwater mine by EOD divers. The neutralization of the mine (the portion of the exercise that involves the use of ordnance) is typically scheduled during daylight hours for safety reasons and completed within a two hour period. Divers deploy from combat rubber raiding craft (CRRC) and a diver will place the explosive next to or on each inert mine shape. Once the neutralization charge is placed on or near the mine, the divers will return to the CRRC and proceed to a safe location for detonation. Based on charge size and operating conditions, EOD will determine a "safe time" and distance needed from the mine before they detonate the charge. Typically two shots per training event are conducted, with a second charge detonated one to two hours after the first shot. After the detonation portion of the exercise is completed, the mine shape is typically recovered unless destroyed by the charge. Divers are redeployed to the detonation area to verify that the mine shape was destroyed or to aid in recovery of the mine. Mine Neutralization training in Inner

Apra Harbor (IAH) is conducted by EODMU-5 and consists of locating and neutralizing LIMPET mines (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations).

Shallow water MCM sites include Tipalao Beach, while deepwater MCM sites are located in Outer Apra Harbor at a depth of 125 ft (38 m), and Dadi Beach, in a water depth ranging from 108 to 115 ft (33 to 35 m). The Piti Floating Mine Neutralization Area lies north of Apra Harbor and supports some EOD training.

Agat Bay supports deepwater EOD MCM training and dive training activites (Figure 5-2). Underwater detonation charges up to 10 pounds are permitted (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). Hydrographic surveys are periodically conducted in this area in conjunction with coral surveys. Dadi Beach has a shallow nearshore reef, with algae, small reef fish, starfish, and sea cucumbers. Corals in this zone are rare, but present. Tipalao Beach has essentially no macrobiota on either the reef flat or the hard, scoured substrate beyond the rubble flat (MRC 1997). The beach rock bench in the Tipalao Beach intertidal zone is barren of macroorganisms other than short algal turfs. The sand zone, within which coral are virtually absent, extends to approximately 65 ft (20 m) offshore and does not exceed 3 ft (1 m) in depth. Throughout Tipalao Bay, benthic biota are extremely uncommon (MRC 1997); living corals comprise less than one percent bottom cover, and benthic macrofauna are essentially absent (Figure 5-2).

Detonations in nearshore subtidal habitat can lead to a temporary and localized impact on FMP species due to death or injury, and depending on the location of the charge, the loss of benthic epifauna and infauna that may serve as prey items for managed species, and increased turbidity. Mobile species are expected to rapidly move back into the area following detonations, whereas sedentary species would be eliminated and may or may not recover to previous abundances depending on the spatial overlap and time interval between detonations. Increases in turbidity could temporarily decrease the foraging efficiency of fishes, however, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized.

For mine neutralization training activities, all demolition activities are conducted in accordance with Commander Naval Surface Forces Pacific (COMNAVSURFPAC) Instruction 3120.8F, Procedures for Disposal of Explosives at Sea/Firing of Depth Charges and Other Underwater Ordnance. Before any explosive is detonated, divers are transported a safe distance away from the explosive. Standard practices for tethered mines require ground mine explosive charges to be suspended 10 feet below the surface of the water. For mines on the shallow water floor (less than 40 feet of water), only sandy areas that avoid/minimize potential impacts to coral are used for explosive charges.

5.2.2 BEACH LANDING TRAINING ACTIVITIES

Amphibious landings consist of a seaborne force from over the horizon assaulting across a beach in a combination of helicopters, aircraft, landing craft air cushion (LCAC), light armored vehicle (LAV), CRRCs, or other landing craft. Locations where amphibious landings occur in the MIRC include the Exclusive Military Use Area (EMUA), which is DoD-leased land covering the northern third of Tinian. The EMUA has two small sandy beaches (Unai Chulu and Unai Dankulo) that are capable of supporting amphibious landing training activities. Existing habitat data indicates that the nearshore waters of Unai Chulu and Unai Dankulo are predominantly ephemeral turf species, with relatively low coral densities (Figures 5-3 and 5-4); however, these data do not allow a detailed analysis due to the lack of resolution. Recent surveys conducted at Unai Chulu indicated that the reef crest is shallow, except where cut by a deeper channel in the reef crest (USMC 2009). The reef crest appears to have a high density of coral colonies, while the reef slope is a well-developed spur and groove system that grades steeply with depth.

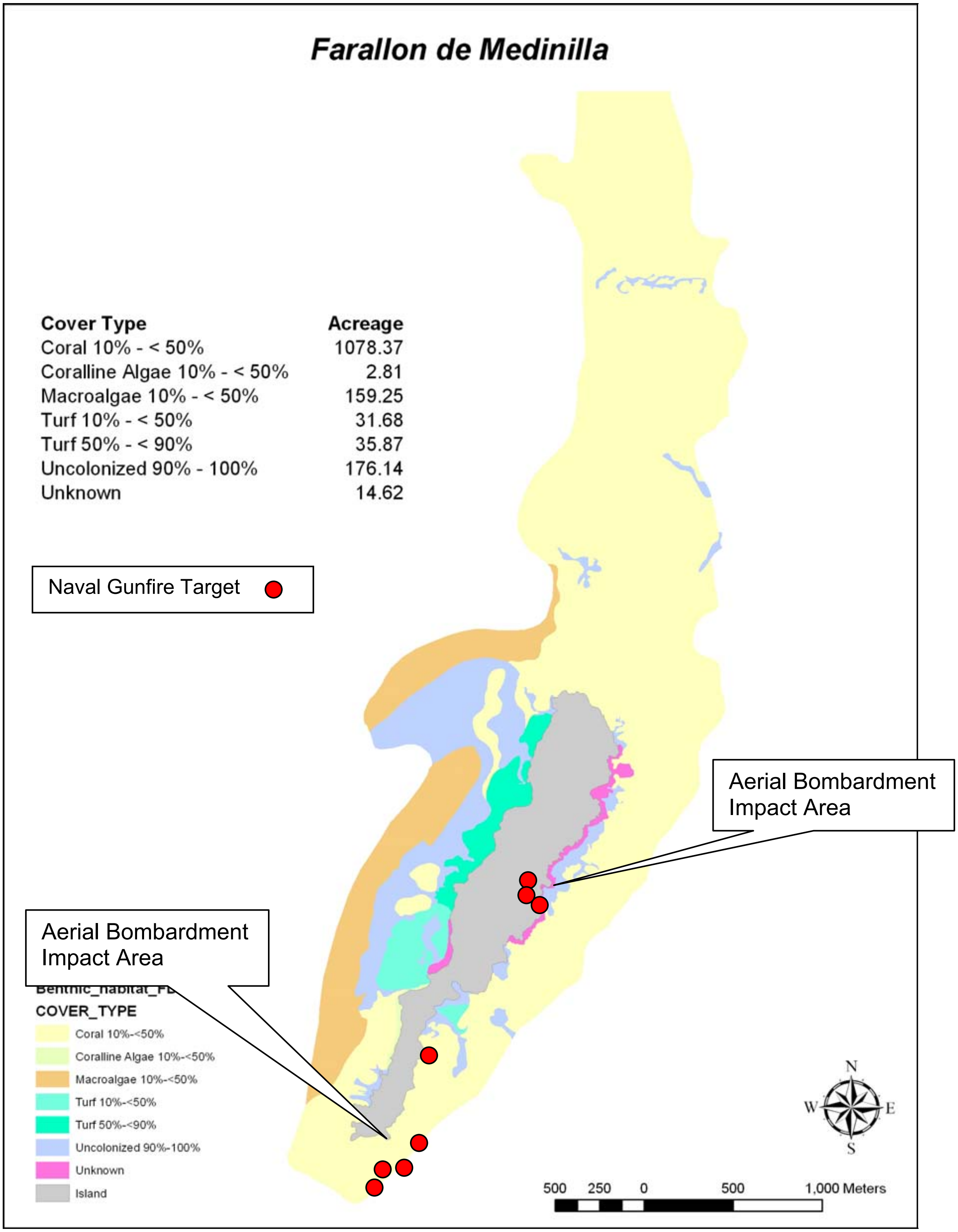


Figure 5-1. Nearshore benthic habitats of Farallon de Medinilla: Live cover. Source data: NCCOS/NOAA (2005).

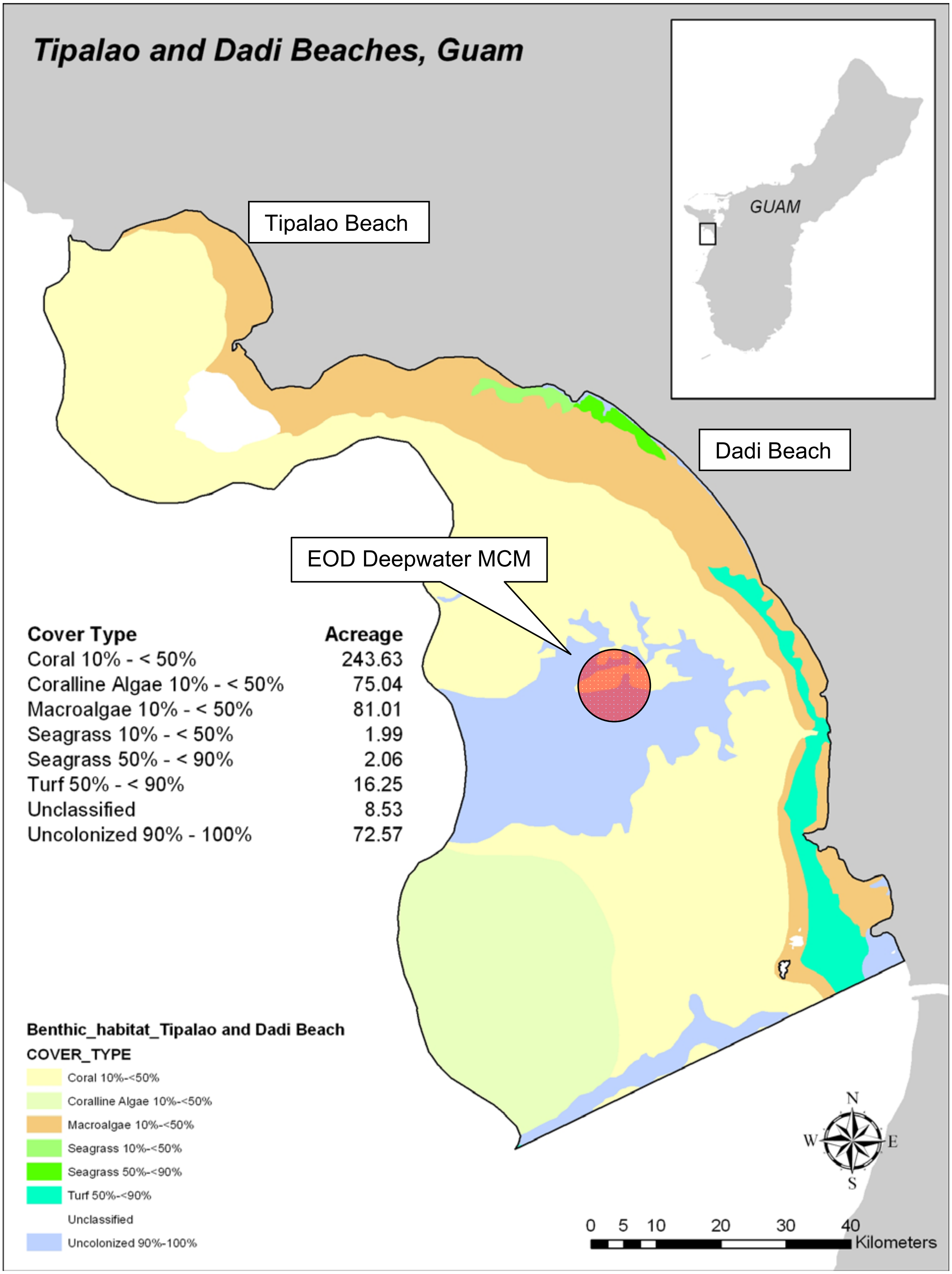


Figure 5-2. Nearshore benthic habitats of Agat Bay: Live cover. Source data: NCCOS/NOAA (2005).

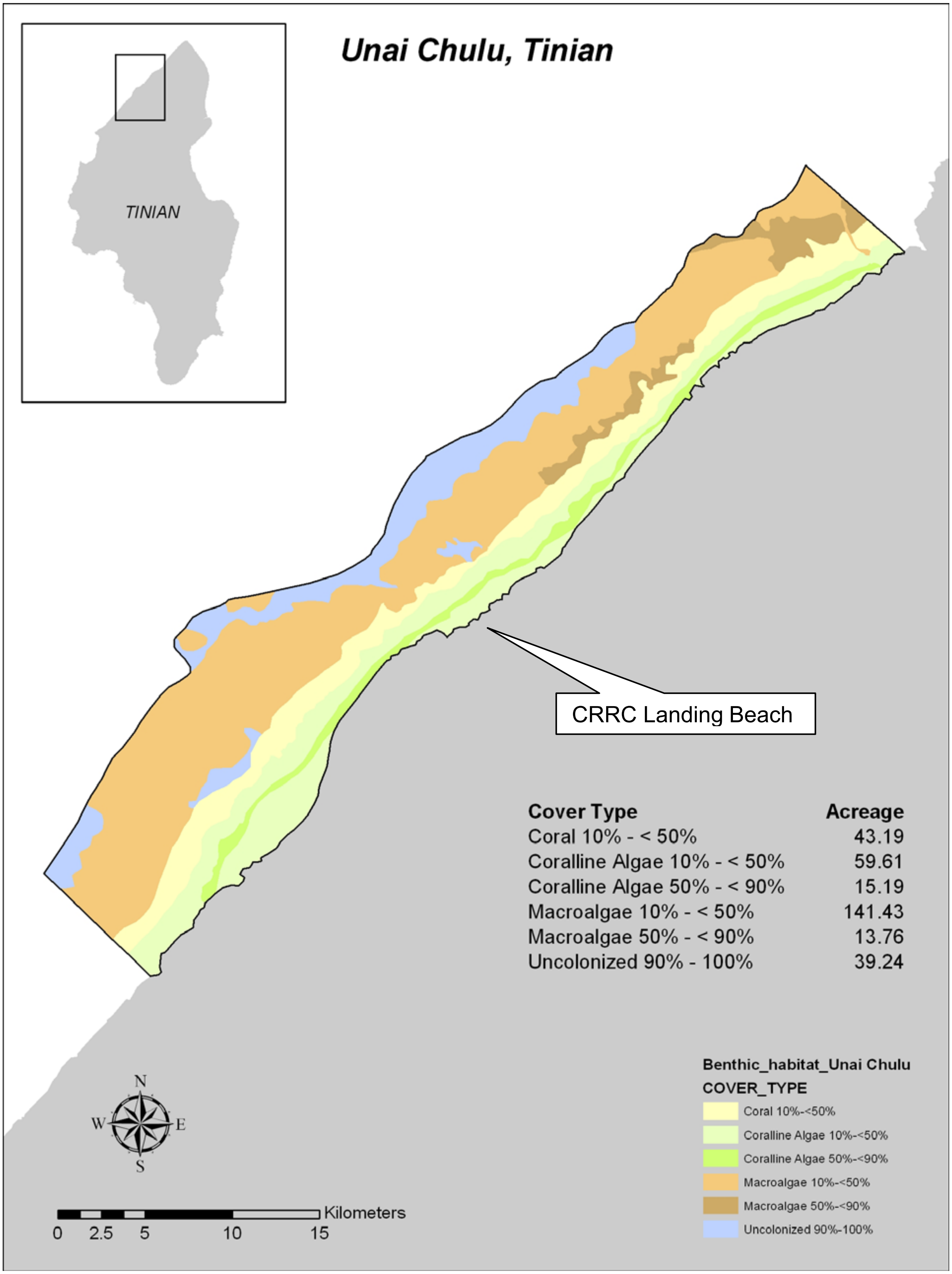


Figure 5-3. Nearshore benthic habitats of the Unai Chulu, Tinian: Live cover. Source data: NCCOS/NOAA (2005).

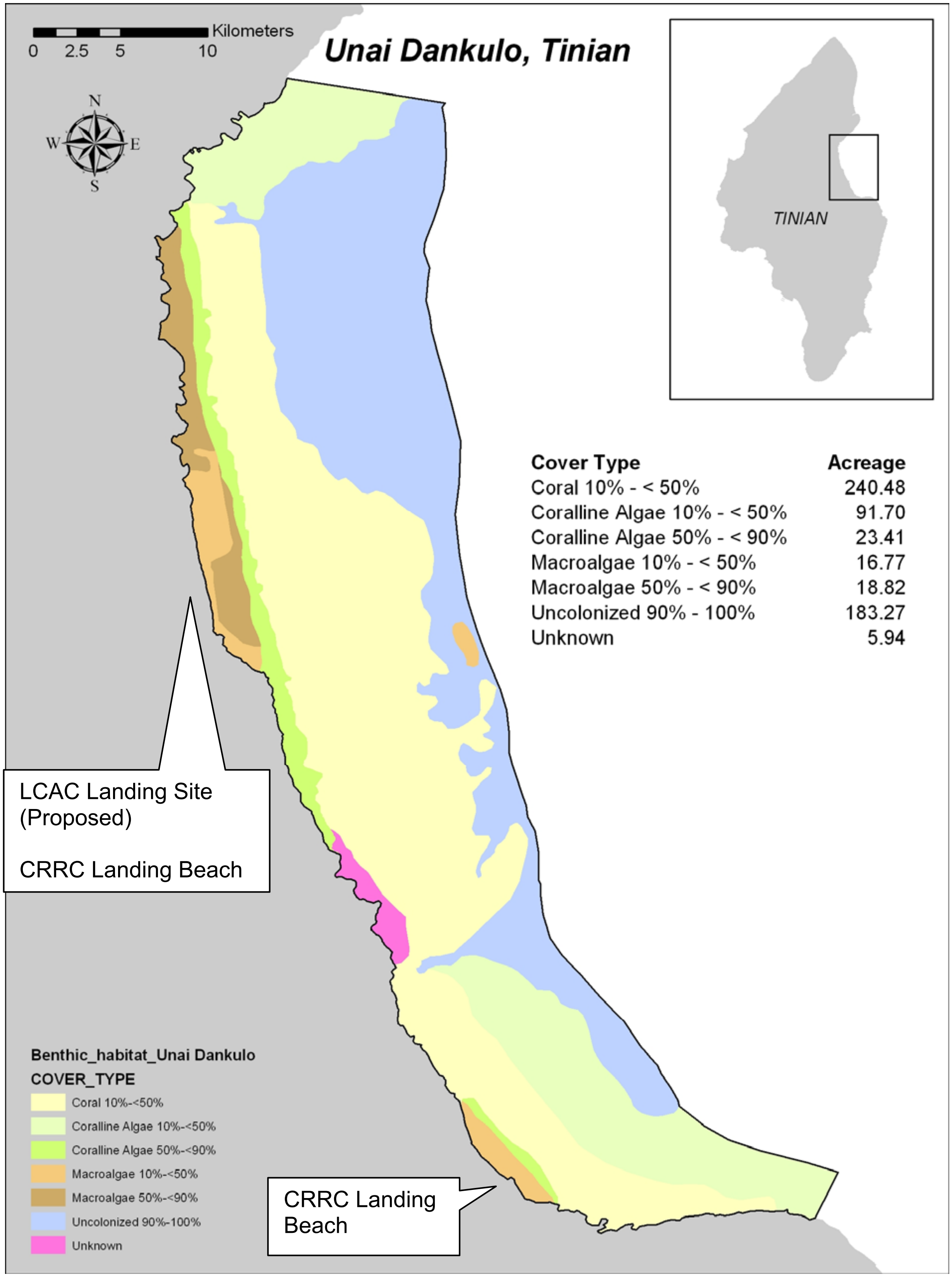


Figure 5-4. Nearshore benthic habitats of Unai Dankulo, Tinian: Live cover. Source data: NCCOS/NOAA (2005).

Fifteen coral taxa in seven genera were found on the Unai Chulu reef flat, with corals in the genus *Acropora* the most common. The coral community on the reef slope was taxonomically diverse with 79 taxa in 24 genera observed, and appeared to be a typical spur and groove coral community, dominated primarily by the taxa in the genera *Goniastrea*, *Favia*, and *Galaxea* (USMC 2009).

In contrast to Unai Chulu, Unai Dankulo consists of numerous long sandy beaches within a wide embayment. The beaches are fronted by a wide reef flat with a shallow reef crest. The Unai Dankulo reef flat had the highest coral density (4.65 ± 1.87 colonies/m^2) and richness (25 taxa in 13 genera) of all the reef flats surveyed in this study, which included Unai Babui and Unai Chulu. The reef slope is a well-developed spur and groove system that grades gently with depth. The Unai Dankulo reef slope had 2.4 times the taxa richness of the reef flat, and had the highest overall taxa richness of all the areas surveyed. The coral community on the reef slope was comprised of 80 taxa in 24 genera, the highest richness found for a single area in the study. Densities of fish and corals were higher on the reef slope than the reef flat, but no trend was apparent for algal cover and non-coral invertebrate densities (USMC 2009).

It is likely that these training activities may have temporary and localized impacts to EFH. Another location includes Tipalao Cove, which provides access to a small beach area capable of supporting a shallow draft amphibious landing craft. As noted in the previous section, benthic biota are extremely uncommon in Tipalao Bay; living corals comprise less than one percent bottom cover, and benthic macrofauna are essentially absent (Figure 5-2).

Although amphibious landings are restricted to specific areas of designated beaches, amphibious landings in nearshore areas can lead to a temporary and localized impact on FMP species due to death or injury, loss of benthic epifauna and infauna that may serve as prey items for managed species, and increased turbidity. Increases in turbidity could temporarily decrease the foraging efficiency of fishes. In sandy areas, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Although corals are not common in the channels that are used for training, recovery to coral that is affected by amphibious landings would be dependent upon the frequency of additional disturbances and other natural factors. Protective measures are in place to insure that impacts to sensitive habitat are avoided and include pre- and post-activity hydrographic surveys, landing at high tide, and monitoring.

As detailed in Chapter 5, conservation measures for amphibious landings and land-based training at Guam and Tinian to reduce the effects to sea turtles associated with amphibious landing activities, the Navy implements the following training measures, which were minimization measures included in previous consultations with USFWS:

- The Navy maintains a sea turtle nesting monitoring program on beaches on DoD property on Guam. Monitoring on Guam occurs on a weekly basis by NAVFACMAR natural resource specialists.
- The Navy began a monitoring program for sea turtles on Tinian in 1998, which involves surveys of all sandy areas within military lease lands on Tinian on a monthly basis (approximate) (DoN 2008b). During the monthly surveys, crawls, nests, potential nests, body pits, and hatchling tracks are noted. Monitoring occurs at Unai Dankulo (Long Beach), Unai Chulu, Unai Masalok, and Unai Lamlam. Lepresarium Beach was once part of the monitoring program, however, monitoring at this location ceased when the MLA boundary was updated to not include this beach. In addition to beach surveys, the Navy conducts semiannual in-water surveys at Unai Chulu and Unai Babui. Surveys also are conducted semiannually at Unai Lamlam to serve as a control site for baseline sea turtle activity where no landings occur. Semiannual surveys measure percent coral

cover, turbidity, fish assemblage, sedimentation rates, and site topography. Monitoring data is shared with both CNMI DFW and USFWS.

- The Navy maintains "No Wildlife Disturbance" (NWD) and "No Training" (NT) areas at Orote Peninsula, Tarague Beach, Unai Chulu, Unai Chiget, and Unai Dankulo (Long Beach). Cross-country off-road vehicle travel, pyrotechnics, demolition, digging/excavation (without prior approval of Joint Region Marianas or 36 Civil Engineering Squadron (CEV) environmental monitors), open fires, mechanical vegetation clearing, live ammunition, firing blanks, flights below 1,000 ft (313 m), and helicopter landings (except for designated landing zones) are prohibited in NWD areas. All entry or training, except specifically authorized administrative troop and vehicle movement on designated roads or trails, are prohibited in NT areas, in addition to prohibitions in NWD areas. The Navy evaluates NWD and NT boundaries based on additional survey information obtained during monthly monitoring surveys for sea turtle nesting activity on Tinian.
- Navy biologists monitor beaches during night-time landing exercises. If sea turtles are observed or known to be within the area, training activities are halted until all nests have been located and sea turtles have left the area. Identified nests are avoided during the night-time landing exercise.
- Prior to beach landings by amphibious vehicles, known sea turtle nesting beaches are surveyed by Navy biologists for the presence of sea turtle nests no more than six hours prior to a landing exercise. Areas free of nests are flagged, and vehicles are directed to remain within these areas. NAVFACMAR biologists survey landing beaches no more than six hours prior to the first landing. Further, each landing activity has a "beach master" that would "wave off" vehicle approaches if sea turtles or sea turtle nests were observed in the water or on the land.

The Navy recognizes that surge waves generated by slow moving LCACs could break off coral heads and cause beach scour, degrading foraging and nesting habitat for sea turtles. To minimize the surge effect, LCAC landings on Tinian are scheduled for high-tide. LCACs stay on-cushion until clear of the water and within a designated Craft Landing Zone (CLZ). Amphibious assault vehicle (AAV) landings at Unai Babui are restricted to an established approach lane and land at high tide one vehicle at a time. Within the CLZ, LCAC come off-cushion with the LCAC oriented to permit expeditious vehicle and cargo offload onto a cleared offload and vehicle traffic area. The Navy recognizes ruts resulting from vehicle traffic on beaches may prevent sea turtle hatchlings from reaching the water and expose them to predation or desiccation. Although LCAC and expeditionary vehicle traffic typically do not leave ruts, some compaction of sand in vehicle tracks is possible. If restoration of beach topography is required, it is conducted using non-mechanized methods.

5.2.3 EXPENDED MATERIALS

Training activities involving the sinking of large vessels (SINKEX) may have the likelihood to affect EFH or HAPC, such as deep water coral reef habitat. The Environmental Protection Agency (EPA) grants the Navy a general permit through the Marine Protection, Research, and Sanctuaries Act to transport vessels "for the purpose of sinking such vessels in ocean waters…" (40 CFR Part 229.2). Each SINKEX uses an excess vessel hulk as a target that is eventually sunk during the course of the exercise. The target is an empty, cleaned, and environmentally remediated ship hull that is towed to a designated location where various platforms would use multiple types of weapons to fire shots at the hulk. Platforms can consist of air, surface, and subsurface elements. Weapons can include missiles, precision and non-precision bombs, gunfire, and torpedoes (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). If none of the shots result in the hulk sinking, either a submarine shot or placed explosive charges would be used to sink the ship. Charges ranging from 100 to 200 pounds, depending on the size of the ship, would be placed on or in the hulk. These activities can have an adverse impact on FMP species (See Section 5.1.3). To reduce impacts to EFH and HAPC, all vessel sinkings are conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nm from land. Therefore, SINKEX training activities would have short-term, localized impact associated with the operation (such as in-water detonations); however, it would not destroy or adversely affect sensitive benthic habitats, although it may alter soft bottom habitats and may provide a beneficial use by providing habitat in the deep water environment.

Training activities involving relatively smaller weapons or equipment (e.g., sonobuoys, inert mines, torpedoes, targets, munitions, intact missiles) may also physically affect benthic habitats. All of the expendable materials would eventually sink to the bottom, but are unlikely to result in any physical impacts to the seafloor because they would sink into a soft bottom, where they eventually would be covered by shifting sediments. Soft bottom habitats are considered less sensitive than hard bottom habitats, and in such areas, the effects of expended materials would be minimal because the density of organisms and expended materials are low. Expended materials may also serve as a potential habitat or refuge for invertebrates and fishes. Given the smaller size of expended materials (compared to SINKEX) and the large size of the range, these items are not expected to adversely affect sensitive EFH or FMP species. Over time, these materials would degrade, corrode, and become incorporated into the sediments. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment. Table 5-5 summarizes estimates of the area, volume, and weight from ordnance expended annually within open water habitat. Calculations were based on the annual expenditures for ordnance used in the offshore training range (Table 2-8 in Appendix A), and making several assumptions, such as no targets (as they vary), items remaining intact, using dimensions of the ordnance to calculate a surface area and volume as a cylinder, and multiplying that to estimate how much is entering into the ocean for each alternative. Based on the estimates in Table 5-5, and given the large area of the range (approximately 14,000 nm^2), the amount of material expended annually is neglible (e.g., 1.3 pounds per nm^2), and would not result in any long-term accumulation, as the likelihood of overlapping activities is low.

Chaff is deployed to confuse radar tracking devices (USAF 2002). Chaff canisters burst in the air releasing millions of aluminum coated glass or silicon fibers (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). Chaff particles are very light and designed to remain airborne as long as possible. Depending on wind speed and direction, chaff particles may be distributed over a wide area. When finally reaching the water, they may remain suspended on the surface for a while before sinking (NRL 1997, DoN 2007c). Eventually, chaff particles would sink or be carried away by currents. Ocean floor sediments are largely composed of silicates (crystalline solids such as quartz and feldspar make up a large percentage of the earth’s crust). The ocean water is constantly exposed to these silicates. Likewise, aluminum is a natural component of the ocean environment, entering the water from sediments and through hydrothermal vents. So, the addition of small amounts of these chemicals from chaff would unlikely have an effect on water or sediment composition (NRL 1999). Effects of chaff on resident populations of fish are likely to be short-term and would not be expected to adversely affect fisheries or their management.

A fish surfacing in an area where chaff has fallen on the ocean surface could have its skin covered with the particles (NRL 1999). However, it is unlikely that the concentration of chaff particles would be great enough to restrict mobility. As the animal submerges, the particles would either disperse into the water, or remain temporarily attached. Fish are unlikely to suffer physical effects from chaff lodging in their gills or ingesting toxic quantities of chaff (USAF 1997).

Table 5-5. Area, Volume, and Weight Entering Ocean (> 3 nm) from Ordnance Expended Annually in MIRC.

	AREA (ft^2)			**VOLUME (ft^3)**			**WEIGHT (lbs) – Includes SINKEX**		
SINKEX	**No Action**	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**
HARM	93	186	186	25	50	50	All Missiles		
SLAM-ER	210	421	421	57	114	114	776	1,543	1,654
HARPOON	232	464	464	63	125	125			
5" Gun Shells	1,040	2,080	2,080	80	160	160	All Bombs		
HELLFIRE	21	41	41	3	6	6	8,309	12,463	12,525
MAVERICK	218	435	435	51	102	102			
GBU-12	552	1104	1104	189	378	378	All Torpedoes		
GBU-10	235	470	470	70	141	141	1,512	3,528	4,608
MK-48	NA	NA	NA	NA	NA	NA			
TOTAL	2,600	5,200	5,200	538	1075	1075			
	AREA (ft^2)			**VOLUME (ft^3)**			**WEIGHT (lbs) – Includes SINKEX**		
ALL OTHER ACTIVITIES	**No Action**	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**
MK-48 EXTORP	NA	NA	NA	NA	NA	NA	All Gun Shells		
REXTORP	NA	NA	NA	NA	NA	NA	37,486	76,161	81,540
Air Deployed Mines [MK-62; MK-56]*	14,880	22,320	22,320	5,600	8,400	8,400			
Inert Bomb Training Rounds [MK-82 I; BDU-45; MK-76]**	582	873	1092	115	173	216	Sonobuoys		
5" Gun Shells	416	832	1040	32	64	80	304	313	339
AIM-7 Sparrow	102	153	204	16	25	33			
AIM-9 Sidewinder	62	93	124	4	7	9	TOTAL WEIGHT (lbs)		
AIM-120 AMRAAM	145	217	290	40	61	81	10,597	17,534	18,787
RIM-7 Sea Sparrow/ RIM-116 RAM / RIM-67 SM II ER	467.8	935.6	935.6	550.1	1100.2	1100.2			
Sonobuoys	98	117	130	98	117	130	Weight per sq. nautical mile (lbs/nm^2)		
TOTAL	16,754	25,542	26,136	6,457	9,946	10,049	0.8	1.3	1.3

Ordnance expenditures from Table 2-8 in EIS/OEIS.
Assumes item remains intact, does not explode, and settles to bottom.
Conservative calculation of area and volume based on largest dimension as a cylinder.
For comparison purposes, W-517 is approx. 14,000 nm^2.

*assumes 50% MK-62 and 50% MK-56
** assumes 33% MK-82, 33% BDU-45, 33% MK-76
Calculations do not include small arms, chaff, or flares.
Calculations do not include target, as target may vary.

The probability of fish ingesting expended materials would depend on factors such as the location of the spent materials, size of the materials, and the level of benthic foraging that occurs in the impact area, which is a function of benthic habitat quality, prey availability, and species-specific foraging strategies. It is possible that persistent expended material could be colonized by benthic organisms, and mistaken for prey, or that expended materials could be accidentally ingested while foraging for natural prey items. Ingestion of expended materials may affect individual fish; however, it would not result in adverse effects to fish populations, and as discussed in Section 5.3, no long-term impacts to water or sediment quality are anticipated from expended materials.

5.3 ALTERATION OF WATER OR SEDIMENT QUALITY FROM EXPENDED MATERIALS OR DISCHARGE

One potential impact to water quality would primarily be associated with the incidental release of materials from surface ships, submarines, or other vessels. Hazardous constituents of concern possibly emitted from the surface ship or submarine (i.e., fuel, oil) are less dense than seawater and would remain near the surface and therefore would not affect the benthic community. Sheens produced from these activities are not expected to cause any significant long-term impact on water quality or EFH because a majority of the toxic components would evaporate within several hours to days and/or be degraded by biogenic organisms (e.g., bacteria, phytoplankton, zooplankton).

The resulting expended materials and/or discharges from training activities may also affect the physical and chemical properties of benthic habitats and the quality of surrounding marine waters, in turn, affecting EFH. Hazardous constituents can be released from sonobuoys, targets, torpedoes, missiles, and underwater explosions (discussed individually below). Impacts from hazardous materials, primarily batteries, may affect water or sediment quality in the vicinity of the expended materials. The release of metal ions (e.g., Pb^{+2}, Cu^{+2}, and Ag^{+}) during operation of the seawater batteries or as a result of corrosion of sonobuoy or target components represents a source of potential environmental degradation for marine invertebrates. In general, the toxicological impact of exposure to high concentrations of heavy metals can result in either immediate mortality of exposed organisms (acute effect) or accumulation of heavy metal residues by these same species. Benthic communities exposed to high concentrations of heavy metals (specifically copper and zinc) are characterized by reduced species richness (number of species), reduced abundance (number of organisms), and a shift in community composition from sensitive to more tolerant taxa.

Sonobuoys are expendable devices used for the detection of underwater acoustic sources and for conducting vertical water column temperature measurements (see Table A-9 in Appendix A for annual expenditures and training activity). The primary source of contaminants in each sonobuoy is the seawater battery; these batteries have a maximum operational life of 8 hours, after which the chemical constituents in the battery are consumed. Long-term releases of lead and other metal from the remaining sonobuoy components would be substantially slower than the release during seawater battery operation. Lead has the potential to accumulate in bottom sediments, but the potential concentrations would be well below sediment quality criteria based on thresholds for negative biological effects. By far the greatest amount of material would likely to be deposited in a relatively inert form, as the lead ballast weights would become encrusted with lead oxide and other salts and would be covered by the bottom sediments. Lead, copper, and silver are heavy, naturally-occurring metals, widely distributed in the marine environment. They have relatively low solubility in seawater and slow corrosion rates (D'Itri 1990). The slow rate at which metal components are corroded by seawater translates into slow release rates into the marine environment. Once the metal surfaces corrode, the rate of metal released would decline. Releases of chemical constituents from all metal and non-metal sonobuoy components would be further minimized as a result of natural encrustation of exposed surfaces.

Sonobuoy emissions are not anticipated to accumulate or result in additive effects on water or sediment quality as would occur within an enclosed body of water since the constituents of sonobuoys would be widely dispersed in space and time throughout training areas. In addition, dispersion of released metals and other chemical constituents due to currents near the ocean floor would help minimize any long-term degradation of water and sediment quality. As a result, sonobuoy training activities may have a short-term and localized effect, but would not adversely affect sediment quality, water quality, or EFH.

Most air targets contain jet fuel, oils, hydraulic fluid, batteries, and explosive cartridges as part of their operating systems (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). Following an activity, targets are generally flown (using remote control) to a pre-determined recovery point. Fuel is shut off by an electronic signal, the engine stops, and the target descends. A parachute is activated and the target drops to the ocean surface where it is retrieved by range personnel using helicopters or range support boats. However, some targets are physically hit by missiles, and these targets fall into the ocean, and could potentially result in temporary, localized impacts on water quality. This would occur in the open ocean away from sensitive EFH. Most of the hazardous constituents of concern (i.e., fuel, oil) are less dense than seawater and would remain near the surface and therefore would not affect sediment quality. Ocean currents at the surface and within the water column would also rapidly dilute any metal ions or other chemical constituents released by the target. Sheens (e.g., oil or fuel) produced from these activities would not adversely effect EFH because a majority of the toxic components (e.g., aromatics) would evaporate within several hours to days or be degraded by biogenic organisms. This process may occur at a faster rate depending on sea conditions (e.g., wind and waves). Potential effects of torpedoes on water or sediment quality are associated with propulsion systems, chemical releases, or expended accessories. During normal exercise activities, none of the potentially hazardous or harmful materials are released into the marine environment because the torpedo is sealed and, at the end of a run, the torpedos are recovered. It would be unlikely that OTTO Fuel II contained in a torpedo would be released into the marine environment. Under the worst-case scenario of a catastrophic failure, however, up to 59 pounds (lb) (27 kg) could be released from a MK-46 (DoN 1996). It is anticipated that in the event of such a maximum potential spill, temporary and localized impacts to water quality and EFH would occur, but no long-term adverse impacts to water quality are anticipated because:

- The water volume and depth of the MIRC would dilute the spill.
- Although OTTO Fuel II may be toxic to marine organisms (DoN 1996), in particular, sessile benthic animals and vegetation, mobile organisms may move away from areas of high OTTO Fuel II concentrations.
- Common marine bacteria degrade and ultimately break down OTTO Fuel (DoN 1996).

Missiles contain hazardous materials as normal parts of their functional components (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). In general, the largest single hazardous material type is solid propellant, but there are numerous hazardous materials used in igniters, explosive bolts, batteries, and warheads. For missiles falling in the ocean, the principal source of potential impacts to water and sediment quality would be the unburned solid propellant residue and batteries. The remaining solid propellant fragments would sink to the ocean floor and undergo changes in the presence of seawater. Testing has demonstrated that water penetrates only 0.06 inches (0.14 centimeters [cm]) into the propellant during the first 24 hours of immersion, and that fragments would very slowly release ammonium and perchlorate ions. These ions would be expected to be rapidly diluted and disperse in the surrounding water such that local concentrations would be extremely low. However, assuming that all of the propellant on the ocean floor would be in the form of 4-inch cubes, only 0.42 percent of it would be wetted during the first 24 hours. If all the ammonium perchlorate leaches out of the wetted propellant, then approximately 0.01 lb (0.003 kg) would enter the surrounding seawater. The concentration would decrease over time as the leaching rate decreases and further dilution occurs. The aluminum would remain in the propellant binder and would eventually be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide would not pose a threat to the marine environment. Therefore, effects from missile propellant may have temporary and localized impacts on water quality and EFH, but would not be adverse.

Both chaff and flares are used during aircraft training exercises (see Tables A-7 and A-8 in Appendix A for annual expenditures and training locations). Chaff is an aluminum coated glass fiber used as a defensive mechanism to reflect radar. All of the components of the aluminum coating are present in seawater in trace amounts, except magnesium, which is present at 0.1 percent. The stearic acid coating is biodegradable and nontoxic. The potential for chaff to have a long-term adverse impact on water quality and sensitive EFH is very unlikely, and chemicals leached from the chaff would also be diluted by the surrounding seawater, thus reducing the potential for concentrations to build up to levels that could have effects on sediment quality and benthic habitats.

Flares are used over water during training. They are composed of a magnesium pellet that burns quickly at a very high temperature leaving ash and end caps and pistons. Laboratory leaching tests of flare pellets and residual ash using synthetic seawater found barium in the pellet tests, while boron and chromium were found in the ash tests. The pH of the test water was raised in both tests. Ash from flares would be dispersed over the water surface and then settle out. Chemical leaching would occur throughout the settling period through the water column, and any leaching after the particles reached the bottom would be dispersed by currents. Therefore, localized and temporary impacts to water quality and EFH may occur, but no long-term adverse impact is anticipated.

The majority of objects that fall to the sea floor become buried in the sediment. Metals like lead, copper, and silver will oxidize in the upper part of the sediment where bioturbation creates oxygen-rich conditions. Below this level, oxidation is less likely, and when leaching does occur, the metals tend to adsorb onto the particulate organic carbon in the sediments (Ankley 1996). Acid volatile sulphide is formed in anoxic zones and complexes with the metal ions in the porewater, rendering the metal relatively nontoxic and less subject to bioaccumulation. Metals can also form complexes with soluble ligands (both organic and inorganic) in pore water (Ankley 1996). Many of the heavier expendable objects are made of metal and tend to sink deeply into the anoxic layer of the sediments.

Unexploded five-inch shells and non-explosive ordnance practice shells would not be recovered and would sink to the bottom. The rapid-detonating explosive (RDX) material of unexploded ordnance would not be exposed to the marine environment, as it is encased in a non-buoyant cylindrical package. Should the RDX be exposed on the ocean floor, it would break down within a few hours (DoN 2001). It does not bioaccumulate in fish or in humans. Over time, the RDX residue would be covered by ocean sediments or diluted by ocean water.

Solid-metal components of unexploded ordnance and non-explosive ordnance would be corroded by seawater at slow rates, with comparable slow release rates. Exposure of fish to chemical constituents from all metallic and non-metallic ordnance components would be further reduced as a result of natural encrustation of external surfaces. Consequently, the release of contaminants from unexploded ordnance and non-explosive ordnance would not adversely affect EFH.

Turbidity is the only potential water quality impact from detonations, since products from the detonation of high explosives are non-hazardous (e.g., CO, CO_2, H_2, H_2O, N_2, and NH_3). In shallow water, underwater explosions would resuspend sediments into the water column creating a turbidity plume. This would be a localized event and impacts would not be considered adverse because the turbidity plume would eventually dissipate as particles return to the bottom and/or currents disperse the plume.

5.4 ALTERNATIVES ANALYSIS

5.4.1 ALTERNATIVE 1

Under Alternative 1, in addition to accommodating the No Action Alternative will be the addition of increased training activities as a result of upgrades and modernization of existing ranges and training areas. This alternative also includes increased training activities from meeting new training and capability requirements for personnel and platforms, to an overall increase in the number and types of activities [including major exercises, the Intelligence, Surveillance and Reconnaissance /Strike (ISR/Strike) Air Force initiative at Andersen AFB, USMC activities, and the participation of the allied forces in major exercises in the MIRC]. Training activities will increase as a result of the development of a laser certified range area in W-517. This laser range capability will aid in the training of aircrews in the delivery of air-to-surface missiles against surface vessel targets. Primarily conducted in W-517, the weapon systems commonly used in this training activity are the laser guided HELLFIRE missile or an inert captive air training missile (CATM). The CATM is a missile shape that contains electronics only, and it remains attached to the aircraft weapon mounting points. The MISSILEX involves in-flight laser designation and guidance, and arming and releasing of the air to surface weapon by aircraft, typically against a small stationary, towed, or maneuvering target; however a CATM Exercise (CATMEX) may be conducted against any laser reflective target mounted on or towed by a target support vessel. Training activities will also increase as a result of the acquisition and development of new Portable Undersea Tracking Range (PUTR) capabilities supporting anti-submarine warfare (ASW), and new facility capabilities supporting Military Operations in Urban Terrain (MOUT) training. Of the proposed activities, only PUTR and increased training activities may affect EFH.

The PUTR system allows targets, torpedoes, and submarines to be tracked underwater in conjunction with Navy training exercises, and would consist of ten 800 lbs. (363 kg) transponders spread on the ocean floor over a specified area. The transponders are anchored to the bottom one at a time using a 275 lbs. (125 kg) clump weight and then surveyed in place using acoustic survey techniques. During exercises, the Shipboard Processing Unit aboard the support boat communicates with the transponders using a hydrophone, and outputs unclassified ping arrival time information to a radio modem that transmits the data to shore. The transponders currently uses a stack of 90 D-cells, and when the transponder batteries are depleted over the course of several weeks, the support boat recovers the transponders by activating their acoustic releases. The transponders are returned to shore, and maintenance is performed prior to the next deployment cycle.

No area supporting a PUTR system has been identified; however, potential impacts to EFH can be assessed based on several assumptions. Assuming that transponders are not deployed on sensitive or coral reef habitat, but rather on soft bottom habitats, impacts would be similar to those discussed in Section 5.2.3 – Expended Materials. There would be direct impact to soft bottom habitat where the clump weight contacted the bottom, which may result in localized mortality to epifauna and infauna within the footprint, although it is anticipated that recolonization would occur within a relatively short period of time. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components. The clump weight is not recovered, and since it is composed of inert material, it is not a potential source of contaminants, and could provide a substrate for benthic fauna. There may also be indirect effects associated with increased turbidity due to resuspension of sediments from the clump weight contacting the bottom. The turbidity plume is expected to be localized and temporary, as sediment would eventually settle to the ocean floor or be dispersed by ocean currents. Therefore, localized and temporary impacts to benthic fauna and water quality and EFH may occur from the PUTR, but no long-term adverse impact is anticipated.

Training activities would be increased to include training in major exercises, multi-Service and Joint exercises involving multiple strike groups and task forces. As discussed in the Cumulative Impact Section (Section 5.5), impacts were assessed based on single events or activities; however, during major range exercises, multiple activities could be conducted simultaneously over a relatively short period of time. Due to the temporal and spatial variation of major range events, which would include multiple training activities over a large area, and avoidance of HAPCs, they are not expected to result in long-term adverse impacts to EFH. Although some individual activities could affect EFH or managed species at the individual level due to localized impacts, these impacts are not additive when considering major range events or the increase in tempo.

5.4.2 ALTERNATIVE 2

Training activities would be increased to include training in major exercises, multi-Service and Joint exercises involving multiple strike groups and task forces (See Appendix A, Table A-7). As discussed in the Cumulative Impact Section (Section 5.5), impacts were assessed based on single events or activities; however, during major range exercises, multiple activities could be conducted simultaneously over a relatively short period of time. Due to the temporal and spatial variation of major range events which would include multiple training activities over a large area, and avoidance of HAPCs, they are not expected to result in long-term adverse impacts to EFH. Although some individual activities could affect EFH or managed species at the individual level due to localized impacts, these impacts are not additive when considering major range events or the increase in tempo. Therefore, no long-term adverse impacts to EFH would be expected from major range events or increased tempo.

5.5 CUMULATIVE ECOSYSTEM IMPACTS

Federal and DoN regulations implementing NEPA (42 USC § 4321 et seq. and 32 CFR 775 respectively) require that the cumulative impacts of a Proposed Action be assessed. NEPA defines cumulative impact as:"the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future action regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative ecosystem impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR § 1508.7). In general, a particular action or group of actions must meet all of the following criteria to be considered a cumulative ecosystem impact: effects of several actions occur in a common locale or region; effects on a particular resource are similar in nature, such that the same specific element of a resource is affected in the same specific way; and, effects are long-term as short-term ecosystem impacts dissipate over time and cease to contribute to cumulative ecosystem impacts.

Human uses of the MIRC include prior, current, and future Navy activities, navigation, transportation, coastal development, oil/gas exploration and development, sand and mineral mining, dredge and fill operations, cooling water intake and discharge, wastewater discharge, mariculture, and recreational and commercial fishing. Potential threats to EFH and managed species include sound from aircraft and vessel traffic, degradation of water quality, habitat modification, pollution (thermal, chemical, marine expended materials, etc.), introduction of exotic species, disease, natural events, and global climate change (Field et al. 2001).

Fishing activities, individually or in combination, can adversely affect EFH and managed species (NOAA 1998, Dayton et al. 2003, Morgan and Chuenpagdee 2003, Levin et al. 2006). Potential impacts of commercial fishing include over-fishing of targeted species and bycatch, both of which negatively affect fish stocks (Barnette 2001, NRC 2002). Mobile fishing gears such as bottom trawls disturb the seafloor and reduce structural complexity (Auster and Langton 1998, Johnson 2002). Indirect effects of trawls include increased turbidity; alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing, and generation of marine expended materials (Hamilton 2000). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats. Recreational fishing also poses a threat because of the large number of participants and the concentrated use of specific habitats (Coleman et al. 2004).

Natural stresses include storms and climate-based environmental shifts, such as harmful algal blooms and hypoxia (DoN 2005b). Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Pew Oceans Commissions 2003). As evidenced by Carpenter et al. (2008), approximately one-third of the world's reef building corals face extinction risk from bleaching and diseases driven by ocean acidification and globally elevated sea surface temperatures, as well as human-induced impacts at the local level. Development of the world's coasts has accelerated, with some 37% of the world's population living within 60 miles (100 km) of the coast, at a population density twice the global average (UNEP 2006). Heavy population pressure on the coasts is causing the destruction or modification of more and more of the natural environment. Halpern et al. (2008) developed an ecosystem-specific, multiscale spatial model to synthesize 17 global data sets of anthropogenic drivers of ecological change for 20 marine ecosystems. Their analysis indicated that no area is unaffected by human influence and that a large fraction (41%) is strongly affected by multiple drivers. Small human population and coastal watershed size predicted light human impact, but do not ensure it, as shipping, fishing, and climate change affect even remote locations. Their data suggested that almost half of all coral reefs experience medium high to very high impact; however, it appeared that the area emcompassing the MIRC study area was regarded as experiencing medium impact.

Potential cumulative impacts of Navy training exercises include release of chemicals into the ocean, introduction of expended materials into the water column and onto the seafloor, mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives, and, physical and acoustic impacts of vessel activity. Impacts to EFH were assessed based on single events, and based on single events, some training activities would result in temporary and localized impacts to FMP species. This finding was based on the generally small area that was affected, the avoidance of HAPCs, the relatively large size of the MIRC, and the distribution of FMP species. Due to the temporal and spatial variation of each training activity, multiple concurrent activities and/or actions proposed under Alternatives 1 and 2 (i.e., major training and increased tempo), would not contibute to long-term adverse impacts to EFH. For training activities that occur in nearshore waters, there is a greater probability that these activities could affect EFH and HAPC, such as coral reefs. However, administrative controls reduce the likelihood of impacts to coral reefs and HAPC, such as conducting nearshore activities in less sensitive habitats, like sandy bottom habitat. Although, there may still be impacts to these less sensitive habitats, the impacts would be localized and temporary. The incremental contribution by the Proposed Action and alternatives to impacts on the marine ecosystem structure and function and associated ecosystem services is expected to be insignificant. The overall effect on fish stocks would be negligible compared to the impact of commercial and recreational fishing in the MIRC. After completion of an exercise, repopulation of an area by fish should take place within a matter of hours. Implementation of protective measures designed to avoid adverse or long-term impacts would further protect marine life and the environment.

Because of the transient nature of the training exercises and the minor, localized potential ecosystem effects, there would not be incremental or synergistic impacts on present or reasonably foreseeable future ecosystem structure and function or ecosystem services within the MIRC. The Proposed Action and alternatives would not make a significant contribution to the regional cumulative ecosystem impacts on EFH or Managed Species.

5.6 CONCLUSIONS

Using an ecosystems-based management approach, and considering:

- local, regional and global effects of Navy actions to the structure and function of ecosystems and the provision of ecosystem services in the MIRC Study Area; and
- protective measures implemented to protect sensitive habitats in nearshore waters and other habitats in the MIRC Study Area;

it is concluded that no long-term, permanent adverse impact would occur as a result of implementation of the Proposed Action and alternatives on EFH and their associated management units relative to the major FMP's administered by the WPRFMC.

Table 5-6. Summary of Potential Impacts to EFH by Activity

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
NO ACTION ALTERNATIVE								
ARMY TRAINING								
	Surveillance and Reconnaissance (S&R)	Finegayan House, Barrigada House, Tinian-Exclusive Military Use Area, and the Lease Back Area	S&R are conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, opposition forces (OPFOR) units may be positioned ahead of the assault force and permitted a period of time to conduct S&R and prepare defenses to the assaulting force.	None	X			N/A
	Field Training Exercise (FTX)	Polaris Point Field, Tinian-Exclusive Military Use Area, Orote Point Airfield/Runway, Fire Break #3, Andersen Air Force Base - Northwest Field, and Andersen South housing Area	An FTX is an exercise where the battalion and its combat and combat service support units deploy to field locations to conduct tactical training activities under simulated combat conditions. A company or smaller-sized element of the Army Reserve, Guam Army National Guard, or Guam Air National Guard will typically accomplish an FTX within the MIRC, due to the constrained environment for land forces. The headquarters and staff elements may simultaneously participate in a Command Post Exercise (CPX) mode.	None	X			N/A
	Live Fire	Tarague Beach Small Arms Range	Live fire training is conducted to provide direct fire in support of combat forces.	None	X			N/A
	Parachute Insertions and Air Assault	Orote Point Triple Spot, Polaris Point Field, and the Ordnance Annex Breacher House	These air training activities are conducted to insert troops and equipment by parachute and/or air land by fixed or rotary wing aircraft to a specified objective area.	None	X			N/A
	Military Operations in Urban Terrain (MOUT)	Orote Point CQC House, the Ordnance Annex Breacher House, Barrigada Housing, and the Andersen South Housing Area	MOUT training activities encompass advanced offensive close quarter battle techniques used on urban terrain conducted by units trained to a higher level than conventional infantry. Techniques include advanced breaching, selected target engagement, and dynamic assault techniques using organizational equipment and assets. MOUT is primarily an offensive operation, where noncombatants are or may be present and collateral damage must be kept to a minimum.	None	X			N/A

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
MARINE CORP TRAINING								
	Ship to Objective Maneuver (STOM)	EMUA on Tinian	STOM is conducted to gain a tactical advantage over the enemy in terms of both time and space. The maneuver is not aimed at the seizure of a beach, but builds upon the foundations of expanding the battlespace.	• Vessel Movement • Amphibious Landings		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. • Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to mitigation measures outlined in Chapter 5 of this EIS/OEIS, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.
	Operational Maneuver	Fire Break #3 and the Southern Land Navigation Area	This training exercise supports forces achieving a position of advantage over the enemy for accomplishing operational or strategic objectives.	None	X			**N/A**
	Non-Combatant Evacuation Order (NEO)	EMUA on Tinian	NEO training activities are conducted when directed by the Department of State, the Department of Defense, or other appropriate authority whereby noncombatants are evacuated from foreign countries when their lives are endangered by war, civil unrest, or natural disaster to safe havens or to the United States.	None	X			**N/A**
	Assault Support (AS)	Polaris Point Field, Orote Point KD Range, and EMUA on Tinian	Assault Support exercises provide helicopter support for command and control, assault escort, troop lift/logistics, reconnaissance, search and rescue (SAR), medical evacuation (MEDEVAC), reconnaissance team insertion/extract and Helicopter Coordinator (Airborne) (HC(A)) duties.	None	X			**N/A**
	Reconnaissance and Surveillance (R & S)	EMUA on Tinian	R & S is conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, OPFOR units may be positioned ahead of the assault force and permitted a period of time to conduct R&S and prepare defenses to the assaulting force	None	X			**N/A**
	Military Operations in Urban Terrain (MOUT)	Ordnance Annex Breacher House	Marine Corps MOUT training is similar in nature and intent to Army MOUT training.	None	X			**N/A**

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
	Direct Fire	FDM, Orote Point KD Range and ATCAA 3A airspace	Direct Fires, similar in nature and content to Navy Marksmanship exercises, are used to train personnel in the use of all small arms weapons for the purpose of defense and security. Another form of Marine Corp Direct Fires exercises involves the use of aircraft acting as forward observers for Naval Surface Fires Support. During these training activities, Marine aircraft will act as spotters for the ships and relay targeting and battle hit assessments information.	• Vessel Movement • Aircraft Overflight • Weapons Firing· • Expended Materials		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column. Low potential for injury or mortality to fish. • Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Expended materials may physically affect benthic habitats. Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Exercise Command and Control (C2)	Andersen AFB	C2 provides primary communications training for command, control, and intelligence, providing critical interpretability and situation awareness information.	None	X			**N/A**
	Protect and Secure Area of Operations (Protect the Force)	Northwest Field on Andersen Air Force Base	Force protection training activities increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack.	None	X			**N/A**

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
NAVY TRAINING								
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Tracking Exercise	MIRC Offshore Areas, W-517	ASW TRACKEX trains aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines. The use of sonobuoys is generally limited to areas greater than 100 fathoms, or 600 feet, in depth.	• Vessel Movement • Underwater Explosions· • Sonar· • Collision		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Potential for mortality (swim bladder rupture) or injury (such as hearing loss), or displacement of prey items. Potential for masking of sounds within frequency ranges of LFA, MFA, and HFA sonar systems that overlap with some fish species' hearing. • Potential for injury or mortality from direct strikes of fish by inert torpedoes. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Torpedo Exercise	MIRC Offshore Areas, W-517	ASW TORPEX training activities train crews in tracking and attack of submerged targets, using active or passive acoustic systems, and firing one or two Exercise Torpedoes (EXTORPs) or Recoverable Exercise Torpedoes (REXTORPs). TORPEX targets used in the Offshore Areas include live submarines, MK-30 ASW training targets, and MK-39 Expendable Mobile ASW Training Targets (EMATT).	• Vessel Movement • Underwater Explosions· • Sonar· • Collision		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column. Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Limited injury or mortality to fish eggs and larvae. • Short-term and localized disturbance to water column and benthic habitats. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Potential for mortality (swim bladder rupture) or injury (such as hearing loss), or displacement of prey items.. Potential for masking of sounds within frequency ranges of LFA, MFA, and HFA sonar systems that overlap with some fish species' hearing. • Potential for injury or mortality from direct strikes of fish by inert torpedoes. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Anti-Air Warfare (AAW)	Missile Firing Exercises (MISSILEX)	MIRC Offshore Areas, W-517, ATCAA 1/2/3/4/5	MISSILEX is an operation in which missiles are fired from either aircraft or ships against aerial targets. Air-to-Air exercises involve a fighter or fighter/attack aircraft firing a missile at an aerial target. Aerial targets are typically launched. In the MIRC this event refers to training activities in which air-to-air missiles are fired from aircraft against unmanned aerial target drones, gliders, or flares. The missiles fired are not recovered.	• Vessel Movement • Aircraft Overflight • Weapons Firing • Expended Materials·		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Expended materials may physically affect benthic habitats. Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Short-term and localized disturbance to water column and benthic habitats. Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Low potential for injury or mortality to fish. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Anti-Air Warfare (AAW)	Chaff Exercise	MIRC Offshore Areas, W-517, ATCAA 1/2	A CHAFFEX trains aircraft and shipboard personnel in the use of chaff to counter antiship missile threats. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, which are used to reflect echoes to deceive radars.	• Aircraft Overflight • Expended Materials·		X		• Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Short-term and localized disturbance to water column and benthic habitats. Temporary impacts to water quality due to in release of hazardous materials. Low potential for injury or mortality to fish. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Anti-Air Warfare (AAW)	Flare Exercise	MIRC Offshore Areas, W-517	A flare exercise is an aircraft defensive operation in which the aircrew attempts to cause an infrared (IR) or radar energy source to break lock with the aircraft.	• Aircraft Overflight • Expended Materials·		X		• Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Short-term and localized disturbance to water column and benthic habitats. Temporary impacts to water quality due to in release of hazardous materials. Low potential for injury or mortality to fish. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Anti-Surface Warfare (ASUW)	Surface-to-Surface Gunnery Exercise (GUNEX)	MIRC Offshore Areas, W-517	Surface-To-Surface GUNEX take place in the open ocean to provide gunnery practice for Navy and Coast Guard ships utilizing shipboard gun systems and small craft crews supporting NSW, EOD, and Mobile Security Squadrons (MSS) utilizing small arms. GUNEX training activities conducted in W-517 involve only surface stationary targets such as a MK-42 Floating At Sea Target (FAST), MK-58 marker (smoke) buoys, or 55 gallon drums. The systems employed against surface targets include the 5-inch, 76mm, 25mm chain gun, 20mm Close In Weapon System (CIWS), .50 caliber machine gun, 7.62mm machine gun, small arms, and 40mm grenade.	• Vessel Movement • Weapons Firing· • Expended Materials·		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Low potential for injury or mortality from direct strike of fish by weapon systems. • Short-term and localized disturbance to water column. Injury or mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions. Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Anti-Surface Warfare (ASUW)	Air-to-Surface Gunnery Exercise (GUNEX)	MIRC Offshore Areas, W-517	Air-to-Surface GUNEX training activities are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would use either 7.62mm or .50 caliber door-mounted machine guns. GUNEX training occurs frequently in the MIRC Offshore Areas other than W-517, but exact data on this open ocean training evolution outside of W-517 is not recorded or tracked.	• Vessel Movement • Aircraft Overflight • Weapons Firing· • Expended Materials·		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Low potential for injury or mortality from direct strike of fish by weapon systems. • Short-term and localized disturbance to water column. Injury or mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions. Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Anti-Surface Warfare (ASUW)	Visit Board Search and Seizure (VBSS)	MIRC Offshore Areas, W-517, Outer Apra Harbor	These exercises involve the interception of a suspect surface ship by a Navy ship and are designed to train personnel to board a ship, other vessel or transport to inspect and examine the vessel's papers or examine it for compliance with applicable laws and regulations. Seizure is the confiscating or taking legal possession of the vessel and contraband (goods or people) found in violation of laws and regulations. A VBSS can be conducted both by ship personnel trained in VBSS or by Naval Special Warfare (NSW) SEAL teams trained to conduct VBSS on uncooperative vessels. Employment onto the vessel designated for inspection is usually done by small boat or by helicopter.	• Vessel Movement·		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Anti-Surface Warfare (ASUW) (Continued)	Sink Exercise	MIRC Offshore Areas, W-517	A SINKEX provides training to ship and aircraft crews in delivering live ordnance on a real target. Each SINKEX uses an excess vessel hulk as a target that is eventually sunk during the course of the exercise. The target is an empty, cleaned, and environmentally remediated ship hull that is towed to a designated location where various platforms would use multiple types of weapons to fire shots at the hulk.	• Vessel Movement· • Aircraft Overflight • Weapons Firing· • Underwater Explosions • Expended Materials·		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Low potential for injury or mortality from direct strike of fish by weapon systems. • Short-term and localized disturbance to water column. Injury or mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions. Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Low potential for injury or mortality to fish. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Strike Warfare (STW)	Air to Ground Bombing Exercises (Land) (BOMBEX-Land)	FDM, ATCAA 3	BOMBEX (Land) allows aircrews to train in the delivery of bombs and munitions against ground targets. The weapons commonly used in this training are inert training munitions (e.g., MK-76, BDU-45, BDU-48, BDU-56 and MK-80-series bombs), and live MK-80-series bombs and precision guided munitions (Laser Guided Bombs [LGBs] or Laser Guided Training Round [LGTRs]). BOMBEX exercises can involve a single aircraft, a flight of two, four, or multiple aircraft.	• Aircraft Overflight • Explosive Ordnance • Expended Materials		**X**		• Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Short-term and localized disturbance to water column and benthic habitats in shallow water. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Strike Warfare (STW)	Air to Ground Missile Exercises (MISSILEX)	FDM, ATCAA 1/2/3/5	Air-to-ground Missile Exercise trains aircraft crews in the use of air-to-ground missiles. It is conducted mainly by H-60 Aircraft using Hellfire missiles and occasionally by fixed wing aircraft using Maverick missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire the target, and launch the missile. The missile is launched in forward flight or at hover at an altitude of 300 feet Above Ground Level (AGL).	• Aircraft Overflight • Explosive Ordnance • Expended Materials		**X**		• Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Short-term and localized disturbance to water column and benthic habitats in shallow water. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Naval Special Warfare (NSW)	Naval Special Warfare Operations (NSW OPS)	Various	NSW personnel perform special activities using tactics that are applicable to the specific tactical situations where the NSW personnel are employed.	• Vessel Movement • Weapons Firing • Expended Materials· • Amphibious Landings·		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Short-term and localized disturbance to water column and benthic habitats in shallow water. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Naval Special Warfare (NSW)	Airfield Seizure	Northwest Field on Andersen Air Force Base	Airfield Seizure training activities are used to secure key facilities in order to support follow-on forces, or enable the introduction of follow-on forces. An airfield seizure consists of a raid/seizure force from over the horizon assaulting across a hostile territory in a combination of helicopters, vertical takeoff and landing (VTOL aircraft), and other landing craft with the purpose of securing an airfield or a port.	None	**X**			**N/A**
Naval Special Warfare (NSW)	Breaching	Navy Munitions Site Breacher house	Special Warfare, Army, and USMC personnel use explosives to gain access to buildings where enemy personnel or material could be located or to investigate the building itself.	None	**X**			N/A
Naval Special Warfare (NSW)	Direct Action	Gab Gab Beach to Apra Harbor and Orote Point training areas, FDM	NSW Direct Action is either covert or overt directed against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. Training activities are small-scale offensive actions including raids; ambushes; standoff attacks by firing from ground, air, or maritime platforms; designate or illuminate targets for precision-guided munitions; support for cover and deception activities; and sabotage inside enemy-held territory. They arrive in the area by helicopter or small rubber boats (CRRC) across a beach. Once at FDM, small arms, grenades, and crew served weapons are employed in direct action against targets on the island.	• Vessel Movement • Aircraft Overflight • Expended Materials· • Amphibious Landings		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets. • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Naval Special Warfare (NSW)	Insertion/Extraction	Outer Apra Harbor, Inner Apra Harbor, Gab Gab Beach (western half), Reserve Craft Beach, Orote Point Airfield, and Polaris Point Field	Insertion/extraction training activities train forces, both Navy (primarily Special Forces and EOD) and Marine Corps, to deliver and extract personnel and equipment. These training activities include, but are not limited to, parachute, fast rope, rappel, Special Purpose Insertion/Extraction (SPIE), CRRC, and lock-in/lock-out from underwater vehicles. Additionally, parachute, fast rope, and rappel training activities have been conducted at Orote Point Airfield/Runway, Orote Point Triple Spot, Orote Point CQC House, Dan Dan Drop Zone, Orote Point KD Range, and the Ordnance Annex Breacher House.	• Vessel Movement • Aircraft Overflight • Amphibious Landings		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.
Naval Special Warfare (NSW)	Military Operations in Urban Terrain (MOUT)	Ordnance Annex, Orote Pt. CQC House, Breacher House	Navy (NSW) MOUT training is similar in nature and intent to Army and Marine Corps MOUT training, but typically on a smaller scale.	None	**X**			**N/A**
Naval Special Warfare (NSW)	Over the Beach (OTB)	Various	NSW personnel use different methods of moving forces from the sea across a beach onto land areas in order to get closer to a tactical assembly area or target depending on threat force capabilities. A typical OTB exercise would involve a squad to a platoon or more of NSW personnel being covertly inserted into the water off of a beach area of a hostile land area. However, the insertion could accomplished by other means, such as fixed-winged aircraft, helicopter, submarine, or surface ship. From the insertion point several miles at sea, the SEALs may use a CRRC, RHIB, SDV, ASDS, or swim to reach the beach, where they will move into the next phase of the exercise and on to the objective target area and mission of that phase of the exercise.	• Vessel Movement • Aircraft Overflight • Expended Materials • Amphibious Landings		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets. • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Amphibious Warfare (AMW)	Naval Surface Fire Support (FIREX Land)	FDM	FIREX (Land) consists of the shore bombardment of an Impact Area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed.	• Vessel Movement • Weapons Firing • Expended Materials· • Amphibious Landings		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Short-term and localized disturbance to water column and benthic habitats in shallow water. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets. • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.
Amphibious Warfare (AMW)	Marksmanship	Orote Point and Finegayan small arms ranges, and Orote Point KD range	Marksmanship exercises are used to train personnel in the use of all small arms weapons for the purpose of ship self defense and security. Basic marksmanship training activities are strictly controlled and regulated by specific individual weapon qualification standards. Small arms include but are not limited to 9mm pistol, 12-gauge shotgun, and 7.62mm rifles.	None	**X**			**N/A**

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Amphibious Warfare (AMW)	Expeditionary Raid	Reserve Craft Beach	An Expeditionary Raid is an attack involving swift incursion into hostile territory for a specified purpose. The attack is then followed by a planned withdrawal of the raid forces. A raid force can consist of varying numbers of aviation, infantry, engineering, and fire support forces. A key influence in every raid is the ability to insert, complete the assigned mission, and extract without providing the enemy force with opportunity to reinforce their forces or plan for counter measures. In FY03 up to 300 31st MEU personnel and equipment were moved ashore at Reserve Craft Beach via LCAC.	• Vessel Movement • Aircraft Overflight • Expended Materials· • Amphibious Landings		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets. • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.
Amphibious Warfare (AMW)	Hydrographic Surveys	FDM, Outer Apra Harbor, Tinian EMUA, and Tipalao Cove	Hydrographic Reconnaissance is conducted to survey underwater terrain conditions and report findings to provide precise analysis typically in support of amphibious landings and precise ship and small craft movement through cleared routes (Q-Routes). Exercises involve the methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and to determine the feasibility of landing an amphibious force on a particular beach. EOD units periodically survey FDM to determine the condition of coral around the island and to detect the presence of Unexploded Ordnance (UXO).	• Vessel Movement • Amphibious Landings·		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Mine Warfare (MIW)	Mine Counter Measures	Agat Bay, Apra Harbor	MIW involves the locating and neutralizing of a deepwater mine by EOD divers. The neutralization of the mine (the portion of the exercise that involves the use of ordnance) is typically scheduled during daylight hours for safety reasons and completed within a two hour period. Divers deploy from combat rubber raiding craft (CRRC) and a diver will place the explosive next to or on each inert mine shape. Based on charge size and operating conditions, EOD will determine a "safe time" and distance needed from the mine before they detonate the charge. Typically two shots per training event are conducted, with a second charge detonated one to two hours after the first shot. After the detonation portion of the exercise is completed, the mine shape is typically recovered unless destroyed by the charge.	• Vessel Movement • Underwater Explosions		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column and benthic habitats. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Temporary impacts to water quality due to increased turbidity. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Utilize sandy areas that avoid/minimize potential impacts to coral habitat.
Explosive Ordnance Disposal (EOD)	Land Demolition	Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, Orote Point CQC House, Orote Point Radio Tower, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, Fire Break # 3, Ordnance Annex Galley Building 460, Southern Land Navigation Area, and Barrigada Housing.	Training activities using land demolitions are designed to develop and hone EOD detachment mission proficiency in location, excavation, identification, and neutralization of buried land mines. During the training, teams transit to the training site in trucks or other light wheeled vehicles. A search is conducted to locate inert (non-explosively filled) land mines or IEDs and then designate the target for destruction. Buried land mines and UXO require the detachment to employ probing techniques and metal detectors for location phase. Use of hand tools and digging equipment is required to excavate. Once exposed and/or properly identified, the detachment neutralizes threats using simulated or live explosives. Land demolition training is actively conducted throughout the MIRC.	None	X			**N/A**

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Explosive Ordnance Disposal (EOD)	Underwater Demolition	Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization	Underwater demolitions are designed to train personnel in the destruction of mines, obstacles or other structures in an area to prevent interference with friendly or neutral forces and non-combatants. It provides NSW and EOD teams experience detonating underwater explosives. Outer Apra Harbor supports this training near the Glass Breakwater at a depth of 125 feet and with up to a 10 pound net explosive weight (NEW) charge. Piti and Agat Bay Floating Mine Neutralization areas also support this type of training.	• Vessel Movement • Expended Materials· • Explosive Ordnance		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Logistics and Combat Services Support	Combat Mission Area Training	Orote Point Airfield/Runway	Special Forces and EOD units conduct mission area training that supports their own and other services combat service needs in both the water and on land. This task includes providing patrolling, scouting, observation, imagery, and air control services and training.	None	X			**N/A**
Logistics and Combat Services Support	Command and Control (C2)	Reserve Craft Beach	C2 training activities provide primary communications for command, control, and intelligence, providing critical interpretability and situation awareness information.	None	X			**N/A**
Combat Search and Rescue (CSAR)	CSAR Training activities	North Field on Tinian	CSAR training activities train rescue forces personnel the tasks needed to be performed to affect the recovery of distressed personnel during war or military activities other than war. These activities could include aircraft, surface ships, submarines, ground forces (NSW and Marine Corps), and their associated personnel in the execution of training events.	• Vessel Movement • Aircraft Overflight • Expended Materials • Amphibious Landings		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets. • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
Protect and Secure Area of Operations	Embassy Reinforcement (Force Protection)	Main Base, Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Airfield/Runway, Orote Point Close Quarters Combat House, Orote Point Radio Tower, and Orote Point Triple Spot	Force protection training activities increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures.	None	**X**			**N/A**
Protect and Secure Area of Operations	Anti-Terrorism (AT)	Inner Apra Harbor, Polaris Point Site III, Ordnance Annex Breacher House, and Orote Annex Detonation Range, Northwest Field	AT training activities concentrate on the deterrence of terrorism through active and passive measures, including the collection and dissemination of timely threat information, conducting information awareness programs, coordinated security plans, and personal training. The goal is to develop protective plans and procedures based upon likely threats and strike with a reasonable balance between physical protection, mission requirements, critical assets and facilities, and available resources to include manpower. AT training activities may involve units of Marines dedicated to defending both U.S. Navy and Marine Corps assets from terrorist attack.	None	**X**			**N/A**

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
MAJOR EXERCISES								
Major Exercises	Joint Exercise/USPACOM; USMC-Navy STOM/USMC-Navy; USMC Urban Ops/USMC	Various	Multiple Strike Group Exercises (Primarily Offshore; annual event, but may include nearshore, Guam, FDM, and CNMI) and Amphibious Assault Group Exercise – No Action Alternative would be one of the two exercises. Alt 1 and Alt 2 consist of one Multiple Strike Group Exercise, and on Amphibious Assault Exercise Expeditionary Warfare Exercise (Offshore/Nearshore/ Tinian/Guam/Saipan/Rota/FDM) Urban Warfare Exercise (Sustainment) (Primarily on Guam; semi-annually, 3-4 weeks per event; may include STOM and Tinian/Saipan/Rota)	• Vessel Movement • Aircraft Overflight • Weapons Firing· • Expended Materials • Underwater Explosions· • Amphibious Landings· • Sonar • Collision		X		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Disturbance to FMP species, and potential loss of benthic epifauna and infauna that may serve as prey items for managed species at beach landing locations. Temporary impacts to water quality due to increased turbidity may reduce foraging efficiency of FMP species or increase sedimentation. • Potential for mortality (swim bladder rupture) or injury (such as hearing loss), or displacement of prey items. Potential for masking of sounds within frequency ranges of LFA, MFA, and HFA sonar systems that overlap with some fish species' hearing. • Potential for injury or mortality from direct strikes of fish by inert torpedoes. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets. • Amphibious landings are restricted to specific areas of designated beaches away from sensitive EFH or HAPC, and are conducted in accordance to B.O. 1-2-98-F-07, which includes landings at high tide, LCACs under full cushion, reach beach prior to coming off cushion, and pre- and post-activity surveys.

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
AIR FORCE TRAINING								
	Counter Land	FDM, ATCAA 3	Counter Land is similar in nature and content to the Navy's BOMBEX (Land) operation.	• Aircraft Overflight • Explosive Ordnance • Expended Materials.		X		• Possible short-term behavioral responses to aircraft overflight. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Short-term and localized disturbance to water column and benthic habitats in shallow water. Mortality to all life stages of fish and larvae of other marine organisms in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • No long-term population-level effects or reduction in the quality and/or quantity of EFH. Avoidance Measures: • Designated land targets.
	Counter Sea (Chaff)	W-517, ATCAA 1 & 2	Counter Sea os similar in nature and content to the Navy's Chaff Exercise	• Aircraft Overflight • Expended Materials		X		• Possible short-term behavioral responses to aircraft overflight. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Short-term and localized disturbance to water column and benthic habitats. Temporary impacts to water quality due to in release of hazardous materials. Low potential for injury or mortality to fish. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Airlift	Northwest Field, Andersen Air Force Base	Airlift training activities provide airlift support to combat forces.	None	X			**N/A**
	Air Expeditionary	Northwest Field, Andersen Air Force Base	This type of training provides air expeditionary support to forward deployed forces.	None	X			**N/A**
	Force Protection	Northwest Field, Tarague Beach Small Arms Range, Main, Andersen Air Force Base	This type of training is to provide Force Protection to individuals, buildings, and specific areas of interest.	None	X			**N/A**

Table 5-6. Summary of Potential Impacts to EFH by Activity (cont'd)

MISSION AREA	EVENT	ACTIVITY AREA	BRIEF DESCRIPTION OF ACTIVITY	POTENTIAL IMPACTS TO EFH				
				POTENTIAL STRESSOR	NO IMPACT	TEMPORARY OR LOCALIZED IMPACT	SIGNIFICANT OR PERMANENT ADVERSE IMPACT	DESCRIPTION OF IMPACT AND AVOIDANCE MEASURES
ALTERNATIVE 1— INCREASE OPERATIONAL TRAINING, MODERNIZATION AND UPGRADES								
Major Exercises	Joint Exercise/USPACOM; USMC-Navy STOM/USMC-Navy; USMC Urban Ops/USMC	Various	Training activities would be increased to include training in major exercises, multi-Service and Joint exercises involving multiple strike groups and task forces.	Similar to No Action Alternative		**X**		Similar to No Action Alternative
ISR/Strike		Andersen AFB	The Air Force has established the ISR/Strike program at Andersen AFB, Guam. ISR/Strike will be implemented in phases over a planning horizon of FY 2007–FY 2016. ISR/Strike force structure consists of up to 48 fighter, 12 aerial refueling, six bomber, and four unmanned aircraft with associated support personnel and infrastructure. Aircraft activities out of Andersen AFB ultimately will increase by 45 percent over the current level (FY 2006).	None	**X**			**N/A**
Modernization and Upgrades of Ranges and Training Areas	Anti-Submarine Warfare (ASW)	No Undersea Tracking Range site has been identified for the Mariana Islands.	A critical component of ASW training is the Undersea Training (or Tracking) Range (UTR). This is an instrumented range that allows near real-time tracking and feedback to all participants. The tracking range should provide for both a shallow water and deep water operating environment, with a variety of bottom slope and sound velocity profiles similar to potential contingency operating areas. Guam-homeported submarine crews, as well as crews of transient submarines require ASW training events to maintain qualifications. A MIRC instrumented ASW portable undersea tracking range (PUTR), target support services, and assigned torpedo retriever craft would meet support requirements for TORPEX and TRACKEX activities in the MIRC in support of SSN and SSGN and other deployed forces.	• Vessel Movement • Expended Materials		**X**		• Short-term behavioral responses to vessel movement and extremely low potential for injury/mortality from collisions. • Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion or exposure to hazardous materials. • Short-term and localized disturbance to water column and benthic habitats. Temporary impacts to water quality due to turbidity. Low potential for injury or mortality to fish. • No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Military Operations in Urban Terrain (MOUT)		The MIRC will need to acquire range space, design, and develop a MOUT facility that will support the training requirements of the Army, Marine Corps, and special warfare units stationed at or deployed into the MIRC.	None	**X**			**N/A**
ALTERNATIVE 2— NEW DEDICATED CAPABILITIES ON EXISTING DOD RANGES AND TRAINING AREAS								
Increase Major At Sea Exercises and Training	Major At Sea Exercises (similar to ANNUALEX), WESTPAC USWEX, SHAREM	Various	Training activities would be increased to include training in major exercises, multi-Service and Joint exercises involving multiple strike groups and task forces.	Similar to No Action Alternative		**X**		Similar to No Action Alternative

6.0 REFERENCES

Abraham, T., M. Beger, D. Burdick, E. Cochrane, P. Craig, G. Didonato, D. Fenner, A. Green, Y. Golbuu,J. Gutierrez, M. Hasurmai, C. Hawkins, P. Houk, D. Idip, D. Jacobson, E. Jospeh, T. Keju, J. Kuartei, S. Palik, L. Penland, S. Pinca, K. Rikim, J. Starmer, M. Trianni, S. Victor, and L. Whaylen. 2004. Status of the coral reefs in Micronesia and American Samoa. Edited by R. Kelty, and J. Kuartei. Pages 381-409 in C. Wilkinson, ed. Status of Coral Reefs of the World: 2004. Townsville, Queensland: Australian Institute of Marine Science.

Allen, G.R. 1985. FAO species catalogue. Volume 6: Snappers of the world. An annotated and illustrated catalogue of lutjanid species known to date. FAO Fish. Synop.,(125). Rome, Italy: Food and Agriculture Organization of the United Nations.

Allen, G.R. 1999. Apogonidae - Cardinalfishes. Pages 2602-2610 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Allen, G.R., and M. Adrim. 2003. Coral reef fishes of Indonesia. Zoological Studies 42(1):1-72.

Allen, G.R., and R.C. Steene. 1987. Reef fishes of the Indian Ocean: A pictorial guide to the common reef fishes of the Indian Ocean. Neptune City, New Jersey: T.F.H. Publications, Inc.

Allen, G.R., R. Steene, P. Humann, and N. DeLoach. 2003. Reef fish identification: Tropical Pacific. Jacksonville, Florida: New World Publications Inc.

Allen, J.R. 2001. Pomacentridae - Damselfishes (Anemomefishes). Pages 3337-3356 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Amesbury, S.S., F.A. Cushing, and R.K. Sakamoto. 1986. Guide to the coastal resources of Guam. Volume 3: Fishing on Guam. Mangilao, Guam: University of Guam Press.

Amesbury, S.S., and R.F. Myers. 2001. Guide to the coastal resources of Guam. Volume 1: The fishes. Accessed 18 February 2005. http://www.uog.edu/marinelab/fish/thefishes.html.

Amesbury, S., R. Bonito, R. Chang, L. Kirkendale, C. Meyer, G. Paulay, R. Ritson-Williams, and T. Rongo. 2001. Marine biodiversity resource survey and baseline reef monitoring survey of the Haputo Ecological Reserve Area, COMNAVMARIANAS. Final. Mangilao, Guam: Marine Laboratory, University of Guam.

Amoser, S. and F. Ladich 2003. Diversity in noise-induced temporary hearing loss in otophysine fishes. J. Acoust. Soc. Am. 113: 2170–2179.

Anderson, W.D., Jr., and G.R. Allen. 2001. Lutjanidae - Snappers (jobfishes). Pages 2840-2918 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Ankley, G. T. 1996. Evaluation of metal/acid volatile sulfide relationships in the prediction of metal bioaccumulation by benthic macroinvertebrates. Environmental Toxicological Chemistry, 15: 2138-2146.

Artificial Reef Subcommittee. 1997. Guidelines for marine artificial reef materials. FWS Grant Agreement No. GS-96. Ocean Springs, Mississippi: Gulf States Marine Fisheries Commission.

Astrup, J. 1999. Ultrasound detection in fish – a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects? Comparative Biochemistry and Physiology Part A 124: 19-72.

Astrup J. and B. Møhl. 1993. Detection of intense ultrasound by the cod *Gadus morhua*. Journal of Experimental Biology 182:71–80.

Au, W.W.L. and K. Banks. 1998. The acoustics of the snapping shrimp *Synalpheus parneomeris* in Kaneohe Bay. Journal of the Acoustical Society of America 103:41-47.

Auster, P.J. and R.W. Langton. 1998. The Effect of Fishing on Fish Habitat. National Undersea Research Center. Univ. of Connecticut. Groton, CT. 51 p.

Bailey-Brock, J.H. 1995. Polychaetes of western Pacific islands: A review of their systematics and ecology. Pages 121-134 in J.E. Maragos, M.N.S. Peterson, L.G. Eldredge, J.E. Bardach, and H.F. Takeuchi, eds. Marine and coastal biodiversity in the tropical island Pacific region, Volume 1. Species systematics and information management priorities. Honolulu, Hawaii: East-West Center.

Bailey-Brock, J.H. 2003. Coral reef polychaetes of Guam and Saipan, Mariana Islands. Micronesica 35-36:200-217.

Baine, M. 2001. Artificial reefs: A review of their design, application, management and performance. Ocean and Coastal Management 44:241-259.

Baker, N., P. Fryer, F. Martinez, and T. Yamazaki. 1996. Rifting history of the northern Mariana Trough: SeaMARC II and seismic reflection surveys. Journal of Geophysical Research 101(B5):11427-11455.

Ball, E.E., D.C. Hayward, R. Saint, and D.J. Miller. 2004. A simple plan--Cnidarians and the origins of developmental mechanisms. Nature Reviews Genetics 5:567-577.

Barnette, M.C. 2001. A Review of the Fishing Gear Utilized Within the Southeast Region and their Potential Impacts on Essential Fish Habitat. National Marine Fisheries Service. Southeast Regional Office. St. Petersburg, Fl. 68p.

Bellwood, O. 2002. The occurrence, mechanics and significance of burying behaviour in crabs (Crustacea: Brachyura). Journal of Natural History 36:1223-1238.

Bennett, M.B., I. Gordon, and P.M. Kyne. 2003. Carcharhinus galapagensis. In: IUCN 2004. The 2004 IUCN red list of threatened species. Accessed 3 February 2005. http://www.redlist.org.

Bester, C. n.d. Biological profiles: Spotted eagle ray. Accessed 18 February 2005. http://www.flmnh.ufl.edu/fish/Gallery/Descript/SERay/SERay.html.

Birkeland, C. 1997. Status of coral reefs in the Marianas. Pages 91-100 in R.W. Grigg, and C. Birkeland, eds. Status of Coral Reefs in the Pacific. Honolulu, Hawaii: Sea Grant College Program, School of Ocean and Earth Science and Technology, University of Hawaii.

Birkeland, C., D. Rowley, and R.H. Randall. 1981. Coral recruitment patterns at Guam. Pages 339-344 in E.D. Gomez, C.E. Birkeland, R.W. Buddemeier, R.E. Johannes, J.A. Marsh Jr., and R.T. Tsuda, eds. Proceedings of the Fourth International Coral Reef Symposium, Manila, 1981. Volume 2. Manila, Philippines: Marine Sciences Center, University of the Philippines.

Blue Water. 2002. Fatal attraction. Accessed 30 March 2004. http://www.bluewatermag.com.au/dec02feature2.asp.

Boehlert, G.W., and A. Genin. 1987. A review of the effects of seamounts on biological processes. Pages 319-334 in B.H. Keating, P. Fryer, R. Batiza, and G.W. Boehlert, eds. Seamounts, islands, and atolls. Washington, D.C.: American Geophysical Union.

Bohkle, E.B., J.E. McCosker, and D.G. Smith. 1999. Muraenidae - Morays. Pages 1643-1657 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Bohnsack, J.A., D.L. Johnson, and R.F. Ambrose. 1991. Ecology of artificial reef habitats and fishes. Pages 61-107 in W. Seaman Jr., and L. M. Sprague, eds. Artificial habitats for marine and freshwater fisheries. San Diego, California: Academic Press.

Bonito, V., and R. Richmond. Submitted. 2005. Long-term changes in coral community structure and correlations with Acanthaster planci feeding preferences on Guam. Marine Ecology Progress Series.CDIP (The Coastal Data Information Program, Integrative Oceanography Division). 121 Ipan, Guam. Accessed 25 January 2005. http://cdip.ucsd.edu/?nav=historic&sub=data&stn=121&stream=p1.

Briggs, J.C. 1974. Marine zoogeography. New York, New York: McGraw-Hill Book Company.

Budelmann, B.U. 1992a. Hearing by Crustacea. In Evolutionary Biology of Hearing, eds. D.B. Webster, R.R. Fay, and A.N. Popper, 131-139. New York: Springer Verlag.

Budelmann, B.U. 1992b. Hearing in nonarthropod invertebrates. In Evolutionary Biology of Hearing, eds. D.B. Webster, R.R. Fay, and A.N. Popper, 141-155. New York: Springer Verlag.

Cabanban, A. 2004. *Epinephelus fuscoguttatus*. In: IUCN 2004. The 2004 IUCN red list of threatened species. Accessed 30 November 2004. http://www.redlist.org.

Carlson, C., and P.J. Hoff. 2003. The opisthobranchs of the Mariana Islands. Micronesica 35-36:271-293.

Carpenter, K.E. 1988. FAO species catalogue. Vol. 8. Fusilier fishes of the world. An annotated and illustrated catalogue of caesionid known to date. FAO Fish. Synop. (125). Rome, Italy: Food and Agriculture Organization of the United Nations.

Carpenter, K.E. 2001a. Kuhliidae - Flagtails. Pages 3317-3320 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Carpenter, K.E. 2001b. Lethrinidae - Emperors (emperor snappers). Pages 3004-3050 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Carpenter, K.E. 2001c. Caesionidae - Fusiliers. Pages 2919-2941 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Carpenter, K.E., M. Abrar, G. Aeby, R.B. Aronson, S. Banks, A. Bruckner, A.Chiriboga, J. Cortés, J.C. Delbeek, L. DeVantier, G.J. Edgar, A.J. Edwards, D. Fenner, H. M. Guzmán, B.W. Hoeksema, G. Hodgson, O. Johan, W.Y. Licuanan, S.R. Livingstone, E.R. Lovell,J.A. Moore, D.O. Obura, D. Ochavillo, B.A. Polidoro, W.F. Precht, M.C. Quibilan, C. Reboton, Z.T. Richards, A.D. Rogers, J. Sanciangco, A. Sheppard, C. Sheppard, J. Smith, S. Stuart, E. Turak, J.E.N. Veron, C. Wallace, E. Weil, E. Wood. 2008. One-Third of Reef-Building Corals Face Elevated Extinction Risk from Climate Change and Local Impacts. Science Express. /www.sciencexpress.org/10 July 2008/Page 1/10.1126/science.1159196.

Casper, B.M., P.S. Lobel, and H.Y. Yan. 2003. The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods. Environmental Biology of Fishes 68: 371-379.

Casper, B.M and D.A. Mann. 2006. Evoked potential audiograms of the nurse shark (Ginglymostoma cirratum) and the yellow stingray (*Urobatis jamaicensis*). Environmental Biology of Fishes 76:101–108.

Cavanagh, R.D., P.M. Kyne, S.L. Fowler, J.A. Musick, and M.B. Bennett, eds. 2003. The conservation status of Australasian chondrichthyans: Report of the IUCN shark specialist group, Australia and Oceania regional red list workshop, Queensland, Australia, 7-9 March 2003. Brisbane, Australia: The University of Queensland, School of Biomedical Sciences.

Chan, T.Y. 1998a. Shrimps and prawns. Pages 851-972 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Chan, T.Y. 1998b. Lobsters. Pages 973-1044 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Chandron, R. 1988. The distribution and abundance of holothurians in Saipan Lagoon, Mariana Islands. Master's thesis, University of Guam.

Chapman, C.J. 1973. "Field studies of hearing in teleost fish." Helgoländer wissenschaftliche Meeresuntersuchungen 24:371-390.

Chapman, L. 2004. Nearshore domestic fisheries development in Pacific Island countries and territories. Draft. Noumea, New Caledonia: Secretariat of the Pacific Community.

Chapman, C. J., and A. D. Hawkins. 1973. A field study of hearing in cod (*Gadus morhua* L.). J. Comp. Physiol. 85: 147-167.

Chapman, C.J. and O. Sand. 1974. "Field studies of hearing in two species of flatfish *Pleuronectes platessa* (L.) and *Limanda limanda* (L.) (family Pleuronectidae)." Comparative Biochemistry and Physiology 47(A):371-385.

CNMI DFW (Commonwealth of the Northern Marianas Islands Department of Fish and Wildlife). 2005. A map describing the location of Fish Aggregation Devices in the CNMI. Accessed 13 January 2005. http://www.dfw.gov.mp/images/FAD-map-large.jpg.

Colgan, M.W. 1987. Coral reef recovery on Guam (Micronesia) after catastrophic predation by *Acanthaster planci*. Ecology 68(6):1592-1605.

Colin, P.L., and A.C. Arneson. 1995. Tropical Pacific invertebrates: A field guide to the marine invertebrates occurring on tropical Pacific coral reefs, seagrass beds and mangroves. Beverly Hills, California: Coral Reef Press.

Collette, B.B. 1999. Echeneidae - Remoras (Sharksuckers, discfishes). Pages 2652-2653 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Collette, B.B., and C.E. Nauen. 1983. FAO species catalogue: Vol. 2: Scrombids of the world: An annotated and illustrated catalogue of tunas, mackerels, bonitos, and related species known to date. FAO Fish. Synop. (125). R ome, Italy: Food and Agriculture Organization of the United Nations.

Collins, A.G. 2002. Phylogeny of Medusozoa and the evolution of cnidarian life cycles. Journal of Evolutionary Biology 15:418-432.

Coleman, F.C., W.F. Figueira, J.S. Ueland, and L.B. Crowder. 2004. The Impact of United States Recreational Fisheries on Marine Fish Populations. Science 305: 1958-1960.

Commonwealth of the Northern Mariana Islands Coastal Resources Management. 2001. Shipwrecks, groundings, marine debris and dredging. Accessed 13 January 2005. http://www.crm.gov.mp/marine/wreck_debris/debris.htm.

Compagno, L.J.V. 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2: Carcharhiniformes. FAO Fish. Synop. (125) Vol. 4, Part 1. Rome, Italy: Food and Agriculture Organization of the United Nations.

Compagno, L.J.V. 1998. Sphyrnidae - Hammerhead and bonnethead sharks. Pages 1361-1366 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Compagno, L.J.V. 2000. *Urogymnus asperrimus*. In: IUCN 2004. The 2004 IUCN red list of threatened species. Accessed 30 November 2004. http://www.redlist.org.

Compagno, L.J.V., and P.R. Last. 1999a. Myliobatiidae - Eagle rays. Pages 1511-1519 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Compagno, L.J.V., and P.R. Last. 1999b. Mobulidae - Devil rays. Pages 1524-1530 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Compagno, L.J.V., and V.H. Niem. 1998. Carcharinidae - Requiem sharks (Also, ground sharks, blue sharks, sharpnose sharks). Pages 1312-1360 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Conand, C. 1998. Holothurians. Pages 1157-1190 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Conlan, R., and R. Service. 2000. El Niño and La Niña: Tracing the dance of ocean and atmosphere. Accessed 11 January 2005. http://www7.nationalacademies.org/opus/elnino.html.

Coombs, S. and A.N. Popper. 1979. Hearing differences among Hawaiian squirrelfish (family Holicentridae) related to differences in the peripheral auditory system. Journal of Comparative Physiology A 132:203-207.

CoRIS. 2003. Deep water corals. Accessed 11 August 2005. http://www.coris.noaa.gov/about/deep/deep.html.

Cornish, A., Y. Sadovy, and B. Russell. 2004. *Cheilinus undulatus*. In: IUCN 2004. The 2004 IUCN red list of threatened species. Accessed 31 January 2005. http://www.redlist.org.

Culik, B. M., S. Koschinski, N. Tregenza, and G. M. Ellis. 2001. Reactions of Harbour Porpoises (*Phocoena phocoena*) and Herring (*Clupea harengus*) to Acoustic Alarms. Marine Ecology Progress Series 211:255-260.

Dahan, M., and Y. Benayahu. 1997. Clonal propagation by the azooxanthellate octocoral *Dendronephthya hemprichi*. Coral Reefs 16:5-12.

Dalen J., and A. Raknes 1985. Scaring effects on fish from three-dimensional seismic surveys. Report No. FO 8504. Institute of Marine Research. Bergen, Norway.

Dalen J., and G. M. Knutsen 1986. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic exploration. In: Merklinger, H.M. (Ed.), Progress in Underwater Acoustics. Plenum Press, New York, pp. 93–102.

Daniel, R., and Minton, D. 2004. Inventory & monitoring program, Pacific Island Network Monitoring Plan-Appendix A: Marine report. http://www.nature.nps.gov/im/units/pacn/monitoring/plan/2004/pacn_Saipan, CNMI: National Park Service.

Darnitsky, V.B. 1980. On the synoptic variability of the geostrophic circulation in areas of underwater elevations in the North Pacific Ocean. From Works of the Far Eastern Regional Scientific Research Institute of the Order of the Red Banner of Labor. Problems of Oceanography. Gidrometeoizdat, Leningrad, No. 86, p.63-70. Translation No. 120. Honolulu, Hawaii: U.S. Department of Commerce. 1987. Translated from the Russian by Wilvan G. Van Campen for the SWFC Honolulu Laboratory, NMFS, NOAA. November.

Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR). 2004. Sport fish restoration: Locations of fish aggregating devices, Guam. Mangilao, Guam: Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR).

Dawson, C.E. 1985. Indo-Pacific pipefishes (Red Sea to the Americas). Ocean Springs, Mississippi: The Gulf Coast Research Laboratory

Day, J.W., C.A.S. Hall, W.M. Kemp, and A. Yáñez-Arancibia. 1989. Estuarine Ecology. New York, New York: John Wiley & Sons, Inc.

Dayton, P.K., S. Thrush, and S.A. Coleman. 2003. Ecological Effects of Fishing in Marine Ecosystems of the United States. Prepared for the Pew Ocean Commission. 52p.

Debelius, H. 2001. Indian Ocean reef guide. Frankfurt, Germany: IKAN- Unterwasserarchiv.

Debelius, H. 2002. Fish guide: Southeast Asia. Phuket, Thailand: Dive Supply.

Department of Fish and Wildlife Commonwealth of the Northern Mariana Islands (DFW CNMI). 2005. A map describing the location of fish aggregation devices in the Commonwealth of the Northern Mariana Islands. Saipan, CNMI: Commonwealth of the Northern Mariana Islands, Department of Fish and Wildlife.

Department of Fisheries and Oceans (DFO). 2004. Potential impacts of seismic energy on snow crabs. Habitat Status Report 2004/003. Fisheries and Oceans Canada, Gulf Region.

Department of the Navy (DoN). 1984. Establishment report for Orote Peninsula Ecological Reserve Area at the U.S. Naval communication area master station WESTPAC Territory of Guam Mariana Islands. Pearl Harbor, Hawaii: Pacific Division, Naval Facilities Engineering Command.

Department of the Navy (DoN). 1986. Management plan for the Haputo Ecological Reserve Area. Pearl Harbor, Hawaii: Pacific Division, Naval Facilities Engineering Command.

Department of the Navy (DoN). 1998. Draft environmental impact statement (DEIS) for Military training in the Marianas. Draft EIS. Pearl Harbor, Hawaii: U.S. Pacific Command.

Department of the Navy (DoN). 1998b. Final environmental impact statement: Shock testing the SEAWOLF submarine. Department of the Navy, Southern Division, Naval Facilities Engineering Command, North Charleston, SC.

Department of the Navy (DoN). 1999a. Final environmental impact statement: Military training in the Marianas. Final EIS. Prepared for U.S. Pacific Command, Pearl Harbor, Hawaii by Belt Collins Hawaii, Honolulu, Hawaii.

Department of the Navy (DoN). 1999b. Wetland delineation data layers for Guam Navy lands. Received 4 May 2005 from Robert W. Wescom, Natural Resources Manager, Commander, U.S. Naval Forces Marianas, Guam.

Department of the Navy (DoN). 2000. Deck Gun Noise Blast Test Results Aboard the USS Cole. Naval Surface Warfare Center, Dahlgren, MD.

Department of the Navy (DoN).). 2001. Final Environmental Impact Statement, Shock Trial of the USS WINSTON S. CHURCHILL (DDG-81). Washington, D.C. Naval Sea Systems Command. 597p.

Department of the Navy (DoN). 2001b Final Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active LFA (SURTASS/LFA) Sonar. Washington, D.C. Available at www.surtass-lfa-eis.com/Download/index.htm.

Department of the Navy (DoN). 2002. Final Environmental Impact Statement/Overseas Environmental Impact Statement Point Mugu Sea Range. March 2002.

Department of the Navy (DoN). 2002b. Biological Assessment for Explosive Ordnance Disposal (EOD) Mine Warfare Exercises in the East Coast Operating Areas. Naval Facilities Engineering Command. Norfolk, Virginia. July 2002.

Department of the Navy (DoN). 2003a. Integrated natural resources management plan--Farallon de Medinilla and Tinian military lease areas-Commonwealth of the Northern

Mariana Islands. Plan duration: FY 03-12. Prepared for Commander, U.S. Naval Forces Marianas by Helber Hastert & Fee, Planners.

Department of the Navy (DoN). 2003b. Final environmental assessment, Inner Apra Harbor maintenance dredging Guam. Pearl Harbor, Hawaii: Pacific Division, Naval Facilities Engineering Command.

Department of the Navy (DoN). 2004. Year 2003 assessment of marine and fisheries resources-Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. Final report. Submitted to Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii, under contract no. N62742-02-D-1802, DO 002, by the Environmental Company, Honolulu, Hawaii.

Department of the Navy (DoN). 2004b. Environmental Assessment/Overseas Environmental Assessment for Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring and Simulator (Vast/Impass) System. May 2004.

Department of the Navy (DoN). 2005. Year 2004 assessment of marine and fisheries resources: Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. Second working copy. Prepared for Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii by the Environmental Company, Honolulu, Hawaii under contract no. N62742-02-D-1802, DO 004.

Department of the Navy (DoN). 2005b. Marine Resources Assessment for the Marianas Operationd Area. Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Contract #N62470-02-D-9997, CTO 0027. Prepared by Geo-Marine, Inc., Plano, Texas.

Department of the Navy (DoN). 2005c. Overseas Environmental Assessment for Air-To-Ground Bombing Exercises (BOMBEX) in Southeastern OPAREAs. January 2005.

Department of the Navy (DoN). 2005d. Supplemental Environmental Impact Statement. Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. November 2005.

Department of the Navy (DoN). 2005e. Essential Fish Habitat Assessment for Explosive Charge Detonations Associated with Mine Warfare Training in the East Coast Naval Operating Areas. June 2005.

Department of the Navy (DoN). 2005f. Environmental Assessment/Overseas Environmental Assessment for Explosive Charge Detonations Associated with Mine Warfare Training in the East Coast Naval Operating Areas. July 2005.

Department of the Navy (DoN). 2006. Year 2005 assessment of marine and fisheries resources-Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. Prepared by S.H. Smith and D.E. Marx, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. May.

Department of the Navy (DoN). 2007. Overseas Environmental Assessment. Surface Routine Training Exercises in East and Gulf Coast Operation Areas and Seaward. January 2007.

Department of the Navy (DoN). 2007b. United States Navy. Whales and Sonar. http://www.whalesandsonar.navy.mil.

Department of the Navy (DoN). 2007c. Overseas Environmental Assessment Air Routine Training Exercises in East and Gulf Coast Operation Areas and Seaward. January 2007.

Department of the Navy (DoN). 2009. 2006, 2007, and 2008 assessment of nearshore marine resources at Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. Prepared by S.H. Smith and D.E. Marx, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. February.

Dijkgraaf, S. 1952. "Uber die Schallwahrnehmung bei Meeresfischen." Zeitschrift verglishende Phyiologie 34:104-122.

D'Itri, F. M. 1990. The biomethylation and cycling of selected metals andmetalloids in aquatic sediments. Pp. 163-214 in: Baudo, R., J. P. Giesy and H. Muntau (eds.). 1990. Sediments: Chemistry and toxicity of in-place pollutants. Lewis Publishers, Inc. Ann Arbor, Michigan.

Donguy, J.R., C. Henn, A. Morliere, and J.P. Rebert. 1982. Thermal changes in the western tropical Pacific in relation to the wind field. Deep-Sea Research 29(7A):869-882.

Dooley, J.K. 1999. Branchiostegidae - Tilefishes (also quakerfish, blanquillos, burrowfishes, amadais, horseheads, and sand tilefishes). Pages 2630-2648 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Duenas & Associates (Saipan) Inc. 1997. Saipan lagoon use management plan, survey of sea cucumbers and fish in the Saipan lagoon, Northern Mariana Islands. D&A (ES) Rept. No. 97-6(F). Prepared for Coastal Resources Management Office, Department of Lands and Natural Resources, Government of the Northern Mariana Islands, San Jose, Saipan, MP.

Dunning, M.C. 1998a. Nautilidae - Chambered nautiluses. Pages 709-711 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Dunning, M.C. 1998b. Loliginidae - Inshore squids, pencils, squids. Pages 764-780 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Dunning, D.J., Q.E. Ross, P. Geoghegan, J.J. Reichle, J.K. Menezes, and J.K. Watson. 1992. Alewives avoid high-frequency sound. North American Journal of Fisheries Management. 12:407-416.

Dunning, M.C., M.D. Norman, and A.L. Reid. 1998. Cephalopods - Introduction and general remarks. Pages 688-705 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Earthquake Engineering Research Institute (EERI). 1993. The Guam earthquake of August 8, 1993. EERI Special Earthquake Report. Accessed 28 January 2005. http://www.eeri.org/lfe/pdf/guam_1993_eeri_preliminary_report.pdf.

Egner S.A. and D.A. Mann. 2005. Auditory sensitivity of sergeant major damselfish *Abudefduf saxatilis* from post-settlement juvenile to adult. Marine Ecology Progress Series 285: 213–222.

Eldredge, L.G. 1979. Marine biological resources within the Guam seashore study area and the War in the Pacific National Historical Park. Technical Report No. 57. Mangilao, Guam: University of Guam Marine Laboratory. Submitted to National Park Service, U.S. Department of Interior.

Eldredge, L.G. 1983. Summary of environmental and fishing information on Guam and the Commonwealth of the Northern Mariana Islands: Historical background, description of the islands, and review of the climate, oceanography, and submarine topography. NOAA Technical Memorandum NMFS-SWFC-40:1-181.

Eldredge, L.G. 1995. Status of crustaceans systematics. Pages 161-169 in J.E. Maragos, M.N.A. Peterson, L.G. Eldredge, J.E. Bardach, and H.F. Takeuchi, eds. Marine and coastal biodiversity in the tropical island Pacific region, Volume 1: Species systematics and information management priorities. Honolulu, Hawaii: East-West Center.

Eldredge, L.G., R. Dickinson, and S. Moras, eds. 1977. Marine survey of Agat Bay. Technical Report No. 31. Mangilao, Guam: University of Guam Marine Laboratory. Submitted to Guam Oil and Refinery Co., Inc.

Elsner, J.B., and K. Liu. 2003. Examining the ENSO-typhoon hypothesis. Climate Research 25:43-54.

Embley, R.W., E.T. Baker, W.W. Chadwick, J.E. Lupton, J.A. Resing, G.J. Massoth, and K. Nakamura. 2004. Explorations of Mariana Arc volcanoes reveal new hydrothermal systems. EOS 85(4):37-44.

Engas, A. and S. Lokkeborg. 2002. Effects of seismic shooting and vessel generated noise on fish behavior and catch rates. Bioacoustics 12:313-315.

Engas, A., S. Lokkeborg, E. Ona, and A. Soldal 1996. Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). Can. J. Fish. Aquat. Sci. 53: 2238-2249.

Fager, E.W. 1971. Pattern in the development of a marine community. Limnology and Oceanography 16(2):241-253.

Falkowski, P.G. 1994. The role of phytoplankton photosynthesis in global biogeochemical cycles. Photosynthesis Research 39:235-258.

Fautin, D.G. 2002. Reproduction of cnidaria. Canadian Journal of Zoology 80:1735-1754.

Fautin, D.G., and S.L. Romano. 1997. Cnidaria: Sea anemones, corals, jellyfish, sea pens, hydra. Accessed 25 October 2005. http://tolweb.org/tree?group=Cnidaria&contgroup=Animals.

Fay, R.R. 1988. Hearing in vertebrates, A psychophysics databook. Hill-Fay Associates, Winnetka, IL.

Fay, R. and A.N. Popper. 2000. Evolution of hearing in vertebrates: the inner ears and processing. Hearing Research. 149: 1-10.

Fedorov, V.V., and S.D. Chistikov. 1985. Landscapes of seamounts as indicators of the biological productivity of the surrounding waters. In M.E. Vinogradev and M.V. Flint, eds, Biological bases of the commercial exploitation of the open areas of the ocean. Academy of Science of the U.S.S.R., Commission on problems of the world ocean. Published by Nauka Publ., Moscow, p. 221-230. Translation No. 126. Honolulu, Hawaii: U.S. Department of Commerce. Translated from the Russian by Wilvan G. Van Campen for the SWFC Honolulu Laboratory, NMFS, NOAA. April 1988.

Feltes, R.M. 2001. Polynemidae - Threadfins. Pages 3090-3116 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Field, J.C., D.F. Boesch, D. Scavia, R. Buddemeier, V.R. Burkett, D. Cayan, M. Fogarty, M. Harwell, R. Howarth, C. Mason, L.J. Pietrafesa, D. Reed, T. Roye, A. Sallenger, M. Spranger, and J.G. Titus. 2003. Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources. In: Climate Change Impacts in the United States. US Global Change Research Program: 461-487. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/foundation.htm.

Fish, J.F. and G.C. Offutt. 1972. "Hearing thresholds from toadfish, *Opsanu tau*, measured in the laboratory and field." Journal of the Acoustical Society of America 51:1318-1321.

Freiwald, A., J.H. Fosså, A. Grehan, T. Koslow, and J.M. Roberts. 2004. Cold-water coral reefs: Out of sight-no longer out of mind. Cambridge, United Kingdom: UNEP-WCMC.

Fritzsche, R.A., and K.G. Thiesfeld. 1999a. Aulostomidae - Trumpetfishes. Page 2277 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Fritzsche, R.A., and K.G. Thiesfeld. 1999b. Fistularidae - Cornetfishes (flute mouths). Pages 2278-2279 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Froese, R., and D. Pauly, eds. 2004. FishBase. World Wide Web Electronic Publication. Accessed 23 November 2004. http://www.fishbase.org/search.cfm.

Fryer, P. 1996. Evolution of the Mariana convergent plate margin system. Reviews of Geophysics 34(1): 89-125.

Fryer, P., C.G. Wheat, and M.J. Mottl. 1999. Mariana blueschist mud volcanism: Implications for conditions within the subduction zone. Geology 27(2): 103-106.

Fryer, P., N. Becker, B. Appelgate, F. Martinez, M. Edwards, and G. Fryer. 2003. Why is the Challenger Deep so deep? Earth and Planetary Science Letters 211:259-269.

Galkin, S.V. 1997. Megafauna associated with hydrothermal vents in the Manus Back-Arc Basin (Bismark Sea). Marine Geology 142:197-206.

Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental Testing of Acoustic Alarms (Pingers) to Reduce Bycatch of Harbour Porpoise in the State of Washington. J. Cet. Res.Manag. 2(1):1-9.

Giese, B.S., and J.A. Carton. 1999. Interannual and decadal variability in the tropical and midlatitude Pacific Ocean. Journal of Climate 12:3402-3418.

Gill, A.C. 1999. Pseudochromidae - Dottybacks (eelblennies). Pages 2557-2577 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture.

Gilmartin, M., and N. Revelante. 1974. The 'island mass' effect on the phytoplankton and primary production of the Hawaiian Islands. Journal of Experimental Marine Biology and Ecology 16:181-204.

Goertner, J. F. 1982. Prediction of Underwater Explosion Safe Ranges for Sea Mammals. NSWC/WOL TR 82-188. Naval Ordnance Laboratory. Silver Spring, MD.

Goertner, J. F., M. L. Wiley, G. A. Young, and W. W. McDonald 1994. Effects of underwater explosions on fish without swimbladders. Naval Surface Warfare Center, Dahlgren Division, White Oak Detachment, Silver Spring, MD. NSWC TR 88-114.

Goldman, K.J. and B. Human. 2000. *Lamna ditropis*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 16 November 2004. http://www.redlist.org.

Goldman, K.J. and members of the Shark Specialist Group. 2001. *Alopias vulpinus*. 2003 IUCN Red List of Threatened Species. Accessed 16 November 2004. http:// www.redlist.org.

Green, A. 1997. An assessment of the status of the coral reef resources, and their patterns of use, in the U.S. Pacific Islands. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council, National Oceanic and Atmospheric Administration.

Gregory, J. and P. Clabburn. 2003. Avoidance behaviour of *Alosa fallax fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river. Aquatic Living Resources 16: 313–316.

Greze, N.V., and A.V. Kovalev. 1985. Distribution of plankton in areas of elevations of the ocean bottom. In: Vinogradev, M.E., and M.V. Flint, eds. Biological bases of the commercial exploitation of the open areas of the ocean. Academy of Science of the U.S.S.R., Commission on problems of the world ocean. Published by Nauka Publ., Moscow, p. 204-210. Translation No. 135. Honolulu, Hawaii: U.S. Department of Commerce. Translated from the Russian by Wilvan G. Van Campen for the SWFC Honolulu Laboratory, NMFS, NOAA. January 1991.

Grigg, R.W., and C. Birkeland. 1997. Status of coral reefs in the Pacific. Sea Grant College Program, School of Ocean and Earth Science and Technology, University of Hawaii. HAWAU-W-97-001:1-144.

Grimes, C.B. 1987. Reproductive biology of Lutjanidae: A review. Pages 239-294 in J.J. Polovina and S. Ralston, eds. Tropical snappers and groupers: Biology and fisheries management. Boulder, Colorado: Westview Press.

Guam Environmental Protection Agency (GEPA). 1998. Letter to Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Dated September 28, 1998.

Guerra, A., A.F. Gonzalez, F. Rocha, and J. Gracia Ecobiomar. 2004. Calamares gigantes varados. Victimas de exploraciones acústicas. Investigación y Ciencia July:35-37.

Gutierrez, J. 2002. Guam coral reef fisheries. Slide presentation. Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR).

Haight, W.R., D. Kobayashi, and K.E. Kawamoto. 1993. Biology and management of deepwater snappers of the Hawaiian Archipelago. Marine Fisheries Review 55(2):20-27.

Halpern, B.S., S. Walbridge, K.A. Selkoe, C.V. Kappel, F. Micheli,C. D'Agrosa, J.F. Bruno, K.S. Casey, C. Ebert, H.E. Fox, R. Fujita, D. Heinemann, H.S. Lenihan, E.M.P. Madin, M.T. Perry, E. R. Selig, M. Spalding, R. Steneck, and R. Watson. A Global Map of Human

Impact on Marine Ecosystems. Science 319 948 (2008); DOI: 10.1126/science.1149345.

Hanauer, E. 2001. Diving Micronesia. New York, New York: Aqua Quest Publications, Inc.

Handschumacher, D.W., W.W. Sager, T.W.C. Hilde, and D.R. Bracey. 1988. Pre-Cretaceous tectonic evolution of the Pacific plate and extension of the geomagnetic polarity reversal time scale with implications for the origin of the Jurassic "Quiet Zone". Tectonophysics 155:365-380.

Harrison, I.J., and H. Senou. 1999. Mugilidae - Mullets. Pages 2069-2108 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Harvell, C.D., K. Kim, J.M. Burkholder, R.R. Colwell, P.R. Epstein, D.J. Grimes, E.E. Hofmann, E.K. Lipp, A.D.M.E. Osterhaus, R.M. Overstreet, J.W. Porter, G.W. Smith, and G.R. Vasta. 1999. Emerging marine diseases-climate links and anthropogenic factors. Science 285:1505-1510.

Hashimoto, J., S. Ohta, K. Fujikura, and T. Miura. 1995. Microdistribution pattern and biogeography of the hydrothermal vent communities of the Minami-Ensei Knoll in the Mid Okinawa Trough, Western Pacific. Deep-Sea Research I 42(4):577-598.

Hastings, M. C. and A. N. Popper 2005. Effects of Sound on Fish. Report to California Department of Transportation, January 2005. 82pp. http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf.

Hastings, M. C., A. N. Popper, J. N. Finneran, and P. J. Lanford. 1996. Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*. J. Acoust. Soc. America 99(3): 1759-1766.

Hawaii Biological Survey. 2001a. Polychaete *Sabellastarte spectabilis*, featherduster worm, fan Worm. Accessed 27 October 2005. http://www2.bishopmuseum.org/HBS/invertguide/species_pdf/sabellastartespectabilis.pdf.

Hawaii Biological Survey. 2001b. Bryozoan, *Amathia distans*. Accessed 27 October 2005. http://www2.bishopmuseum.org/HBS/invertguide/species_pdf/amathiadistans.pdf.

Hawkins, A.D. and A.D.F. Johnstone. 1978. The hearing of the Atlantic salmon, *Salmo salar*. Journal of Fish Biology 13: 655-673.

Heberholz J. and B.A. Schmitz. 2001. Signaling via water currents in behavioral interactions of snapping shrimp (*Alpheus heterochaelis*). Biological Bulletin 201:6-16.

Heemstra, P.C., and J.E. Randall. 1993. FAO species catalogue. Volume 16: Groupers of the world (Family Serranidae, subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper, and lyretail species known to date. FAO Fish.Synop. No. 125, Vol. 16. Rome, Italy: Food and Agriculture Organization of the United Nations.

Heemstra, P.C., and J.E. Randall. 1999. Serranidae - Groupers and sea basses (also soapfishes, anthiines, etc). Pages 2442-2548 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Helfman, G.S., B.B. Collette, and D.E. Facey. 1999. The diversity of fishes. 4th ed. Malden, Massachusetts: Blackwell Science.

Hennemann, R.M. 2001. Sharks and rays: Elasmobranch guide of the world: Pacific Ocean, Indian Ocean, Red Sea, Atlantic Ocean, Caribbean, and Arctic Ocean. Frankfurt, Germany: IKAN – Unterwasserarchiv.

Hensley, R.A., and T.S. Sherwood. 1993. An overview of Guam's inshore fisheries. Marine Fisheries Review 55(2):129-138.

Heupel, M. 2000. *Carcharhinus melanopterus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 23 November 2004. http://www.redlist.org.

Hessler, R.R., and P.F. Lonsdale. 1991. Biogeography of Mariana Trough hydrothermal vent communities. Deep-Sea Research 38(2):185-199.

Higgins, H.W., and D.J. Mackey. 2000. Algal class abundances, estimated from chlorophyll and carotenoid pigments, in the western Equatorial Pacific under El Niño and non-El Niño conditions. Deep-Sea Research I 47:1461-1483.

Higgs, D. M., D. T. Plachta, A. K. Rollo, M. Singheiser, M. C. Hastings, and A. N. Popper. 2004. Development of ultrasound detection in American shad (*Alosa sapidissima*). The Journal of Experimental Biology 207: 155-163

Hodgson, G. 1998. Corals. Pages 101-122 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 1: Seaweeds, corals, bivalves, and gastropods. Rome, Italy: Food and Agriculture Organization of the United Nations.

Holthuis, L.B. 1991. FAO species catalogue. Volume 13: Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date. FAO Fisheries Synopsis No. 125, Vol. 13. Rome, Italy: Food and Agriculture Organization.

Hoover, J.P. 1998. Hawai'i's sea creatures: A guide to Hawai'i's marine invertebrates. Honolulu, Hawaii: Mutual Publishing.

Houk, P. 2001. State of the reef report for Saipan Island, Commonwealth of the Northern Mariana Islands. Saipan, MP: CNMI Inter-Agency Marine Monitoring Team.

Humphris, S.E. 1995. Hydrothermal processes at mid-ocean ridges. Reviews of Geophysics Supplement, Vol. 33. Accessed 13 January. http://www.agu.org/revgeophys/humphr01/humphr01.html.

Hutchins, J.B. 2001. Monacanthidae - Filefishes (leatherjacks). Pages 3929-3947 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Ishihara, H. 2000. Aetobatus narinari. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 3 February 2005. http://www.redlist.org.

Ishihara, H., and members of the Shark Specialist Group. 2002. *Manta birostris*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 3 February 2005. http://www.redlist.org.

International Union for Conservation of Nature and Natural Resources (IUCN). 2004. 2004 IUCN red list of threatened species. Accessed 29 November 2004. http://www.redlist.org.

Iversen, R.T.B. 1967. Response of the yellowfin tuna (*Thunnus albacares*) to underwater sound. Pages 105-121 in W.N. Tavolga (editor), Marine Bio-Acoustics II. Pergamon Press, New York.

Iversen, R.T.B. 1969. Auditory thresholds of the scombrid fish *Euthynnus affinis*, with comments on the use of sound in tuna fishing. Proceedings of the FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics, October 1967. FAO Fisheries Reports No. 62 Vol. 3. FRm/R62.3.

Jerkø, H., I. Turunen-Rise, P.S. Enger, and O. Sand. 1989. "Hearing in the eel (*Anguilla anguilla*)." Journal of Comparative Physiology 165:455-459.

Johnson, R.H. 1973. Acoustic observations of nonexplosive submarine volcanism. Journal of Geophysical Research 78(26):6093-6096.

Johnson, J. S. 2001. Final overseas environmental impact statement and environmental impact statement for Surveillance Towed Array Sensor Low Frequency Active (SURTASS-LFA) Sonar. Volumes 1 and 2.

Johnson, K.A. 2002. A Review of National and International Literature on the Effects of Fishing on Benthic Habitat. NOAA Tech. Memo. NMFS-F/SPO-57.

Jones, R.S., R.H. Randall, and R.T. Tsuda. 1974. A candidate marine environmental impact survey for potential U.S. military projects on Tinian Island, Mariana Islands. Technical Report No. 9. Mangilao, Guam: University of Guam Marine Laboratory.

Jørgensen, R., N.O. Handegard, H. Gjøsæter, and A. Slotte. 2004. Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. Fisheries Research 69: 251-261.

Jørgensen, R., K. K. Olsen, I.-B. Falk-Petersen, and P. Kanapthippilai. 2005. Investigations of Potential Effects of Low Frequency Sonar Signals on Survival, Development and Behaviour of Fish Larvae and Juveniles. Norwegian College of Fishery Science University of Tromsø. 49pp.

Joint Typhoon Warning Center, Naval Pacific Meteorology and Oceanography Center (JTWC). 1998. Appendix A: Definitions. Accessed 25 January 2005. http://www.npmoc.navy.mil/jtwc/atcr/1998atcr/appendix/appendix_page1.html.

JTWC (Joint Typhoon Warning Center, Naval Pacific Meteorology and Oceanography Center). 2005. JTWC TC climatology tables: Northwestern Pacific Ocean. Accessed 25 January 2005. https://metoc.npmoc.navy.mil/jtwc/climostats/nwpclimotables.html.

Karl, D.M. 1999. A sea of change: Biogeochemical variability in the North Pacific Subtropical Gyre. Ecosystems 2:181-214.

Kato, C., L. Yi, Y. Nogi, Y. Nakamura, J. Tamaoka, and K. Horikoshi. 1998. Extremely barophilic bacteria isolated from the Mariana Trench, Challenger Deep, at a depth of 11,000 meters. Applied Environmental Microbiology 64(4):1510-1513.

Kawabe, M., S. Fujio, and D. Yanagimoto. 2003. Deep-water circulation at low latitudes in the western North Pacific. Deep-Sea Research I 50:631-656.

Kay, E.A. 1995. Pacific island marine mollusks: Systematics. Pages 135-159 in J.E. Maragos, M.N.A. Peterson, L.G. Eldredge, J.E. Bardach, and H.F. Takeuchi, eds. Marine and coastal biodiversity in the tropical island Pacific region. Volume 1. Species systematics and information management priorities. Honolulu, Hawaii: East-West Center.

Keevin, T. M., and G. L. Hempen 1997. The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts. U.S. Army Corps of Eng. St. Louis, MO. 118p.

Kelley-Borges, M., and C. Valentine. 1995. The sponges of the tropical island region of Oceania: A taxonomic status review. Pages 83-120 in J.E. Maragos, M.N.A. Peterson, L.G. Eldredge, J.E. Bardach, and H.F. Takeuchi, eds. Marine and coastal biodiversity in the tropical island Pacific region. Volume 1. Species systematics and information management priorities. Honolulu, Hawaii: East-West Center.

Kelly, M., J. Hooper, V. Paul, G. Paulay, R. van Soest, and W. de Weerdt. 2003. Taxonomic inventory of the sponges (Porifera) of Mariana Islands. Micronesica 35-36:100-120.

Kennett, J.P. 1982. Marine geology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Kenyon, T.N. 1996. Ontogenetic changes in the auditory sensitivity of damselfishes (Pomacentridae). Journal of Comparative Physiology 179: 553-561.

Kirkendale, L., and D.R. Calder. 2003. Hydroids (Cnidaria: Hydrozoa) from Guam and the Commonwealth of the Northern Mariana Islands CNMI). Micronesica 35-36:159-188.

Kirkendale, L., and C.G. Messing. 2003. An annotated checklist and key to the Crinoidae of Guam and the Commonwealth of the Northern Mariana Islands. Micronesica 35-36:523-546.

Klima, E.F., and D.A. Wickham. 1971. Attraction of coastal pelagic fishes with artificial structures. Transactions of the American Fisheries Society 100:86-99.

Knudsen, F. R., C. B.Schreck, S. M. Knapp, P. S. Enger, and O. Sand 1997. Infrasound produces flight and avoidance response in Pacific juvenile salmonids. J. Fish Biol. 51, 824-829.

Knudsen, F. R., Enger, P. S., and O. Sand 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, Salmo salar L. J. Fish Biol. 40, 523-534.

Knudsen, F. R., P. S. Enger, and O. Sand 1994. Avoidance response to low frequency sound in downstream migrating Atlantic salmon smolt, Salmo salar L. J. Fish Biol. 45: 227-233.

Kojima, S. 2002. Deep-sea chemoautosynthesis-based communities in the northwestern Pacific. Journal of Oceanography 58:343-363.

Kolinski, S.P., D.M. Parker, L.I. Ilo, and J.K. Ruak. 2001. An assessment of the sea turtles and their marine and terrestrial habitats at Saipan, Commonwealth of the Northern Mariana Islands. Micronesia 34(1):55-72.

Kotas, J.E. 2000. *Sphyrna lewini*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 3 February 2005. http://www.redlist.org.

Kottelat, M. 2001. Monodactylidae - Moonfishes. Pages 3216-3220 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Kubota, I. 1987. The western Pacific and El Niño. Oceanus 30(1):75-77.

Kuiter, R.H., and H. Debelius. 2001. Surgeonfishes, rabbitfishes and their relatives: A comprehensive guide to Acanthuroidei. Chorleywood, United Kingdom: TMC Publishing.

Kvadsheim, P. H. and E. M. Sevaldsen. 2005. The Potential impact of 1 – 8 kHz active sonar on stocks of juvenile fish during sonar exercises. Forsvarets Forskningsinstitutt, PO Box 25, NO-2027, Kjeller, Norway.

Ladich F. and A.H. Bass. 2003. Underwater sound generation and acoustic reception in fishes with some notes on frogs. Pages 173-193 in Collin, S.P. and N.J. Marshall (editors), Sensory Processing in Aquatic Environments. Springer-Verlag, New York.

Lagardère, J-P and M.R. Régnault. 1980. Influence du niveau sonore de bruit ambient sur la métabolisme de Crangon crangon (Decapoda: Natantia) en élevage. Marine Biology 57:157-164.

Lagerloef, G.S.E., G.T. Mitchum, R.B. Lukas, and P.P. Niller. 1999. Tropical Pacific near-surface currents estimated from altimeter, wind, and drifter data. Journal of Geophysical Research 104(C10):23313-23326.

Lambert, G. 2003. Marine biodiversity of Guam: The ascidiacea. Micronesica 35-36:584-593.

Larson, H.K., and E.O. Murdy. 2001. Gobiidae - Gobies. Pages 3578-3603 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Lasker, H.R. 1988. The incidence and rate of vegetative propagation among coral reef alcyonarians. Pages 763-768 in J.H. Choat, D. Barnes, M.A. Borowitzka, J.C. Coll, P.J. Davies, P. Flood, B.G. Hatcher, D. Hopley, P.A. Hutchings, D. Kinsey, G.R. Orme, M. Pichon, P.F. Sale, P. Sammarco, C.C. Wallace, C. Wilkinson, E. Wolanski, and O. Bellwood, eds. Proceedings of the Sixth International Coral Reef Symposium, Australia, 1988. Volume 2. Townsville, Australia: Sixth International Coral Reef Symposium Executive Committee.

Last, P.R., and L.J.V. Compagno. 1999. Dasyatidae - Stingrays. Pages 1479-1505 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Latha, G., S. Senthilvadivu, R. Venkatesan, R. Rajendran. 2005. Sound of shallow and deep water lobsters: Measurements, analysis, and characterization (L). Journal of the Acoustical Society of America 117:2720-2723.

Le Bouteiller, A., J. Blanchot, and M. Rodier. 1992. Size distribution patterns of phytoplankton in the western Pacific: Towards a generalization for the tropical open ocean. Deep-Sea Research 39(5):805-823.

Lehodey, P., M. Bertignac, J. Hampton, A. Lewis, and J. Picaut. 1997. El Niño Southern Oscillation and tuna in the western Pacific. Nature 389:715-718.

Leis, J.M. 1987. Review of the early life history of tropical groupers (Serranidae) and snappers (Lutjanidae). Pages 189-237 in J.J. Polovina and S. Ralston, eds. Tropical snappers and groupers: Biology and fisheries management. Boulder, Colorado: Westview Press.

Leis, J.M. 2001. Diodontidae - Porcupinefishes (burrfishes). Pages 3958-3965 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Leis, J.M., and T. Trnski. 1989. The larvae of Indo-Pacific shorefishes. Kensington, NSW Australia: New South Wales University Press.

Levin, P.S., E.E. Holmes, K.R. Piner, and C.J. Harvey. 2006. Shifts in a Pacific Ocean fish assemblage: the potential influence of exploitation. Conserv. Biol. 20(4) 1181-1190.

Lobban, C.S., and R.T. Tsuda. 2003. Revised checklist of benthic marine macroalgae and seagrasses of Guam and Micronesia. Micronesica 35-36:54-99.

Lord, C., C. Plank, I. Zelo, and D. Helton. 2003. Surveys of abandoned vessels: Guam and the Commonwealth of the Northern Mariana Islands. Seattle, Washington: NOAA, National Ocean Service, Office of Response and Restoration.

Lourie, S.A., S.J. Foster, E.W.T. Cooper, and A.C.J. Vincent. 2004. A guide to the identification of seahorses. Project Seahorse and TRAFFIC North America. Washington, D.C.: University of British Columbia and World Wildlife Fund.

Lovell, J.M., M.M Findlay, R.M. Moate, and D.A. Pilgrim. 2005. The polarization of inner ear ciliary bundles from a scorpaeniform fish. Journal of Fish Biology 66: 836–846.

Lovell, J. M., M.M. Findlay, R.M. Moate, and H.Y. Yan. 2005. The hearing abilities of the prawn *Palaemon serratus*. Comparative Biochemistry and Physiology, Part A. 140: 89-100.

Mackey, D.J., J.S. Parslow, F.B. Griffiths, H.W. Higgins, and B. Tilbrook. 1997. Phytoplankton productivity and the carbon cycle in the western Equatorial Pacific under El Niño and non-El Niño conditions. Deep-Sea Research II 44(9-10):1951-1978.

Mann, D.A., Z. Lu, and A.N. Popper. 1997. “A clupeid fish can detect ultrasound.” Nature 389:341.

Mann, D.A., Z. Lu, M.C. Hastings, and A.N. Popper. 1998. Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima*). Journal of the Acoustical Society of America 104 (1): 562-568.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. 2001. Ultrasound detection by clupeiform fishes. The Journal of the Acoustical Society of America 109: 3048-3054.

Mann, D.A., A.N. Popper, and B. Wilson. 2005. Pacific herring hearing does not include ultrasound. Biology Letters 1: 158-161.

Manning, R.B. 1998. Stomatopods. Pages 827-841 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Mantua, N.J. 2002. Pacific-decadal oscillation (PDO). Pages 592-594 in M.C. MacCracken, and J.S. Perry, eds. Encyclopedia of global environmental change. Chichester, England: John Wiley and Sons, Ltd.

Mantua, N., and S.R. Hare. 2002. The Pacific Decadal Oscillation. Journal of Oceanography 58:35-44.

Mantyla, A.W., and J.L. Reid. 1978. Measurements of water characteristics at depths greater than 10 km in the Marianas Trench. Deep-Sea Research 25:169-173.

Maragos, J., and D. Gulko, eds. 2002. Coral reef ecosystems of the northwestern Hawaiian Islands: Interim results emphasizing the 2000 surveys, pp. 1-46 pp. Honolulu, Hawaii: USFWS and Hawaii Department of Land and Natural Resources.

Mariana Trench. 2003 . The Mariana Trench – Biology. Accessed 18 January 2005. http://www.marianatrench.com/mariana_trench-biology_001.htm.

Marine Research Consultants (MRC). 1999. Marianas training effects of LCAC landing on coral reefs. Contract report. Honolulu, Hawaii: Belt Collins.

Marine Research Consultants (MRC). 1997. Marine environmental impact assessment for military training exercises off Tipalao and Dadi Beaches, Guam Naval Station, Guam, Mariana Islands. Contract report. Honolulu, Hawaii: Belt Collins.

Marsh, J.A., Jr., R.M. Ross, and W.J. Zolan. 1982. Water circulation on two Guam reef flats. Pages 355-360 in E.D. Gomez, C.E. Birkeland, R.W. Buddemeier, R.E. Johannes, J.A. Marsh Jr., and R.T. Tsuda, eds. Proceedings of the Fourth International Coral Reef Symposium. Manila, 1981. Volume 1.

Martinez, E., and K. Maamaatuaiahutapu. 2004. Island mass effect in the Marquesas Islands: Time variation. Geophysical Research Letters 31:L18307.

Matsuura, K. 2001a. Ostraciidae - Boxfishes. Pages 3948-3951 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Matsuura, K. 2001b. Tetraodontidae - Puffers. Pages 3954-3957 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M-N Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and C. McCabe. 2000. Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals; and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Report R99-15 prepared by Centre for Marine Science and Technology, Curtin University of Technology, Western Australia for Australian Petroleum Production and Exploration Association.

McGowan, J.A., and P.W. Walker. 1985. Dominance and diversity maintenance in an oceanic ecosystem. Ecological Monographs 55(1):103-118.

McKay, R.J. 2001. Haemulidae - Grunts (sweetlips, rubberlips, hotlips, and velvetchins). Pages 2961- 2989 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

McMullin, E.R., D.C. Bergquist, and C.R. Fisher. 2000. Metazoans in extreme environments: Adaptations of hydrothermal vent and hydrocarbon seep fauna. Gravitational and Space Biology Bulletin 13(2):13-23.

Micronesia. 2005. Northern Mariana Islands; Fiestas, sports events, food, fun and more. Accessed 15 August 2005. http://micronesia.hawaii.com/marianas/events/.

Micronesian Divers Association, Inc. 2005. American Tanker. Accessed 5 May 2005. http://www.mdaguam.com/tanker.htm.

Miller, G. S. 1991. The bow shock environment from a 16-inch projectile flyby. Naval Surface Weapons Center Technical Report TR91-621. Naval Surface Weapons Center. Silver Spring, MD.

Miller, J.M., W. Watson, and J.M. Leis. 1979. An atlas of common nearshore marine fish larvae of the Hawaiian Islands. Honolulu, Hawaii: University of Hawaii Sea Grant College Program. UNIHISEAGRANT-MR-80-02:1-168.

Miskelly, A. 1968. Sea urchins of Australia and the Indo-Pacific. Sydney, Australia: Capricornica Publications.

Misund, O. A. 1997. Underwater acoustics in marine fisheries and fisheries research. Review of Fish Biology and Fisheries 7:1-34.

Moffitt, R.B. 1993. Deepwater demersal fish. Pages 73-95 in A. Wright and L. Hill, eds. Nearshore marine resources of the South Pacific. Honiara, Solomon Islands: Forum Fisheries Agency; Suva, Fiji: Institute of Pacific Studies; and Canada: International Centre for Ocean Development.

Moffitt, R.B., and F.A. Parrish. 1996. Habitat and life history of juvenile Hawaiian pink snapper, *Pristipomoides filamentosus*. Pacific Science 50(4):371-381.

Mooi, R.D. 1999. Plesiopidae - Roundheads (prettyfins, longfins). Pages 2578-2585 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Morgan, L.E. and R. Chuenpagdee. 2003. Shifting gears, addressing the collateral impacts of fishing methods in U.S. waters. Marine Conservation Biology Institute. 40 pp.

Mottl, M.J., C.G. Wheat, P. Fryer, J. Gharib, and J.B. Martin. 2004. Chemistry of springs across the Mariana forearc shows progressive devolatilization of the subducting plate. Geochimica et Cosmochimica Acta 68(23):4915-4933.

Munro, J. 1993. Giant clams. Pages 431-449 in A. Wright and L. Hill, eds. Nearshore marine resources of the South Pacific. Honiara, Solomon Islands: Forum Fisheries Agency; Suva, Fiji: Institute of Pacific Studies; and Canada: International Centre for Ocean Development.

Myers, R. 1999. Micronesian reef fishes: A comprehensive guide to the coral reef fishes of Micronesia. 3rd ed. Barrigada, Territory of Guam: Coral Graphics.

Myers, R.F. 1993. Guam's small-boat-based fisheries. Marine Fisheries Review 55(2):117-128.

Myers, R.F., and T.J. Donaldson. 2003. The fishes of the Marianas Islands. Micronesica 35-36:594-648.

Myrberg, A.A. Jr. 1980. Fish bioacoustics: its relevance to the 'not so silent world.' Environmental Biology of Fish 5(4): 297-304.

Myrberg, A.A. Jr and J.Y. Spires. 1980. "Hearing in damselfishes: an analysis of signal detection among closely related species." Journal of Comparative Physiology 140:135-144.

National Atmospheric and Space Administration (NASA). 1998. Goddard Earth Sciences Data and Information Services Center, Distributed Active Archive Center. Accessed 23 January 2004. ftp://daac.gsfc.nasa.gov/data/czcs/level_3/monthly_data/subsets/Chlor/.

National Atmospheric and Space Administration (NASA). 2000. AVHRR Oceans Pathfinder Global Equalangle Best weekly SST averages (NOAA/NASA). Goddard Earth Sciences Data and Information Services Center, Distributed Active Archive Center. Accessed 4 May 2004. ftp://daac.gsfc.nasa.gov/data/avhrr/tile_8km/.

Nash, W. 1993. *Trochus*. Pages 451-495 in A. Wright and L. Hill, eds. Nearshore marine resources of the South Pacific. Honiara, Solomon Islands: Forum Fisheries Agency; Suva, Fiji: Institute of Pacific Studies; and Canada: International Centre for Ocean Development.

Nelson, J. 1994. Fishes of the world. 3rd ed. New York, New York: John Wiley & Sons, Inc.

National Centers for Coastal Ocean Science/National Oceanic and Atmospheric Administration (NCCOS/NOAA). 2005. Shallow-water benthic habitats of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CD-ROM). NOAA Technical Memorandum NOS-CCMA-8:1-48.

National Data Buoy Center (NDBC). 2005. Station 52200 - Ipan, Guam (121). Accessed 26 January 2005. http://www.ndbc.noaa.gov/station_page.php?station=52200.

Nestler, J.M. 2002. Simulating movement patterns of blueback herring in a stratified southern impoundment. Transactions of the American Fisheries Society. 131: 55-69.

Ng, P.K.L. 1998. Lobsters. Pages 1045-1156 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

National Marine Fisheries Service (NMFS). 2002. Fisheries off west coast states and in the western Pacific; Atlantic highly migratory species; Fisheries of the northeastern United States; Implementation of the Shark Finning Prohibition Act. Federal Register 67(28):6194-6202.

National Marine Fisheries Service (NMFS). 2003a. Annual report to Congress on the status of U.S. fisheries - 2002. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS). 2003b. Draft Environmental Impact Statement: Bottomfish and seamount groundfish fisheries in the western Pacific region. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

National Marine Fisheries Service (NMFS). 2003c. 2003 Guam/Marianas fishing derby. Accessed 15 August 2005. http://www.pifsc.noaa.gov/wpacfin/guam/dawr/Pages/gdawr_dawr_3.htm.

National Marine Fisheries Service (NMFS). 2004a. Annual report to Congress on the status of U.S. fisheries - 2003. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS). 2004b. Fisheries off the west coast states and in the Western Pacific; Western Pacific pelagic fisheries; highly migratory species fisheries; overfishing determination for bigeye tuna. Federal Register 69(250):78397-78398.

National Marine Fisheries Service (NMFS). 2004c. Fisheries off west coast states and in the Western Pacific; coral reef ecosystems fishery management plan for the Western Pacific. Federal Register 69(36):8336-8349.

National Marine Fisheries Service (NMFS). 2004d. National Marine Fisheries Service Office of Protected Resources. Accessed 30 November 2004. http://www.nmfs.noaa.gov/pr/species/concern.

National Marine Fisheries Service-Pacific Islands Region (NMFS-PIR). 2001. Final Environmental Impact Statement: Fishery management plan, pelagic fisheries of the western Pacific region. Vol. 1. Volume 1. Prepared for National Marine Fisheries Service-Pacific Islands Regional Office by URS Corporation, Honolulu, HI under contract to Research Corporation of the University of Hawaii.

National Marine Fisheries Service-Pacific Islands Region (NMFS-PIR).). 2004. Draft environmental impact statement, seabird interaction mitigation methods under the Fishery Management Plan Pelagics Fisheries of the Western Pacific Region and pelagic squid fishery management under the Fishery Management Plan Pelagics Fisheries of the Western Pacific Region and the High Seas Fishing Compliance Act. Honolulu, Hawaii: National Marine Fisheries Service, Pacific Islands Regional Office.

National Oceanic and Atmospheric Administration (NOAA). 1998. Ecological Effects of Fishing. Stephen K. Brown, Peter J. Auster, Liz Lauck, and Michael Coyne. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

National Oceanic and Atmospheric Administration (NOAA). 2002. NOAA El Niño page. Accessed 30 January 2005. http://www.elnino.noaa.gov.

National Oceanic and Atmospheric Administration (NOAA). 2004a. Sea surface temperature time series at Guam. Accessed 5 January 2005. http://coralreefwatch.noaa.gov/satellite/archive/sst_series_guam_path.html.

National Oceanic and Atmospheric Administration (NOAA). 2004b. Derelict Vessels in Saipan, Commonwealth of the Northern Marianas Islands (CNMI). NOAA Coral Reef News 1(4):3.

National Oceanic and Atmospheric Administration (NOAA). 2004c. Abandoned vessel project. Accessed 10 February 2004. http://response.restoration.noaa.gov/dac/vessels/inventory/data.html?region_id=mp.

National Oceanic and Atmospheric Administration (NOAA). 2005a. What is La Niña? Accessed 11 January 2005. http://www.pmel.noaa.gov/tao/elnino/la-nina-story.html.

National Oceanic and Atmospheric Administration (NOAA). 2005b. What is an El Niño? Accessed 11 January 2005. http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html.

National Research Council (NRC). 2000. Marine Mammals and Low Frequency Sound: Progress Since 1994. National Academy Press, Washington, DC.

National Research Council (NRC). 2002. Effects of trawling and dredging on seafloor habitats. National Academy Press. 126 p.

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. National Academies Press. Washington, D.C.

National Research Council (NRC). 2005. Marine Mammals Populations and Ocean Noise. Determining When Noise Causes Biologically Significant Effects. National Academies Press. Washington, D.C. 126p.

Naval Research Lab (NRL). 1997. Effects of Aluminized Fiberglass on Representative Chesapeake Bay Marine Organisms. November 23.

Naval Research Lab (NRL). 1999. Environmental Effects of RF Chaff- A Select Panel Report to the Undersecretary of Defense for Environmental Security. Washington, D. C.

Norman, M.D. 1998. Octopodidae - Benthic octopuses. Pages 800-826 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

The National Park Service (NPS). 2004. American Memorial Park, Saipan, Northern Mariana Islands. Accessed 3 February 2005. http://www.nps.gov/amme/main.htm.

Nybakken, J.W. 1997. Marine Biology: An ecological approach. 4th ed. Menlo Park, California: Addison Wesley Educational Publishers, Inc.

Offutt, G.C. 1971. “Response of the tautog (*Tautoga onitis*, teleost) to acoustic stimuli measured by classically conditioning the heart rate.” Conditional Reflex 6(4):205-214.

Ogawa, Y., K. Kobayashi, H. Hotta, and K. Fujioka. 1997. Tension cracks on the oceanward slopes of the northern Japan and Mariana Trenches. Marine Geology 141:111-123.

Pacific ENSO Applications Center. 1995. General information and imagemap of USAPI. US-Affiliated Pacific Islands (USAPI) information and maps. Accessed 13 January 2005. http://lumahai.soest.hawaii.edu/Enso/map/map.html.

Packard, A., H.E. Karlsen, and O. Sand. 1990. Low frequency hearing in cephalopods. Journal of Comparative Physiology A 166:501-505.

Parin, N.V., V.G. Neiman, and Y.A. Rudyakov. 1985. To the question of the biological productivity of waters in areas of submerged elevations of the open ocean. From: Vinogradov, M.E., and M.V. Fline (editors). Biological basis of the commercial exploitation of the open areas of the ocean. Academy of the Sciences of the U.S.S.R., Commission on Problems of the World Ocean, p. 192-203. Nauka Publ., Moscow. Translation No. 141. Honolulu, Hawaii: U.S. Department of Commerce. Translated from the Russian by Wilvan G. Van Campen for the SWFC Honolulu Laboratory, NMFS, NOAA. August 1991.

Parrish, J.D. 1987. The trophic biology of snappers and groupers. Pages 405-463 in J.J. Polovina and S. Ralston, eds. Tropical snappers and groupers: Biology and fisheries management. Boulder, Colorado: Westview Press.

Parry, G.D. and A. Gason. 2006. The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research 79:272-284.

Parsons, T.R., M. Takahashi, and B. Hargrave. 1984. Biological oceanographic processes. 3d ed. Oxford, United Kingdom: Pergamon Press.

Passarelli, N., and A. Piercy. 2004. Manta. Biological profiles. Accessed 29 November 2004. http://www.flmnh.ufl.edu/fish/Gallery/Descript/MantaRay/MantaRay.html.

Paulay, G. 2003a. Marine biodiversity of Guam and the Marianas: Overview. Micronesica 35-36:3-25.

Paulay, G. 2003b. Marine bivalvia (Mollusca) of Guam. Micronesica 35-36:218-243.

Paulay, G. 2003c. Miscellaneous marine invertebrates and protists from the Mariana Islands. Micronesica 35-36:676-682.

Paulay, G. 2003d. The Asteroidea, Echinoidea, and Holothuroidea (Echinodermata) of the Mariana Islands. Micronesica 35-36:563-583.

Paulay, G., and Y. Benayahu. 1999. Patterns and consequences of coral bleaching in Micronesia (Majuro and Guam) in 1992-1994. Micronesica 31(2):109-124.

Paulay, G., L. Kirkendale, G. Lambert, and J. Starmer. 1997. The biodiversity of Apra Harbor: Significant areas and introduced species, with focus on sponges, echinoderms and ascidians. Prepared for U.S. Department of Defense, COMNAVMARIANAS, University of Guam Marine Laboratory, Mangilao, Guam.

Paulay, G., L. Kirkendale, C. Meyer, P. Houk, T. Rongo, and R. Chang. 2001. Marine biodiversity resource survey and baseline reef monitoring survey of the southern Orote Peninsula and north Agat Bay Area, COMNAVMARIANAS. Mangilao, Guam: University of Guam Marine Laboratory.

Paulay, G., L. Kirkendale, G. Lambert, and C. Meyer. 2002. Anthropogenic biotic interchange in a coral reef ecosystem: A case study from Guam. Pacific Science 56(4):403-422.

Paulay, G., R. Knopp, P.K.L. Ng, and L.G. Eldredge. 2003a. The crustaceans and pycnogonids of the Mariana Islands. Micronesica 35-36:456-513.

Paulay, G., M.P. Puglisi, and J.A. Starmer. 2003b. The non-scleractinian Anthozoa (Cnidaria) of the Mariana Islands. Micronesica 35-36:138-155.

Paulus, T. 1999. Syngnathidae - Pipefishes and seahorses. Pages 2264-2276 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Pawson, D.L. 1995. Echinoderms of the tropical islands Pacific: Status of their systematics and notes on their ecology and biogeography. Pages 171-192 in J.E. Maragos, M.N.S. Peterson, L.G. Eldredge, J.E. Bardach, and H.F. Takeuchi, eds. Marine and coastal biodiversity in the tropical island Pacific region, Volume 1: Species systematics and information management priorities. Honolulu, Hawaii: East-West Center.

Paxton, J.R., and G.D. Johnson. 1999. Anomalopidae - Flashlight fishes. Pages 2212-2213 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Pacific Basin Environmental Consultants, Inc. (PBEC). 1985. CNMI marine parks management plan. Saipan, CNMI: Coastal Resources Management Office.

Pearson, W. J., J. R. Skalski, and C. I. Malme 1992. Effects of sounds from a geophysical survey device on behaviour of captive rockfish (*Sebastes* sp.). Can. J. Fish. Aquat. Sci. 49: 1343.1356.

Pew Oceans Commission. 2003. America's Living Oceans: Charting a Course for Sea Change. 166p.

Phillips, R.C., and E.G. Menez. 1988. Seagrasses. Smithsonian contributions to the Marine Sciences 34:1-104.

Pickard, G.L., and W.J. Emery. 1982. Descriptive physical oceanography: An introduction. 4th ed. Oxford, United Kingdom: Pergamon Press.

Pietsch, T.W. 1999. Antennariidae - Frogfishes (also sea mice, anglerfishes). Pages 2013-2015 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

PIFSC (Pacific Islands Fishery Science Center). 2004. WPacFin. Accessed 10 January 2005. http://www.pifsc.noaa.gov/wpacfin/index.htm.

Pitcher, C.R. 1993. Spiny lobster. Pages 539-607 in A. Wright and L. Hill, eds. Nearshore marine resources of the South Pacific: Information for fisheries development and management. Suva, Fiji: Institute of Pacific Studies; and Honiara, Solomon Islands: Forum Fisheries Agency.

Polovina, J.J. 1993. The lobster and shrimp fisheries in Hawaii. Marine Fisheries Review 55(2):28-33.

Popper, A.N. 1977. "A scanning electron microscopic study of the sacculus and lagena in the ears of fifteen species of teleost fishes." Journal of Morphology 153:397 418.

Popper, A.N. 1980. Scanning electron microscopic study of the sacculus and lagena in several deep-sea fishes. The American Journal of Anatomy157:115-136.

Popper, A. N. 2003. Effects of anthropogenic sounds on fishes. Fisheries 28(10): 24-31.

Popper, A.N. and W.N. Tavolga. 1981. Structure and function of the ear in the marine catfish, *Arius felis*. Journal of Comparative Physiology 144: 27-34.

Popper, A.N. and T.J. Carlson. 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127: 673-707.

Popper, A. N., M. Salmon, and K. W. Horch. 2001. Acoustic detection and communication by decapod crustaceans. Journal of Comparative Physiology 187(2): 83-89.

Popper, A. N., M. B. Halvorsen, D. Miller, M. E., Smith, J. Song, L. E. Wysocki, M. C. Hastings, A. S Kane, and P. Stein. 2005. Effects of SURTASS Low Frequency Active sonar on fish. Journal of the Acoustical Society of America 117: 2440.

Popper, A. N., M. E. Smith, P. A. Cott, B. W. Hanna, A. O. MacGillivray, M. E. Austin, and D. A. Mann. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. J. Acoust. Soc. Am., 117:3958-3971.

Poss, S.G. 1999a. Scorpaenidae - Scorpionfishes (also lionfishes, rockfishes, stingfishes, stonefishes, and waspfishes). Pages 2291-2352 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Poss, S.G. 1999b. Caracanthidae - Orbicular velvetfishes (coral crouchers). Pages 2353-2358 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Poupin, J. 1996. Crustacea decapoda of French Polynesia (Astacidea, Palinuridea, Anomura, Brachyura). Atoll Research Bulletin 442:1-114.

Poutiers, J.M. 1998a. Gastropods. Pages 363-648 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 1: Seaweeds, corals, bivalves, and gastropods. Rome, Italy: Food and Agriculture Organization of the United Nations.

Poutiers, J.M. 1998b. Bivalves. Pages 123-362 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 1: Seaweeds, corals, bivalves, and gastropods. Rome, Italy: Food and Agriculture Organization of the United Nations.

Preston, G.L. 1997. Review of fishery management issues and regimes in the Pacific Islands Region. South Pacific Regional Environment Programme. Apia, Samoa: South Pacific Commission.

Pyle, R. 2001a. Pomacanthidae - Angelfishes. Pages 3266-3286 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Pyle, R. 2001b. Chaetodontidae - Butterflyfishes. Pages 3224-3265 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Quinn, N.J., and B.L. Kojis. 2003. The dynamics of coral reef community structure and recruitment patterns around Rota, Saipan, and Tinian, Western Pacific. Bulletin of Marine Science 72(3):979-996.

Radenac, M., and M. Rodier. 1996. Nitrate and chlorophyll distributions in relation to thermohaline and current structures in the western tropical Pacific during 1985-1989. Deep-Sea Research II 43(4-6):725-752.

RAE/ERF (Restore America's Estuaries/Estuarine Research Foundation). 1999. Principles of estuarine habitat restoration: Working together to restore America's estuaries. Report on the RAE-ERF partnership – year one – September 1999. Arlington, Viginia/Port Republic, Maryland: RAE/ERF.

Ramcharitar, J., D.M. Higgs, and A.N. Popper. 2001. Sciaenid Inner Ears: A Study in Diversity. Brain Behavior and Evolution 58: 152-162.

Ramcharitar J. and A.N. Popper. 2004. Masked auditory thresholds in sciaenid fishes: A comparative study. Journal of the Acoustical Society of America 116 (3): 1687–1691.

Ramcharitar, J.U., D.M. Higgs, and A.N. Popper. 2006. Audition in sciaenid fishes with different swim bladder-inner ear configurations. Journal of the Acoustical Society of America 119 (1): 439-443.

Randall. 1979. Geologic features within the Guamn seashore study area. University of Guam Marine Laboratory Technical Report No. 55. Mangilao, Guam: University of Guam Marine Laboratory.

Randall, J.E. 2001a. Acanthuridae - Surgeonfishes (tangs, unicornfishes). Pages 3653-3683 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Randall, J.E. 2001b. Mullidae - Goatfishes (surmullets). Pages 3175-3200 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Randall, J.E. 2001c. Cirrhitidae - Hawkfishes. Pages 3321-3328 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Randall, J.E. 2001d. Pinguipedidae - Sandperches. Pages 3501-3510 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Randall, J.E., and D.W. Greenfield. 1999. Holocentridae - Squirrelfishes (soldierfishes) Pages 2225-2256 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Randall, R.H. 1985. Habitat geomorphology and community structure of corals in the Mariana Islands. Pages 261-266 in C. Gabrie, and M. Harmelin, eds. Proceedings of the 5th International Coral Reef Congress, Tahiti. Volume 6. Polynesia: Ecole Pratique des Hautes Etudes.

Randall, R.H. 1995. Biogeography of the reef-building corals in the Mariana and Palau Islands in relation to back-arc rifting and the formation of the Eastern Philippine Sea. Natural History Research 3(2):193-210.

Randall, R.H. 2003. An annotated checklist of hydrozoan and scleractinian corals collected from Guam and other Mariana Islands. Micronesica 35-36:121-137.

Randall, R.H., and L.G. Eldredge. 1977. Effects of typhoon Pamela on the coral reefs of Guam. Pages 526-531 in D.L. Taylor, ed. Proceedings of the 3rd International Coral Reef Symposium. Volume 2. Miami, Florida. Miami, Florida: Rosenstiel School of Marine and Atmospheric Science, University of Miami.

Randall, R.H., and H.G. Siegrist Jr. 1988. Geomorphology of the fringing reefs of northern Guam in response to Holocene sea level changes. Pages 473-477 in J.H. Choat, D. Barnes, MA. Borowitzka, J.C. Coll, P.J. Davies, P. Flood, B.G. Hatcher, D. Hopley, P.A. Hutchings, D. Kinsey, G.R. Orme, M. Pichon, P.F. Sale, P. Sammarco, C.C. Wallace, C. Wilkinson, E. Wolanski, and O. Bellwood, eds. Proceedings of the 6th International Coral Reef Symposium. Volume 3. Townsville, Australia: 6th International Coral Reef Symposium Executive Committee.

Randall, R.H., L.G. Eldredge, B.R. Best, R.N. Clayshulte, A.H. Kitalong, and R.K. Kropp. 1982. Assessment of the shoalwater environments in the vicinity of the proposed OTEC development at Cabras Island, Guam. University of Guam Marine Laboratory Technical Report No. 79. Submitted to Government of Guam, Guam Energy Office.

Randall, R.H., H.G. Siegrist Jr., and A.W. Siegrist. 1984. Community structure of reef-building corals on a recently raised Holocene reef on Guam, Mariana Islands. Palaeontographica Americana 54:394-398.

Reid, A.L. 1998. Sepiidae - Cuttlefishes. Pages 723-763 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians, and sharks. Rome, Italy: Food and Agriculture Organization of the United Nations.

Remage-Healey, L., D.P. Nowacek, and A.H. Bass. 2006. Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. The Journal of Experimental Biology 209: 4444-4451.

Research Planning Inc. 1994. Sensitivity of coastal environments and wildlife to spilled oil, Mariana Islands, Volume 1, Guam: A coastal atlas. Columbia, South Carolina: Hazardous Materials Response and Assessment Division National Oceanic and Atmospheric Administration.

Richardson, W. J., C. R. Greene Jr., C. L. Malme, and D. H. Thomson. 1995. Marine Mammals and Noise. Academic Press, New York.

Richer de Forges, B., J.A. Koslow, and G.C.B. Poore. 2000. Diversity and endemism of the benthic seamount fauna in the southwest Pacific. Nature 405:944-947.

Richmond, R.H. 1994. Effects of coastal runoff on coral reproduction. Pages 360-364 in R.N. Ginzburg, ed. Proceedings on the Colloquium on Global Aspects of Coral Reefs: Health, Hazards, and History. Miami, Florida: University of Miami, Rosenstiel School of Marine and Atmospheric Science.

Richmond, R.H., and G.W. Davis. 2002. Status of the coral reefs of Guam. Pages 189-194 in D.D. Turgeon, R.G. Asch, B.D. Causey, R.E. Dodge, W. Jaap, K. Banks, J. Delaney, B.D. Keller, R. Speiler, C.A. Matos, J.R. Garcia, E. Diaz, D. Catanzaro, C.S. Rogers, Z. Hillis-Starr, R. Nemeth, M. Taylor, G.P. Schmahl, M.W. Miller, D.A. Gulko, J.E. Maragos, A.M. Friedlander, C.L. Hunter, R.S. Brainard, P. Craig, R.H. Richmond, G. Davis, J. Starmer, M. Trianni, P. Houk, C.E. Birkeland, A. Edward, Y. Golbuu, J. Gutierrez, N. Idechong, G. Paulay, A. Tafileichig, and N. Vander Velde. 2002. The state of coral reef ecosystems of the United States and Pacific Freely Associated States: 2002. Silver Spring, Maryland: National Oceanic and Atmospheric Administration/National Ocean Service/National Centers for Coastal Ocean Science.

Richmond, R., R. Kelty, P. Craig, C. Emaurois, A. Green, C. Birkeland, G. Davis, A. Edward, Y. Golbuu, J. Gutierrez, P. Houk, N. Idechong, J. Maragos, G. Paulay, J. Starmer, A. Tafileichig, M. Trianni, and N. Vander Velde. 2002. Status of the coral reefs in Micronesia and American Samoa: US Affiliated and Freely Associated Islands in the Pacific. Pages 217-236 in C. Wilkinson, ed. Status of Coral Reefs of the World: 2002. Townsville, Queensland: Australian Institute of Marine Science.

Riegl, B., R.P. Moyer, B.K. Walker, K. Kohler, D. Gilliam, and R.E. Dodge. 2008. A Tale of Germs, Storms, and Bombs: Geomorphology and Coral Assemblage Structure at Vieques (Puerto Rico) Compared to St. Croix (U.S. Virgin Islands). Journal of Coastal Research 24 (4): 1008-1021.

Rivera, M.A.J., C.D. Kelley, and G.K. Roderick. 2004. Subtle population genetic structure in the Hawaiian grouper, *Epinephelus guernus* (Serranidae) as revealed by mitochondrial DNA analyses. Biological Journal of the Linnean Society. 81:449-468.

Roberts, C. 1996. *Chaetodon flavocoronatus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 31 January 2005. http://www.redlist.org.

Roberts, S., and M. Hirshfield. 2004. Deep-sea corals: Out of sight, but no longer out of mind. Frontiers in Ecology and the Environment. 3:123-130.

Rock, T. 1999. Diving & snorkeling: Guam & Yap. 2d ed. Victoria, Australia: Lonely Planet Publications.

Rodier, M., and R. Le Borgne. 1997. Export flux in the western and central Pacific ocean. Deep-Sea Research II 44(9-10):2085-2113.

Rogers, A.D. 1994. The biology of seamounts. Pages 306-350 in J. H. Blaxter, and A. J. Southward, eds. Advances in Marine Biology, volume 30. San Diego: Academic Press.

Roper, C.F.E., M.J. Sweeny, and C.E. Nauen. 1984. FAO species catalogue: Volume 3. Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish. Synop., (125). Rome, Italy: Food and Agriculture Organization of the United Nations.

Ross, Q. E., D. J. Dunning, J. K Menezes, M. J. Kenna, and G. W. Tiller. 1995. Reducing impingement of alewives with high frequency sound at a power plant on Lake Ontario. North American Journal of Fisheries Management, 15: 378–388.

Ross, Q. E., D. J. Dunning., R. Thorne, J. K. Menezes, G. W. Tiller, and J. K. Watson. 1996. Responses of alewives to high-frequency sound at a power plant intake in Ontario, North American Journal of Fisheries Management, 16: 548–559.

Rountree, R.A. 1990. Community structure of fishes attracted to shallow water fish aggregation devices off South Carolina, U.S.A. Environmental Biology of Fishes 29:241-262.

Sadovy, Y. 1996. *Epinephelus lanceolatus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 29 November 2004. http://www.redlist.org.

Sadovy, Y., M. Kulbicki, P. Labrosse, Y. Letourneur, P. Lokani, and T.J. Donaldson. 2003. The humphead wrasse, *Cheilinus undulatus*: Synopsis of a threatened and poorly known giant coral reef fish. Reviews in Fish Biology and Fisheries 13:327-364.

Safina, C. 1996. *Xiphias gladius*. In: IUCN 2004. 2003 IUCN Red List of Threatened Species. Accessed 16 November 2004. http://www.redlist.org.

Sakai, K. 2001. Kyphosidae - Sea chubs. Pages 3290-3296 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 5: Bony fishes part 3 (Menidae to Pomacentridae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Samoilys, M., and D. Pollard. 2000. Cromileptes altivelis. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 30 November 2004. http://www.redlist.org.

Samples, K.C., and J.R. Hollyer. 1989. Economic considerations in configuring fish aggregation device networks. Bulletin of Marine Science 44(2):863-872.

Sand, O. and A. D. Hawkins. 1973. Acoustic properties of the cod swimbladder. Journal of Experimental Biology, 58: 797–820.

Sand, O. and H. E. Karlsen. 1986. Detection of infrasound by the Atlantic cod. J. Exp. Biol. 125; 197-204.

Sandwell, D.T., W.H.F. Smith, S.M. Smith, and C. Small. 2004. Global topography: Measured and estimated seafloor topography. Accessed 8 September 2004. http://topex.ucsd.edu/marine_topo/mar_topo.html.

Saunders, M.A., R.E. Chandler, C.J. Merchant, and F.P. Roberts. 2000. Atlantic hurricanes and NW Pacific typhoons: ENSO spatial impacts on occurrence and landfall. Geophysical Research Letters 27(8):1147-1150.

Scavia, D. 1988. On the role of bacteria in secondary production. Limnology and Oceanography. 33(5):1220-1224.

Schlappa, K. 2004. Appendix A: Air quality and climate report. National Park Service, Inventory and Monitoring Program Pacific Island Newtork Monitoring Plan. Accessed 16 February 2005. http://www1.nature.nps.gov/im/units/pacn/.

Schwartz, A. L. 1985. The behaviour of fishes in their acoustic environment. Environmental Biology of Fishes 13(1):3-15.

Scott, D.A. 1993. A directory of wetlands in Oceania. Accessed 13 January 2005. http://www.wetlands.org/inventory&/OceaniaDir/Contents.htm.

Seaman, W., Jr., and A. C. Jensen. 2000. Purposes and practices of artificial reef evaluation. Pages 1-19 in W. Seaman Jr., ed. Artificial reef evaluation with application to natural marine habitats. New York, New York: CRC Press.

Senou, H. 2001. Sphyraenidae - Barracudas. Pages 3685-3697 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Siedler, G., J. Holfort, W. Zenk, T.J. Müller, and T. Csernok. 2004. Deep-water flow in the Mariana and Caroline Basins. Journal of Physical Oceanography 34:566-581.

Siegrist, H.G, Jr., and R.H. Randall. 1992. Carbonate geology of Guam. Pages 1195-1216 in R.H. Richmond, ed. Proceedings of the Seventh International Coral Reef Symposium, Guam, Micronesia. Volume 2. Mangilao, Guam: University of Guam Press, UOG Station.

Simpfendorfer, C. 2000. *Galeocerdo cuvier*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 3 February 2005. http://www.redlist.org/search/details.php?species=39378.

Simpson, J.H., P.B. Tett, M.L. Argote-Espinoza, A. Edwards, K.J. Jones, and G. Savidge. 1982. Mixing and phytoplankton growth around an island in a stratified sea. Continental Shelf Research 1(1):15-31.

Sims, N.A. 1993. Pearl oysters. Pages 409-430 in A. Wright and L. Hill, eds. Nearshore marine resources of the South Pacific. Honiara, Solomon Islands: Forum Fisheries Agency; Suva, Fiji: Institute of Pacific Studies; and Canada: International Centre for Ocean Development.

Sisneros, J.A. 2007. "Saccular potentials of the vocal plainfin midshipman fish, *Porichthys notatus*." Journal of Comparative Physiology A 193:413-424.

Sisneros. J. A. and A.H. Bass. 2003. Seasonal placticity of peripheral auditory frequency sensitivity. The Journal of Neuroscience 23(3): 1049-1058.

Skalski, J. R., W.H. Pearson, and C. I. Malme 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp.). Can. J. Fish. Aquat. Sci. 49: 1357.1365.

Slotte, A., K. Kansen, J. Dalen, and E. Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research 67: 143-150.

Smale, M.J. 2000a. *Carcharhinus longimanus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 16 November 2004. http://www.redlist.org.

Smale, M.J. 2000b. *Carcharhinus amblyrhynchos*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 23 November 2004. http://www.redlist.org.

Smith, B.D. 2003. Prosobranch gastropods of Guam. Micronesica 35-36:244-270.

Smith, D.G. 1999. Chlopsidae - False morays. Pages 1639-1640 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Smith, M.E., A.S. Kane, and A.N. Popper. 2004a. Noise-induced stress response and hearing lossin goldfish (*Carassius auritus*). J. Exp. Biol. 2004 Sep: 207 (Pt 20): 3591-602.

Smith, M. E., A.S. Kane, and A.N. Popper. 2004b. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? J. Exp. Biol.: 3591-602.

Smith, M.K. 1993. An ecological perspective on inshore fisheries in the main Hawaiian Islands. Marine Fisheries Review 55(2):34-49.

Smith, S.H. 2004. March 2004 ecological assessment of the marine community in the vicinity of Kilo Wharf, Apra Harbor, Guam. Pearl Harbor, Hawaii: Naval Facilities Engineering Command Pacific.

Smith, S.H. 2007. Ecological assessment of stony corals and associated organisms in the eastern portion of Apra Harbor, Guam. Pearl Harbor, Hawaii: Naval Facilities Engineering Command Pacific.

Smith S.H. and D.E. Marx, Jr. 2006. Assessment of stony corals between Orote Point and Sumay Cove Apra Harbor, Guam. Naval Facilities Engineering Command Technical Report. 31p.

Smithsonian Institute. 1995. Submarine eruption. Bulletin of the Global Volcanism Network 20(10). Accessed on 6 January 2005. http://www.volcano.si.edu/volcanoes/region08/ivm_arc/ruby/var.htm#bgvn_2010.

Smithsonian Institute. 2003. Eruption on 10 May is the first historical activity. Bulletin of the Global Volcanism Network 28(4). Accessed on 13 January 2005. http://www.volcano.si.edu/world/volcano.cfm?vnum=080420=&volpage=var#bgvn_2805.

Smith-Vaniz, W.F. 1999. Carangidae - Jacks and scads (also trevallies, queenfishes, runners, amberjacks, pilotfishes, pampanos, etc.). Pages 2659-2756 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Song, J., A. Mathieu, R.F. Soper, and A.N. Popper. 2006. Structure of the inner ear of bluefin tuna *Thunnus thynnus*. Journal of Fish Biology 68: 1767–1781.

Sorokin, Y.I. 1995. Coral reef ecology. Pages 1-465 in G. Heldmaier, Lange, O.L., Mooney, H., and U. Sommer, eds. Ecological Studies, Volume 102: Analysis and Synthesis. 2d ed. Berlin, Germany: Springer.

South, G.R. 1993. Seaweeds. Pages 683-710 in A. Wright and L. Hill, eds. Nearshore marine resources of the South Pacific. Honiara, Solomon Islands: Forum Fisheries Agency; Suva, Fiji: Institute of Pacific Studies; and Canada: International Centre for Ocean Development.

Spalding, M.D., C. Ravilious, and E.P. Green. 2001. World atlas of coral reefs. Berkeley, California: University of California Press.

Springer, V.G. 2001. Blenniidae - Blennies (Combtooth and sabertooth blennies). Pages 3538-3546 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Starmer, J., ed. 2005. The state of coral reef ecosystems of the Commonwealth of the Northern Mariana Islands. Pages 399-441 in J.E. Waddell, ed. The state of coral reef ecosystems of the United States and Pacific Freely Associated States: 2005. NOAA Technical Memorandum NOSNCCOS-11.

Starmer, J., M.S. Trianni, and P. Houk. 2002. Status of coral reefs in the Commonwealth of the Northern Mariana Islands. Pages 195-204 in D.D. Turgeon, R.G. Asch, B.D. Causey, R.E. Dodge, W. Jaap, K. Banks, J. Delaney, B.D. Keller, R. Speiler, C.A. Matos, J.R. Garcia, E. Diaz, D. Catanzaro, C.S. Rogers, Z. Hillis-Starr, R. Nemeth, M. Taylor, G.P. Schmahl, M.W. Miller, D.A. Gulko, J.E. Maragos, A.M. Friedlander, C.L. Hunter, R.S. Brainard, P. Craig, R.H. Richmond, G. Davis, J. Starmer, M. Trianni, P. Houk, C.E. Birkeland, A. Edward, Y. Golbuu, J. Gutierrez, N. Idechong, G. Paulay, A. Tafileichig, and N. Vander Velde. The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002. Silver Spring, Maryland: National Oceanic and

Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science.

Starmer, J.A. 2003. An annotated checklist of ophiuroids (Echinodermata) from Guam. Micronesica 35-36:563-583.

Starnes, W.C. 1999. Priacanthidae - Bigeyes. Pages 2590-2601 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 4: Bony fishes part 2 (Mugilidae to Carangidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Stevens, J. 2000a. *Isurus oxyrinchus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 16 November 2004. http://www.redlist.org.

Stevens, J. 2000b. *Prionace glauca*. In: IUCN 2004. 2004IUCN red list of threatened species. Accessed 16 November 2004. http://www.redlist.org.

Stinson, D.W., G.J. Wiles, and J.D. Reichel. 1997. Migrant land birds and water birds in the Mariana Islands. Pacific Science 51(3):314-327.

StormSurf. 2005. Pacific Ocean Buoys. Accessed 25 January 2005. http://www.stormsurf.com/page2/links/pacbuoy.shtml.

Strayer, D. 1988. On the limits to secondary production. Limnology and Oceanography 33(5):1217-1220.

Stüben, D., S.H. Bloomer, N.E. Taïbi, T. Neumann, V. Bendel, U. Püschel, A. Barone, A. Lange, W. Shiying, L. Cuizhung, and Z. Deyu. 1992. First results of sulfur-rich hydrothermal activity from an island-arc environment: Esmerelda Bank in the Mariana Arc. Marine Geology 103:521-528.

Sudekum, A.E., J.D. Parrish, R.L. Radkte, and S. Ralston. 1991. Life history and ecology of large jacks in undisturbed, shallow, oceanic communities. Fishery Bulletin 89:492-513.

Sugimoto, T., S. Kimura, and K. Tadokoro. 2001. Impact of El Niño events and climate regime shift on living resources in the western North Pacific. Progress in Oceanography 49:113-127.

Takemura, A., M.D.S. Rahman, S. Nakamura, Y.J. Park, and K. Takano. 2004. Lunar cycle and reproductive activity in reef fishes with particular attention to rabbitfishes. Fish and Fisheries 5:317-328.

Tavolga, W.N. 1974a. “Sensory parameters in communication among coral reef fishes.” The Mount Sinai Journal of Medicine 41(2):324-340.

Tavolga, W.N. 1974b. “Signal/noise ratio and the critical band in fishes.” Journal of the Acoustical Society of America 55:1323-1333.

Tavolga, W.N. and J. Wodinsky. 1963. “Auditory capacities in fishes: pure tone thresholds in nine species of marine teleosts.” Bulletin of the American Museum of Natural History 126:177 240.

Taylor, B., and F. Martinez. 2003. Back-arc basin basalt systematics. Earth and Planetary Science Letters 210:481-497.

Thompson, P.L. 2005. 76th SEABEES of World War II: 76th Bees – An untold story. Accessed 9 September 2005. http://mysite.verizon.net/vzeo0pwz/76thseabeesworldwar2/id3.html.

Thurman, H.V. 1997. Introductory oceanography. 8th ed. Upper Saddle River, New Jersey: Prentice Hall.

Tilbrook, K.J. 2001. Indo-West Pacific species of the genus *Stylopoma* Levinsen, 1909 (Bryozoa: Cheilostomatida). Zoological Journal of the Linnean Society 131:1-34.

Trenberth, K.E. 1997. The definition of El Niño. Bulletin of the American Meteorological Society 78(12):2771-2777.

Trianni, M.S., and C.C. Kessler. 2002. Incidence and strandings of the spinner dolphin, *Stenella longirostris*, in Saipan Lagoon. Micronesica 34(2):249-260.

Truno, G.C., Jr. 1998. Seaweeds. Pages 19-100 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 1: Seaweeds, corals, bivalves, and gastropods. Rome, Italy: Food and Agriculture Organization of the United Nations.

Tsuda, R.T. 2003. Checklist and bibliography of the marine benthic algae from the Mariana Islands (Guam and CNMI). Technical Report No. 107. Mangilao, Guam: University of Guam Marine Laboratory.

Tsuda, R.T., F.R. Fosberg, and M.H. Sachet. 1977. Distribution of seagrasses in Micronesia. Micronesica 13(2):191-198.

Turnpenny, A. W. H., Thatcher, K. P., and J. R. Nedwell. 1994. The Effects on Fish and Other Marine Animals of High-level Underwater Sound. Report FRR 127/94, Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.

Uchida, R. 1983. Summary of environmental and fishing information on Guam and the Commonwealth of the Northern Mariana Islands: A review of the plankton communities and fishery resources. NOAA Technical Memorandum NOAA-TM-NMFS-SWFC-33:1-159.

Uda, M. 1970. Fishery oceanographic studies of frontal eddies and transport associated with the Kuroshio System including the "Subtropical Countercurrent", p. 593-604, In J. C. Marr, ed. The Kuroshio. Honolulu, Hawaii: East-West Center Press.

United Nations Environmental Programme (UNEP). 2006. Ecosystems and Biodiversity in Deep Waters and High Seas. Regional Seas Report and Studies. UNEP Regional Seas Report and Studies No. 178. UNEP/IUCN, Switzerland, 2006. ISBN: 92-807-2734-6.

University of Rhode Island (URI). 2007. Animals and Sound in the Sea. Office of Marine Programs .http://omp.gso.uri.edu/work1/animals/intro.htm

Uozumi, Y. 1996a. *Thunnus alalunga*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 16 November 2004. http://www.redlist.org.

Uozumi, Y. 1996b. *Thunnus obesus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 16 November 2004. http://www.redlist.org.

United States Air Force (USAF). 1997. Environmental Effects of Self-protection Chaff and Flares. U.S. Air Force, Headquarters Air Combat Command. Air Force Base, Langley, VA. NTIS PB98-110620.

United States Air Force (USAF). 2002. Environmental Assessment for the West Coast Combat Search and Rescue (CSAR) Beddown.BEDDOWN. United States Air Force Headquarters Air Combat Command.

U.S. Geological Survey (USGS). 1978. Topographic map of Guam Mariana Islands. Reston, Virginia: United States Geological Survey.

U.S. Geological Survey (USGS). 1980. Topographic map of Tinian Commonwealth of the northern Mariana Islands. Denver, Colorado: United States Geological Survey.

U.S. Geological Survey (USGS). 2004. Historical seismicity, Rota Region Northern Mariana Islands, seismicity 1990 to present, seismicity in 2004, and magnitude 7 and greater earthquakes since 1900. Accessed 19 January 2005. http://neic.usgs.gov/neis/bulletin/neic_scbz_h.html.

U.S. Geological Survey (USGS). 2005a. Major volcanoes of the Mariana Islands. Accessed 28 January 2005. http://vulcan.wr.usgs.gov/Volcanoes/MarianaIslands/Maps/map_mariana_islands_volcanoes.html.

U.S. Geological Survey (USGS). 2005b. Earthquake history of Guam. Accessed 28 January 2005. http://neic.usgs.gov/neis/states/guam/guam_history.html.

U.S. Marine Corps (USMC). 2009. Marine Resource Surveys of Tinian, Commonwealth of the Nothern Mariana Islands, Volumes 1 and 2 (Draft). Prepared by U.S. Fish and Wildlife Service, NOAA-National Marine Fisheries, University of Guam Marine Laboratory, CNMI Division of Fish and Wildlife, CNMI Division of Environmental Quality, CNMI Coastal Resource Management Office. January.

Valiela, I. 1995. Marine ecological processes. 2d ed. New York, New York: Springer-Verlag.

Venrick, E.L. 1990. Phytoplankton in an oligotrophic ocean: Species structure and interannual variability. Ecology 71(4): 1547-1563.

Veridian Corporation. 2001. The global maritime wrecks database. [CD-ROM] Falls Church, Virginia: General Dynamics Corporation.

Veron, J.E.N. 1995. Corals of the tropical island Pacific region: Biodiversity. Pages 75-82 in J.E. Maragos, M.N.A. Peterson, L.G. Eldredge, J.E. Bardach, and H.F. Takeuchi, eds. Marine and coastal biodiversity in the tropical island Pacific region. Volume 1: Species systematics and information management priorities. Honolulu, Hawaii: East-West Center.

Veron, J.E.N. 2000. Corals of the world. (Volumes 1, 2 and 3). Townsville, Australia: Australian Institute of Marine Science.

Vincent, A. 1996a. *Syngnathoides biaculeatus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 29 November 2004. http://www.redlist.org.

Vincent, A. 1996b. *Doryrhamphus dactyliophorus*. In: IUCN 2004. 2004 IUCN red list of threatened species. Accessed 30 November 2004. http://www.redlist.org.

Vinogradov, M.Y., and N.V. Parin. 1973. On the vertical distribution of macroplankton in the tropical Pacific. Oceanology 13:104-113.

Volcano Live. 2005. Volcano News. Accessed 19 July 2005. http://www.volcanolive.com/volcanolive.html.

Waikiki Aquarium. 1998a. Marine life profile: Hawaiian octopus. Accessed 3 December 2004. http://waquarium.otted.hawaii.edu/MLP/root/pdf/MarineLife/Invertebrates/Molluscs/Octopus.pdf.

Waikiki Aquarium. 1998b. Marine life profile: Featherduster worm. Accessed 1 June 2005. http://waquar.otted.hawaii.edu/MLP/root/pdf/MarineLife/Invertebrates/Worms/Featherdusterworm.pdf.

Waikiki Aquarium. 1999a. Marine life profile: Moray eels. Accessed 2 December 2004. http://waquarium.otted.hawaii.edu/MLP/root/pdf/MarineLife/Vertebrates/MorayEels.pdf.

Waikiki Aquarium. 1999b. Marine life profile: Pufferfishes. Accessed 30 November 2004. http://waquarium.otted.hawaii.edu/MLP/root/pdf/MarineLife/Vertebrates/Pufferfishes.pdf.

Waikiki Aquarium. 1999c. Marine life profile: Trumpetfish. Accessed 30 November 2004. http://waquarium.otted.hawaii.edu/MLP/root/pdf/MarineLife/Vertebrates/Trumpetfish.pdf.

Waikiki Aquarium. 1999d. Marine life profile: Flashlightfish. Accessed 30 November 2004. http://waquarium.otted.hawaii.edu/MLP/root/pdf/MarineLife/Vertebrates/Flashlightfish.pd.

Waikiki Aquarium. 1999e. Marine life profile: Frogfishes. Accessed 30 November 2004. http://waquarium.otted.hawaii.edu/MLP/root/pdf/MarineLife/Vertebrates/Frogfish.pdf.

Ward, L.A. 2003. The cephalopods of Guam. Micronesica 35-36:294-302.

Westneat, M.W. 2001. Labridae - Wrasses (also hogfishes, razorfishes, corises, and tuskfishes). Pages 3381-3467 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Wilder, M.J. 1976. Estuarine and mangrove shorelines. Pages 157-189 in Randall, R.H. and L.G. Eldredge, eds. Atlas of the Reefs and Beaches of Guam. Agana, Guam: Guam Bureau of Planning.

Wilson, B. and M. Dill. 2002. Pacific herring respond to simulated odontocete echolocation sounds. Can. J. Fish. Aquat. Sci. 59: 542-553.

Wilson M., Hanlon R.T., Tyack P.L., Madsen P.T. 2007. Intense ultrasonic clicks from echolocating toothed whales do not elicit anti-predator responses or debilitate the squid *Loligo pealeii*. Biology Letters 3:225-227.

Wilson, R.R., and R.S. Kaufmann. 1987. Seamount biota and biogeography. Pages 355-377 in B. H. Keating, P. Fryer, R. Batiza, and G. W. Boehlert, eds. Seamounts, islands, and atolls. Washington, D.C.: American Geophysical Union.

Wolanski, E., R.H. Richmond, G. Davis, E. Deleersnijder, and R.R. Leben. 2003. Eddies around Guam, an island in the Mariana Islands group. Continental Shelf Research 23:991-1003.

Wongratana, T., T.A. Munroe, and N.S. Nizinski. 1999. Engraulidae - Anchovies. Pages 1698-1753 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 3: Batoid fishes, chimaeras, and bony fishes part 1 (Elopidae to Linophyrynidae). Rome, Italy: Food and Agriculture Organization of the United Nations.

Woodland, D.J. 2001. Siganidae - Rabbitfishes (spinefoots). Pages 3627-3650 in K.E. Carpenter and V.H. Niem, eds. FAO species identification guide for fishery purposes. The living marine resources of the western central Pacific. Volume 6: Bony fishes, part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine animals. Rome, Italy: Food and Agriculture Organization of the United Nations.

Western Pacific Regional Fishery Management Council (WPRFMC). 1981. Source document for the final fishery management plan for the spiny lobster fisheries of the Western Pacific Region. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 1982. Final combined fishery management plan, environmental impact statement, regulatory analysis, and draft regulations for the spiny lobster fisheries of the Western Pacific Region. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 1986a. Combined fishery management plan, environmental assessment, and regulatory impact review of the bottomfish and seamount groundfish fisheries of the Western Pacific Region. Final. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 1986b. Fishery management plan for the pelagic fisheries of the Western Pacific Region. Final. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 1998. Magnuson-Stevens Act definitions and required provisions: Amendment 6 to the Bottomfish and Seamount Groundfish Fisheries Management Plan, Amendment 8 to the Pelagic Fisheries Management Plan, Amendment 10 to the Crustaceans Fisheries Management Plan, and Amendment 4 to the precious corals fisheries management plan. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 1999. The value of the fisheries in the Western Pacific Fishery Management Council's Area. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 2001. Final fishery management plan for coral reef ecosystems of the western Pacific region. Volumes I-III including Amendment 7 bottomfish and seamount groundfish fisheries, Amendment 11 crustacean fisheries, Amendment 5 precious corals fisheries, and Amendment 10 pelagic fisheries. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 2004a. EFH/HAPC designations for fishery management units covered under the bottomfish, crustacean, pelagic, precious corals, and coral reef ecosystem fishery management plans. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Western Pacific Regional Fishery Management Council (WPRFMC). 2004b. Bottomfish and seamount groundfish fisheries of the western Pacific region--2003 annual report. Honolulu, Hawaii: Western Pacific Regional Fishery Management Council.

Wright, K.J., D.M. Higgs, A.J. Belanger, and J.M. Leis. 2005. Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae). Marine Biology 147: 1425-1434.

Wright, K.J., D.M. Higgs, A.J. Belanger, and J.M. Leis. 2005. Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae). Erratum. Marine Biology (2007) 150: 1049-1050.

Wright, K.J., D.M. Higgs, A.J. Belanger, and J.M. Leis. 2007. "Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). Erratum." Marine Biology 150:1049-1050.

Yagla, J. J. and R. L. Stiegler 2003. "Gun Blast Noise Transmission Across the Air-Sea Interface," EuroNoise, 19-21 May, Naples, Italy.

Yamazaki, T., F. Murakami, and E. Saito. 1993. Mode of seafloor spreading in the northern Mariana Trough. Tectonophysics 221:207-222.

Yelverton, J.T. 1981. Underwater explosion damage risk criteria for fish, birds and mammals. Manuscript presentation, 102nd Meeting of the Acoustical Society of America.

Yelverton, J. T., Richmond, D. R., Hicks, W., Saunders, K., and Fletcher, E. R. 1975. "The Relationship Between Fish Size and Their Response to Underwater Blast." Report DNA 3677T, Director, Defense Nuclear Agency, Washington, DC.

Young, G. A. 1991. Concise methods for predicting the effects of underwater explosions on marine life. NAVSWC NO 91-220. Naval Surface Warfare Center. Silver Spring, MD.

Zaika, V.E., and A.V. Kovalev. 1984. To the study of the ecosystems of submarine mountains. From Biologiya Morya, No. 5, p. 3-8, 1984. Acad. Sci. U.S.S.R. Ecology. Translation No. 103. Honolulu, Hawaii: U.S. Department of Commerce. Translated from the Russian by Wilvan G. Van Campen for the SWFC Honolulu Laboratory, NMFS, NOAA. October 1986.

Zhang, J., and T. Lay. 1992. The April 5, 1990 Mariana Islands earthquake and subduction zone stresses. Physics of the Earth and Planetary Interiors 72:99-121.

APPENDIX A

DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

APPENDIX A
LIST OF FIGURES

LIST OF TABLES

A PROPOSED ACTION

The Department of Defense (DoD) Representative Guam, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia (FSM) and Republic of Palau (DoD REP) proposes to improve training activities in the Mariana Islands Range Complex (MIRC) by selectively improving critical facilities, capabilities, and training capacities. The Proposed Action would result in focused critical enhancements and increases in training that are necessary to maintain a state of military readiness commensurate with the national defense mission. The Proposed Action includes minor repairs and upgrades to facilities and capabilities but does not include any military construction requirements. This is part of the periodically scheduled reviews of facilities and capabilities within the MIRC.

The U.S. Military Services (Services) need to implement actions within the MIRC to support current, emerging, and future training and Research, Development, Test and Evaluation (RDT&E) activities. These actions will be evaluated in the Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) and include:

- Maintaining baseline training and RDT&E activities at mandated levels;
- Increasing training activities and exercises from current levels;
- Accommodating increased readiness activities associated with the force structure changes (human resources, new platforms, additional weapons systems, including undersea tracking capabilities and training activities to support Intelligence Surveillance and Reconnaissance [ISR]/Strike); and
- Implementing range complex investment strategies that sustain, upgrade, modernize, and transform the MIRC to accommodate increased use and more realistic training scenarios.

A.1 DESCRIPTION OF THE MIRC STUDY AREA

Military activities in MIRC occur (1) on the ocean surface, (2) under the ocean surface, (3) in the air, and (4) on land. Summaries of the land, air, sea, undersea space addressed in the EIS/OEIS are provided in Tables A-1, A-2, A-3, A-4, A-5 in this Appendix. To aid in the description of the training areas covered in the MIRC EIS/OEIS, the range complex is divided into major geographic and functional areas. Each of the individual training areas fall into one of three major MIRC training areas:

- The Surface/Subsurface Area consists of all sea and undersea training areas in the MIRC.
- The Airspace Area includes all Special Use Airspace (SUA) in the MIRC.
- The Land Area includes all land training area in the MIRC.

Figure A-1 depicts the major geographic divisions of the training areas, and Table A-1 provides a summary of the area within the major geographical areas. Table A-2, A-3, A-4, and A-5 summarize the functional training areas of the MIRC.

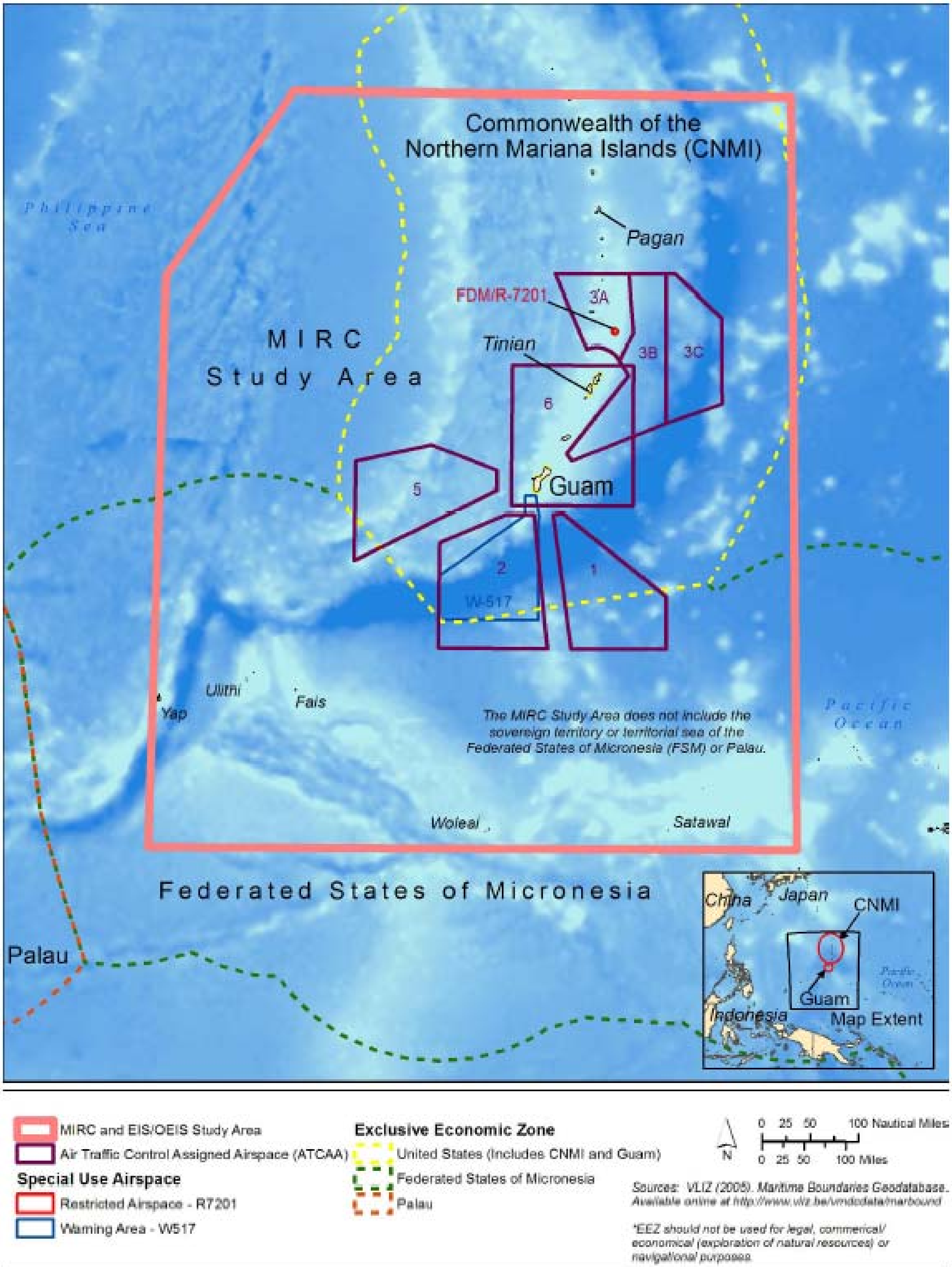


Figure A-1. Mariana Islands Range Complex and EIS/OEIS Study Area.

Table A-1. Summary of the MIRC Air, Sea, Undersea, and Land Space *

Area Name	Airspace (nm^2)			Sea Space (nm^2)	Undersea Space (nm^2)	Land Range (acres)
	Warning Area	Restricted Airspace	ATCAA / Other			
MIRC	14,000	28	63,000	501,873	14,000	24,894

* Sources: 366 Report to Congress. Notes: nm^2 – square nautical miles; ATCAA - Air Traffic Control Assigned Airspace.

The military Services use suitable MIRC air, land, sea, and undersea areas for various military training activities. For purposes of scheduling, managing, and controlling these activities and the ranges, the MIRC is divided into multiple components that are overseen by specific Services.

A.1.1 NAVY CONTROLLED AND MANAGED TRAINING AREAS OF THE MIRC

The MIRC includes land training areas, ocean surface areas, and undersea areas as depicted in Figure A-1. These areas extend from the waters south of Guam to north of Pagan (CNMI), and from the Pacific Ocean east of the Mariana Islands to the Philippine Sea to the west; encompassing 501,873 square nautical miles (nm^2) (1,299,851 square kilometers [km^2]) of open ocean and littorals. The MIRC does not include the sovereign territory (including waters out to 12 nautical miles [nm]) of the FSM. Portions of the Marianas Trench National Monument, which was established in January 2009 by Presidential Proclamation under the authority of the Antiquities Act (16 U.S.C. 431), lie within the Study Area.

Table A-2 provides an overview of each Navy controlled and managed area and its location. Figures A-1 through A-10 depict these training areas.

Table A-2. Navy Controlled and Managed MIRC Training Areas.

Training Area	Detail/Description
Warning Area (Figure A-2)	
W-517	W-517 is special -use airspace (SUA) (approximately 14,000 sq nm^2) that overlays deep open ocean approximately 50 miles south-southwest of Guam and provides a large contiguous area that is relatively free of surface vessel traffic. Commercial air traffic lanes constrain the warning area; however, Air Traffic Control Assigned Airspace (ATCAA) 2 overlays most of W-517, permitting coordination of scheduling of short-lived air space training events with the Federal Aviation Administration (FAA). W-517 altitude limits are from the surface to infinity and capable of supporting Gunnery Exercise (GUNEX), Chaff and Electronic Combat (EC), Missile Exercise (MISSILEX), Mine Exercise (MINEX), Sinking Exercise (SINKEX), Torpedo Exercise (TORPEX), and Carrier training activities.

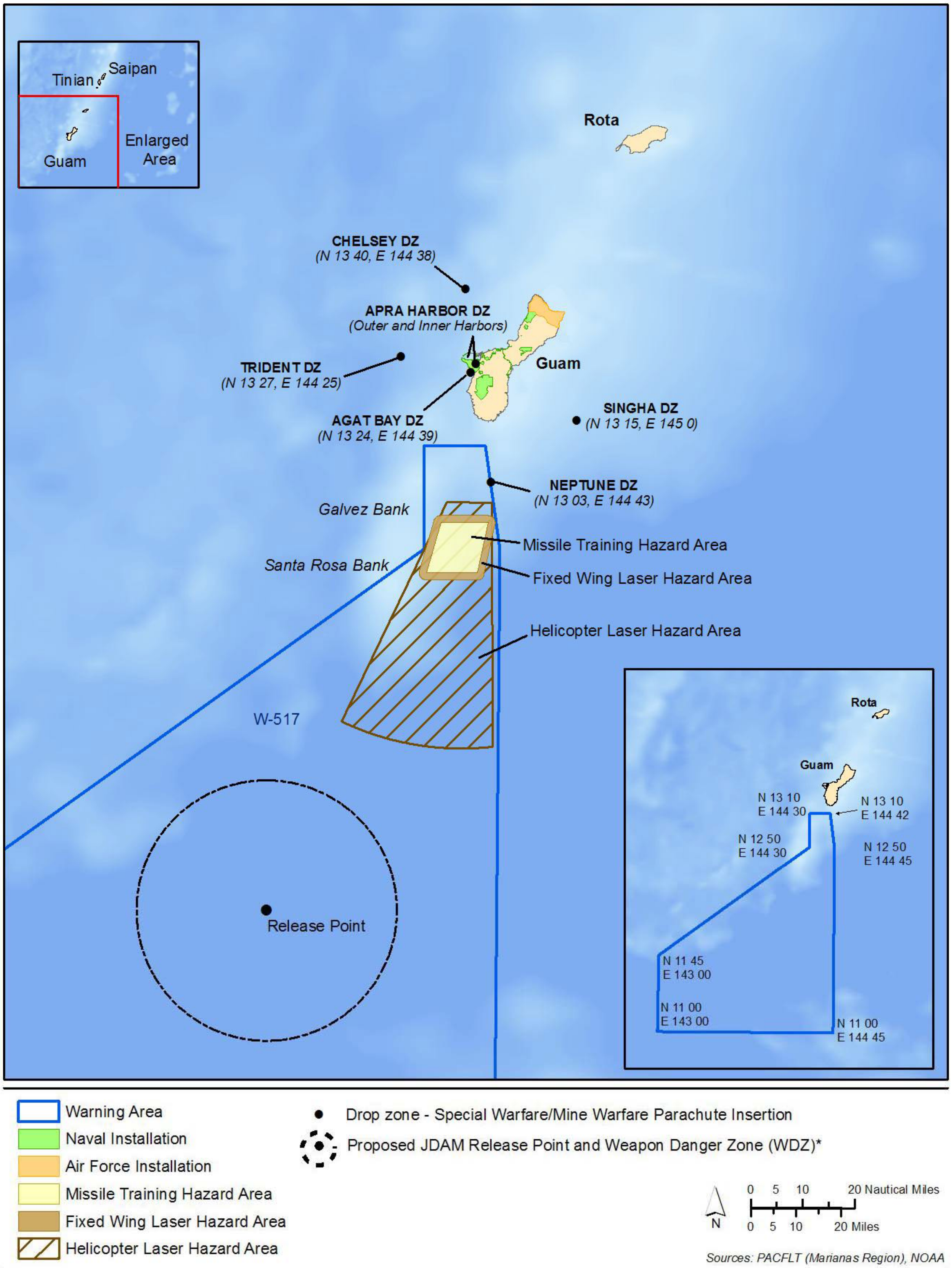
Training Area	Detail/Description
Restricted Area (Figure A-3 and Figure A-4)	
Farallon de Medinilla (FDM)/ R-7201	FDM, which is leased by the DoD from the CNMI, consists of the island land mass and the restricted airspace designated R-7201. The land mass (approximately 182 acres), is approximately 1.7 miles long and 0.3 miles wide. It contains a live-fire and inert bombing range and supports live-fire and inert engagements such as surface-to-ground and air-to-ground GUNEX, BOMBEX, MISSILEX, Fire Support, and Precision Weapons (including laser seeking). R-7201 is the Restricted Area surrounding FDM (extending 3-nm radius from center of FDM, encompassing 28 nm^2, and altitude limits from surface to FL600). Public access to FDM is strictly prohibited and there are no commercial or recreational activities on or near the island. During training exercises, marine vessels are restricted within a 3-nm (5-kilometer [km]) radius, although published Notices to Mariners (NOTMARs) may advise restrictions beyond a 3-nm (5-km) radius out to 30 nm (56 km) or greater as needed for certain training events. These increased advisory restrictions are used in an effort to ensure better protection to the military and the public during some training sessions. For these specific exercises, NOTMARs and Notices to Airmen (NOTAMs) are issued at least 72 hours in advance.
Offshore (Figure A-5)	
Agat Bay	Agat Bay supports deepwater Mine Countermeasure (MCM) training, military dive activities, and parachute insertion training. Underwater detonation charges up to 20 pounds Net Explosive Weight (NEW) are used. Hydrographic surveys to determine hazards for military approaches are periodically conducted in this area.
Tipalao Cove	Tipalao Cove provides access to a small beach area capable of supporting a shallow draft amphibious landing craft and has been proposed for use as a Landing Craft Air Cushion (LCAC) and Amphibious Assault Vehicle (AAV) landing site. Tipalao Cove supports military diving activities and hydrographic survey training.
Drop Zones	Drop Zones (DZ) in the Offshore Areas are shown in Figure 2-4. A DZ may be used for the air to surface insertion of personnel/equipment.
Piti Floating Mine Neutralization Area	The Piti Floating Mine Neutralization Area lies north of Apra Harbor and supports Explosive Ordnance Disposal (EOD) training, with underwater explosive charges up to 20 pounds NEW.
Apra Harbor (Figure A-5)	
Outer Apra Harbor (OAH)	Commanding Officer United States (U.S.) Coast Guard (USCG) is the Captain of the Port and controls OAH. Navy Security zones extend outward from the Navy controlled waterfront and related military anchorages/moorings. OAH supports frequent and varied training requirements for Navy Sea, Air, Land Forces (SEALs), EOD, and Marine Support Squadrons including underwater detonations (explosive charges up to 10 pounds NEW are permitted at a site near Buoy 702), military diving, logistics training, small boat activities, security activities, drop zones, visit board search, and seizures (VBSS) and amphibious craft navigation (LCAC, LCU, and AAVs).

Training Area	Detail/Description
Kilo Wharf	Kilo Wharf is used for ordnance handling and is a training site with limited capabilities due to explosive safety constraints; however, when explosive constraints are reduced it is used for Anti-Terrorism/Force Protection (AT/FP) training and VBSS activities.
Apra Harbor Naval Complex (Main Base): The Main Base comprises a total of approximately 4,500 acres. (Figure A-5)	
Inner Apra Harbor	The inner portion of Apra Harbor (sea space) is Navy controlled and includes the submerged lands, waters, shoreline, wharves, and piers and is associated with the Main Base (658 acres). Activities include military diving, logistics training, small boat activities, security activities, drop zones, torpedo/target recovery training, VBSS, and amphibious landings (LCAC, LCU, and AAVs).
Gab Gab Beach	Gab Gab Beach is used for both military and recreational activities. The western half of Gab Gab Beach is primarily used to support EOD and Naval Special Warfare (NSW) training requirements. Activities include military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP.
Reserve Craft Beach	Reserve Craft Beach is a small beach area located on the western shoreline of Dry Dock Island. It supports both military and recreational activities. It is used as an offload area for amphibious landing craft including LCACs; EOD inert training activities; military diving, logistics training, small boat activities, security activities, and AT/FP.
Sumay Channel/Cove	Sumay Channel/Cove provides moorage for recreational boats and an EOD small boat facility. It supports both military and recreational activities. It is used for insertion/extraction training for NSW and amphibious vehicle ramp activity, military diving, logistics training, small boat activities, security activities, and AT/FP.
Clipper Channel	Clipper Channel provides insertion/extraction training for NSW, military diving, logistics training, small boat activities, security activities, and AT/FP. The Clipper Channel has the potential to support amphibious vehicle ramp activity.
San Luis Beach	San Luis Beach is used for both military and recreational activities. San Luis Beach is used to support EOD and NSW training requirements. Activities include military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP.
Main Base/ Polaris Point (Figure A-5)	
Polaris Point Field (PPF)	Polaris Point Field supports both military and recreational activities and beach access to small landing craft. PPF supports small field training exercises, temporary bivouac, craft laydown, parachute insertions (freefall), assault training activities, AT/FP, and EOD and Special Forces Training.
Polaris Point Beach	Polaris Point Beach supports both military and recreational activities and beach access to small landing craft and LCAC. Polaris Point Beach supports military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP.
Polaris Point Site III	Polaris Point Site III is where Guam-homeported submarines and the submarine tender are located and is the primary site location for docking, training, and support infrastructure. Additionally, it supports AT/FP and torpedo/target logistics training.

Main Base/ Orote Point (Figure A-5)	
Orote Pt. Airfield/Runway	Orote Point Airfield consists of expeditionary runways and taxiways and is largely encumbered by the Explosive Safety Quantity Distance (ESQD) arcs from Kilo Wharf. Orote Pt. Airfield runways are used for vertical and short field military aircraft. They provide a large flat area that supports Field Training Exercise (FTX), parachute insertions, emergency vehicle driver training, and EOD and Special Warfare training. The airfield is on the National Register of Historic Places (NRHP).
Orote Pt. Close Quarter Combat Facility (OPCQC)	The OPCQC, commonly referred to as the Killhouse, is a small one-story building providing limited small arms live-fire training. Close Quarter combat (CQC) is one activity within Military Operations in Urban Terrain (MOUT)-type training. It is a substandard training facility and the only designated live-fire CQC facility in the MIRC.
Orote Pt. Small Arms Range/ Known distance Range (OPKDR)	The Orote Pt. Known Distance Range (OPKDR) supports small arms and machine gun training (up to 7.62mm), and sniper training out to a distance of 500 yards. The OPKDR is a long flat cleared area with an earthen berm that is used to support marksmanship. The OPKDR is currently being upgraded to an automated scored range system.
Orote Pt. Triple Spot	The Orote Pt. Triple Spot is a helicopter landing zone on the Orote Pt. Airfield Runway. It supports personnel transfer, logistics, parachute training, and a variety of training activities reliant on helicopter transport.
Ordnance Annex: The Ordnance Annex comprises approximately 8,800 acres. (Figure A-6)	
Ordnance Annex Breacher House (OABH)	The breacher house is a concrete structure in an isolated part of the Ordnance Annex that is used for tactical entry using a small explosive charge. Live-fire is not authorized in the breacher house. An adjacent flat area allows for a helicopter landing zone (LZ) supporting airborne raid type events.
Ordnance Annex Emergency Detonation Site (OAEDS)	The OAEDS is located within a natural bowl-shaped high valley area within the Ordnance Annex and is used for emergency response detonations, up to 3,000 pounds. A flat area near OAEDS allows for helicopter access. EOD activities are the primary types of training occurring at OAEDS.
Ordnance Annex Sniper Range	The Ordnance Annex Sniper Range is an open terrain, natural earthen backstop area that is used to support marksmanship training. The Ordnance Annex Sniper Range is approved for up to .50 cal sniper rifle with unknown distance targets.
Northern Land Navigation Area (NLNA)	The NLNA is located in the northeast corner of Ordnance Annex where small unit FTX and foot and vehicle land navigation training occurs.
Southern Land Navigation Area (SLNA)	The SLNA is located in the southern half of Ordnance Annex where foot land navigation training occurs.
General	Air training activities occur here, including combat search and rescue (CSAR), insertion/extraction, and fire bucket training.

Communications Annex: The Communications Annex is comprised of approximately 3,000 acres at Finegayan (Figure A-7) and 1,800 acres at Barrigada (Figure A-8). The annex includes open area and secondary forest available for small field exercises, and Haputo Beach for small craft (combat rubber raiding craft [CRRC]) type landings	
Finegayan Communications Annex	Finegayan Communications Annex supports FTX and MOUT training. Haputo Beach is used for small craft (e.g., CRRC) landings and Over the Beach insertions. Haputo Beach is part of the Haputo ecological reserve area. The Finegayan Small Arms Ranges (FSAR) are located in the Finegayan Communications Annex. Also referred to as the "North Range," FSAR supports qualification and training with small arms up to 7.62mm. The small arms ranges are known distance ranges consisting of a long flat cleared, earthen bermed area that is used to support marksmanship. Within the Finegayan Housing area is a small group of unoccupied buildings that support a company-sized (approximately 200-300) ground combat unit to conduct MOUT-type training, including use of LZ and DZ. A new DZ (called Ferguson-Hill) is under review with the FAA. Open areas provide command and control (C2) and logistics training; bivouac, vehicle land navigation, and convoy training; and other field activities.
Barrigada Communications Annex	Barrigada Communications Annex supports FTX and MOUT training. The Barrigada Housing area contains a few unoccupied housing units available for MOUT-type training. Open areas (former transmitter sites) provide command and control (C2) and logistics training; bivouac, vehicle land navigation, and convoy training; and other field activities.

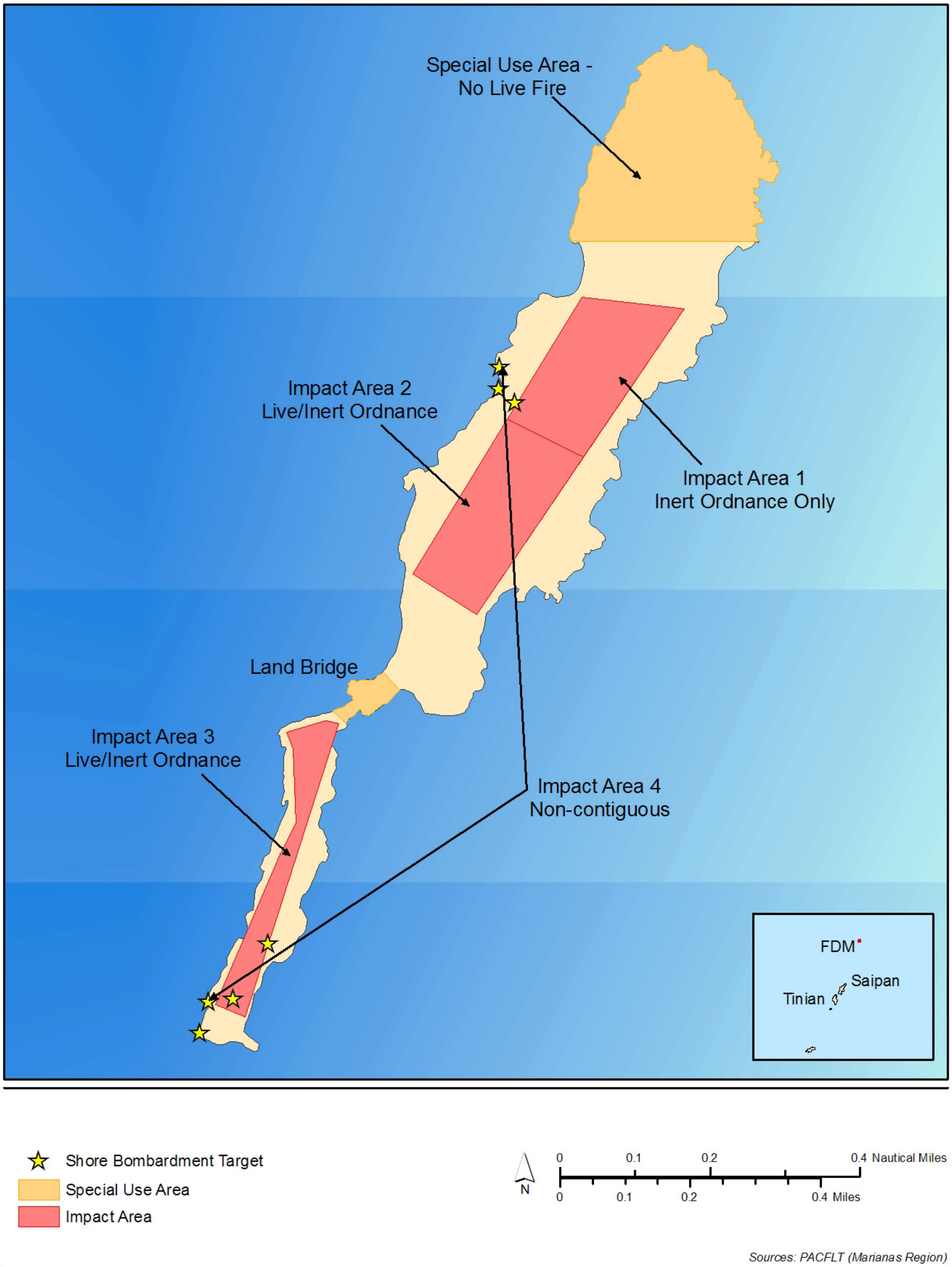
Tinian: Tinian (Figure A-9) consists of the Military Lease Area (MLA), which consists of 15,400 acres divided into two parcels:	
Exclusive Military Use Area (EMUA)	The EMUA is DoD-leased land (7,600 acres) covering the northern third of Tinian. The key feature is North Field, an unimproved expeditionary World War II (WWII) era airfield used for vertical and short-field landings. North Field is also used for expeditionary airfield training including C2, air traffic control (ATC), logistics, armament, fuels, rapid runway repair, and other airfield-related requirements. North Field is a National Historic Landmark. The surrounding area is used for force-on-force airfield defense and offensive training. The EMUA has two sandy beaches, Unai Chulu and Unai Dankulo (Long Beach), that are capable of supporting LCAC training at high tides. Only Unai Chulu has been used for LCAC training; however, storm damage and tree growth requires craft landing zone and beach improvements prior to use. Unai Dankulo also has the capability to support LCAC landings with craft landing zone and beach improvements. Unai Babui is a rocky beach capable of supporting narrow single-lane AAV landings; however, it would require channel, landing zone, and beach improvements. There are no active live-fire ranges on the EMUA, except sniper small arms into bullet traps. Future plans for any live-fire ranges will be addressed in other National Environmental Policy Act (NEPA) documents. Tinian is capable of supporting Marine Expeditionary Unit (MEU) and Marine Air Wing (MAW) events such as ground element training and air element training, Noncombatant Evacuation Operation (NEO), airfield seizure, and expeditionary airfield training, and special warfare activities, including large MEU and MAW training events.
Lease Back Area (LBA)	The LBA is DoD-leased land (7,800 acres) covering the central portion of the island, and makes up the middle third of Tinian. A key feature is the proximity to the commercial airport on the southern boundary of the LBA. The runway is not instrumented; however, it is capable of landing large aircraft. The airport has limited airfield services. The LBA is used for ground element training including MOUT-type training, C2, logistics, bivouac, vehicle land navigation, convoy training, and other field activities. There are no active live-fire ranges on the LBA, except sniper small arms into bullet traps.



* Proposed JDAM release point: (Lat 11 40 N, Long 144 E) and 25 nm radius WDZ

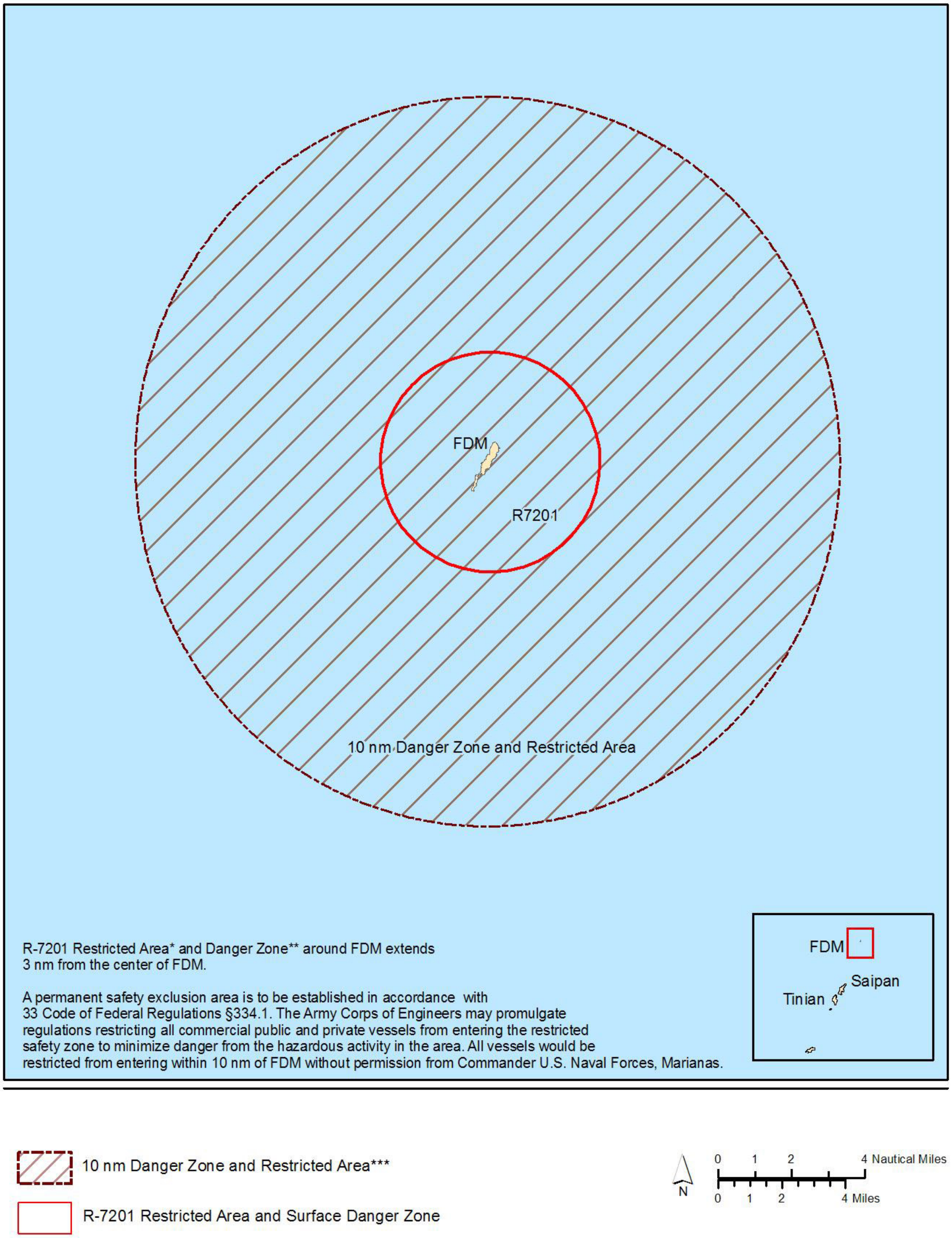
Source: ManTech-SRS

Figure A-2. W-517 Aerial Training Area



Source: ManTech-SRS

Figure A-3. Farallon de Medinilla (FDM)



* In accordance with FAA Order JO 7400.8P: R-7201 center point at lat. 6°01'04"N., long. 146°04'39"E., altitude from surface to FL600.

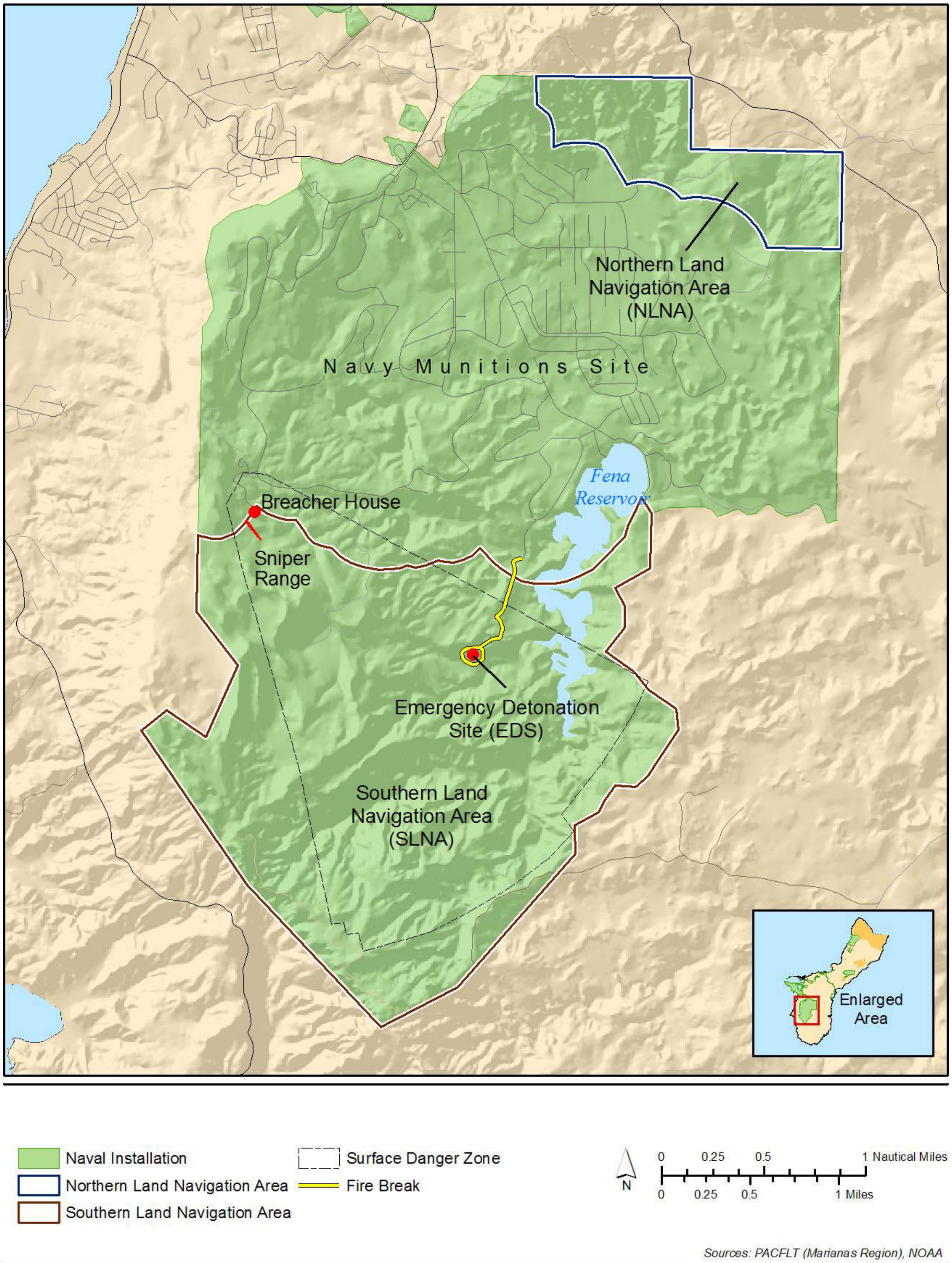
** Danger Zone In accordance with COMNAVMARINST 3502.1 FDM Range User Manual.

*** In accordance with the FDM Lease Agreement, Public access to Farallon de Medinilla Island and the waters of the Commonwealth immediately adjacent thereto are permanently restricted for safety reasons.

Figure A-4. Farallon de Medinilla (FDM) Restricted Area and Danger Zone

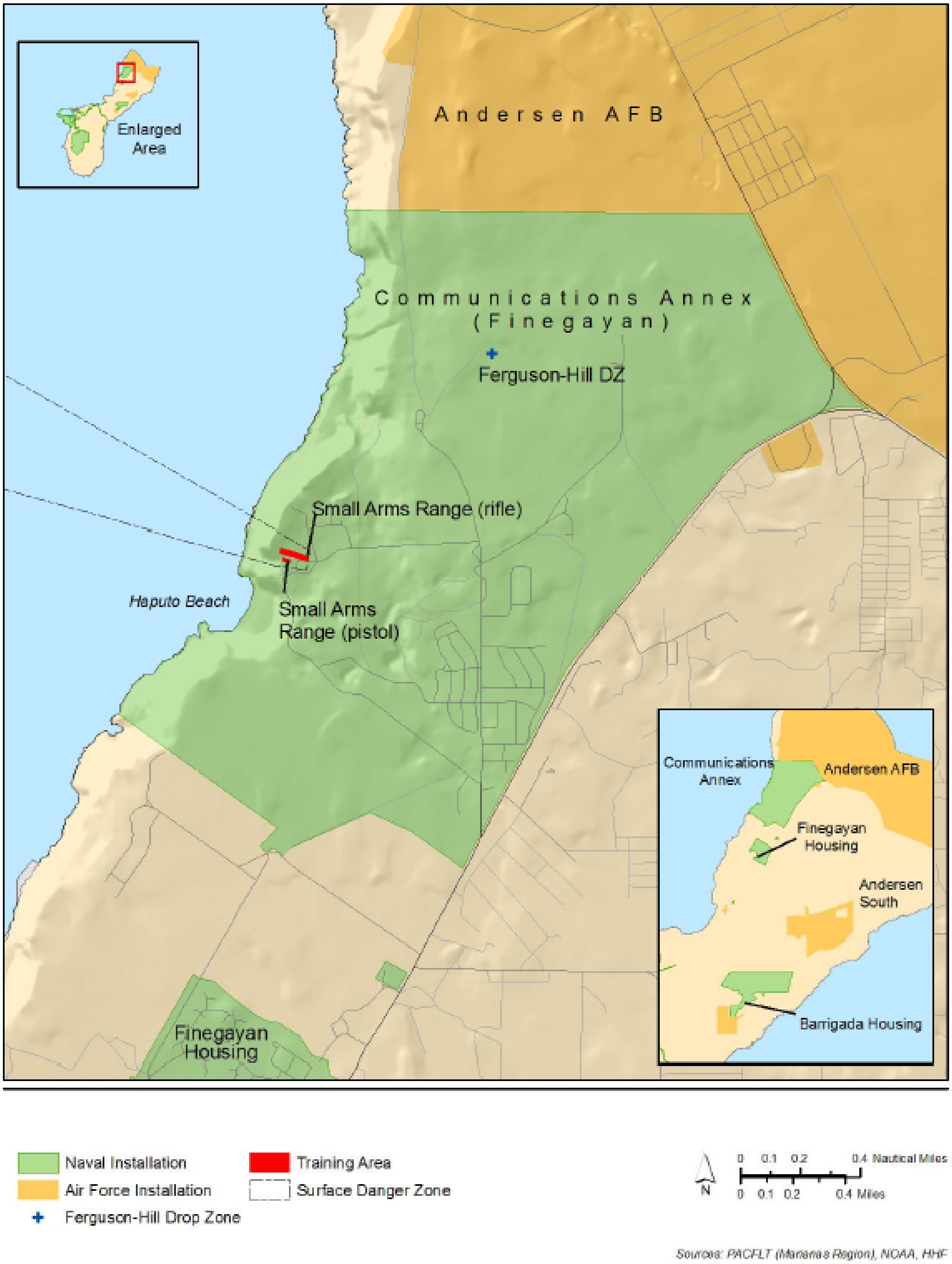
Source: ManTech-SRS

Figure A-5. Apra Harbor and Nearshore Training Areas



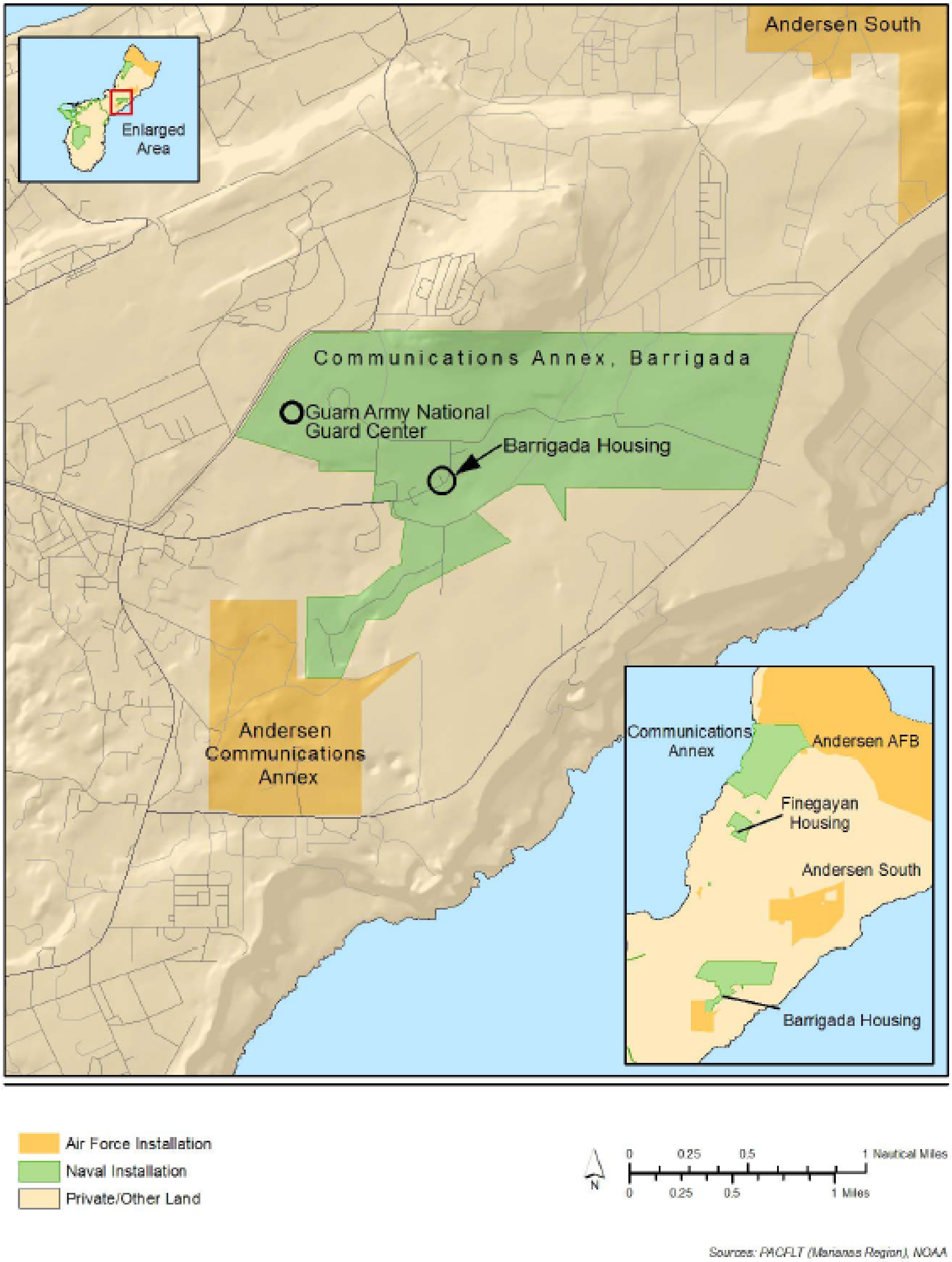
Source: ManTech-SRS

Figure A-6. Navy Munitions Site (aka Ordnance Annex) Training Areas



Source: ManTech-SRS

Figure A-7. Finegayan Communications Annex Training Areas



Source: ManTech-SRS

Figure A-8. Communications Annex, Barrigada

Source: ManTech-SRS

Figure A-9. Tinian Training Land Use and Saipan

*Note the Navy has leased a portion of the EMUA to the VoA_IBB

A.1.2 AIR FORCE CONTROLLED AND MANAGED TRAINING AREAS OF THE MIRC

Administered by 36th Wing, the Main Base at Andersen Air Force Base (AAFB) comprises about 11,500 acres. The base is used for aviation, small arms, and Air Force EOD training. As a large working airfield, the base has a full array of training activities, maintenance, and community support facilities. 36th Wing supports all U.S. military aircraft and personnel transiting the Mariana Islands. 36th Wing is host to deployed bomber and aerial refueling squadrons, and with the completion of the ISR/Strike initiative will host rotationally deployed F-22 aircraft, and permanently deployed air lift and refueling aircraft, and RQ-4 Global Hawk Unmanned Aerial Vehicle (UAV). Facilities are available for cargo staging and inspection. Undeveloped terrain consists of open and forested land. The coastline of the base consists of high cliffs and a long, narrow recreation beach (Tarague Beach) to the northeast. Multiple exposed coral pillars negate use of this beach for amphibious landings by landing craft or amphibious vehicles.

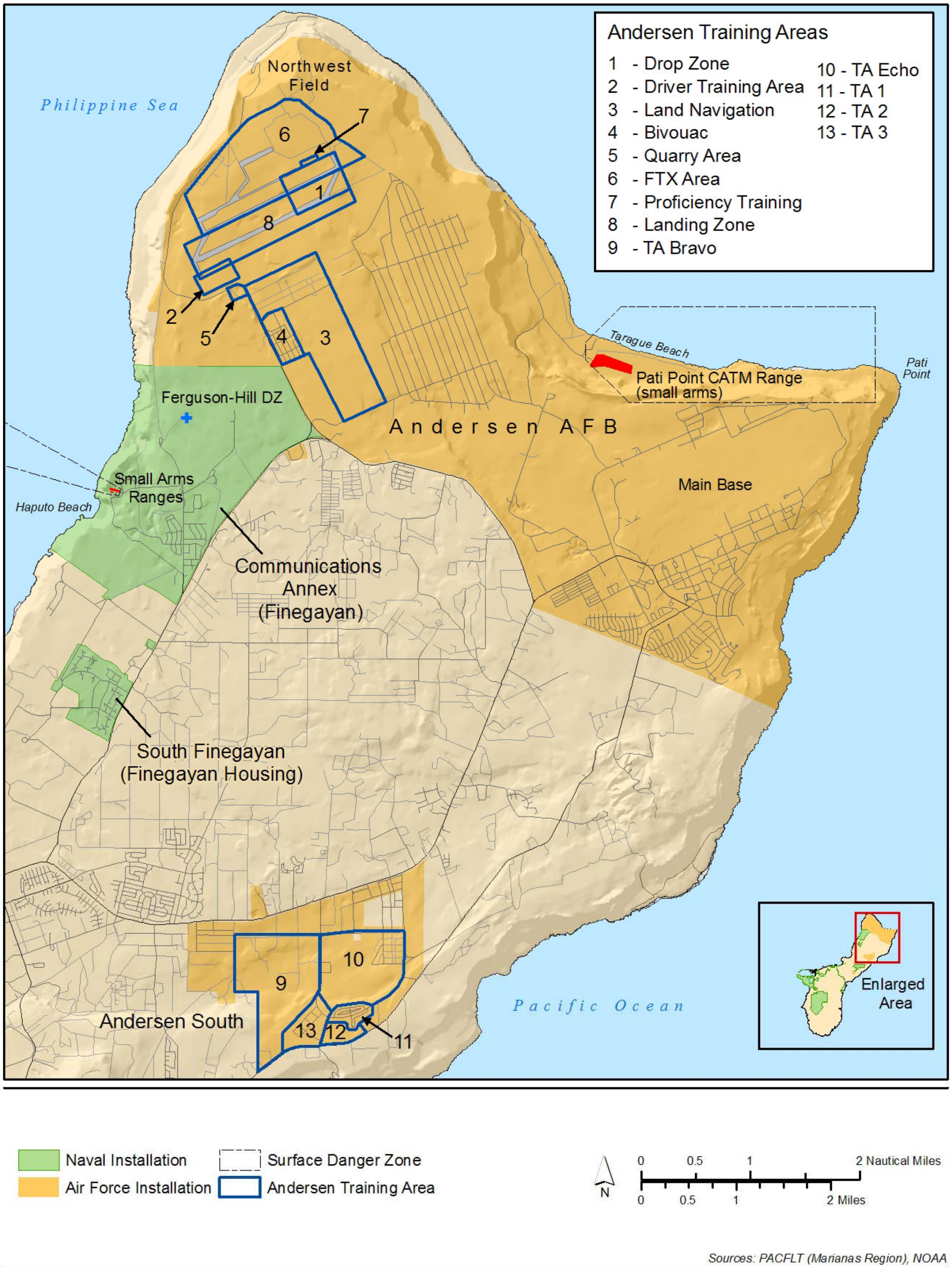
The 36th Contingency Response Group (CRG) is the controlling authority for training activities conducted on Andersen Air Force Base (11,000 acres). Thirty Sixth (36th) CRG controls training at Northwest Field (4,500 acres) and Andersen South (1,900 acres). The 36th Security Forces Squadron (SFS) controls the Pati Pt. Combat Arms Training and Maintenance (CATM) Rifle Range (21 acres).

Table A-3 provides an overview of each Air Force controlled and managed area and its location. Figure A-10 depicts those training areas associated with Andersen AFB.

Table A-3. Air Force Controlled and Managed MIRC Training Areas

Training Area	Detail/Description
Northwest Field	Northwest Field is an unimproved expeditionary WWII era airfield used for vertical and short field landings. Approximately 280 acres of land are cleared near the eastern end of both runways for parachute drop training. The south runway is used for training of short field and vertical lift aircraft and often supports various types of ground maneuver training. Helicopter units use other paved surfaces for Confined Area Landing (CAL), simulated amphibious ship helicopter deck landings, and insertions and extractions of small maneuver teams. About 3,562 acres in Northwest Field are the primary maneuver training areas available at Andersen AFB for field exercises and bivouacs. Routine training exercises include camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training, and chemical attack/response. The Air Force will complete its Northwest Field Beddown and Training and Support Initiative, co-locating at Northwest Field the Rapid

Training Area	Detail/Description
	Engineer Deployable Heavy Operations Repair Squadron Engineers (RED HORSE) and its Silver Flag training unit, the Commando Warrior training program, and the Combat Communications squadron. Additional information concerning these activities is contained in the Northwest Field Beddown Initiative Environmental Assessment (EA).
Andersen South	Andersen South consists of abandoned military housing and open area consisting of 1,922 acres. Andersen South open fields and wooded areas are used for basic ground maneuver training including routine training exercises, camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training. Vacant single-family housing and vacant dormitories are used for MOUT training and small-unit tactics. The buildings may need repairs and upgrade to be suitable for consistent use in training.
Main Base	Andersen Main Base is dedicated to its primary airfield mission. Administered by 36th Wing, the Main Base at Andersen AFB comprises about 11,500 acres. The base is used for aviation, small arms, and Air Force EOD training. As a working airfield, the base has a full array of operations, maintenance, and community support facilities. 36th Wing supports all U.S. military aircraft and personnel transiting the MIRC. Facilities are available for cargo staging and inspection.
Pati Point (Tarague Beach) Combat Arms and Training Maintenance (CATM) Range and EOD Pit	Pati Point consists of 21 acres used for the CATM small arms range. The CATM range supports training with pistols, rifles, machine guns up to 7.62mm, and inert mortars up to 60mm. Training is also conducted with the M203 40mm grenade launcher using inert training projectiles only.



Source: ManTech-SRS

Figure A-10. Andersen Air Force Base Assets

A.1.3 FEDERAL AVIATION ADMINISTRATION AIR TRAFFIC CONTROLLED ASSIGNED AIRSPACE

As per the Letter of Agreement (LOA) dated 15 May, 2007 between Guam Air Route Traffic Control Center (ARTCC), Commander, U.S. Naval Forces Marianas (COMNAVMAR), and 36th Operations Group, COMNAVMAR is designated the scheduling and using agency for W-517, and ATCAAs 1, 2, 3A, 3B, 3C, 4, 5, and 6. Guam ARTCC is designated the Controlling Agency. Guam ARTCC decommissioned ATCAA 4 in November 2007.

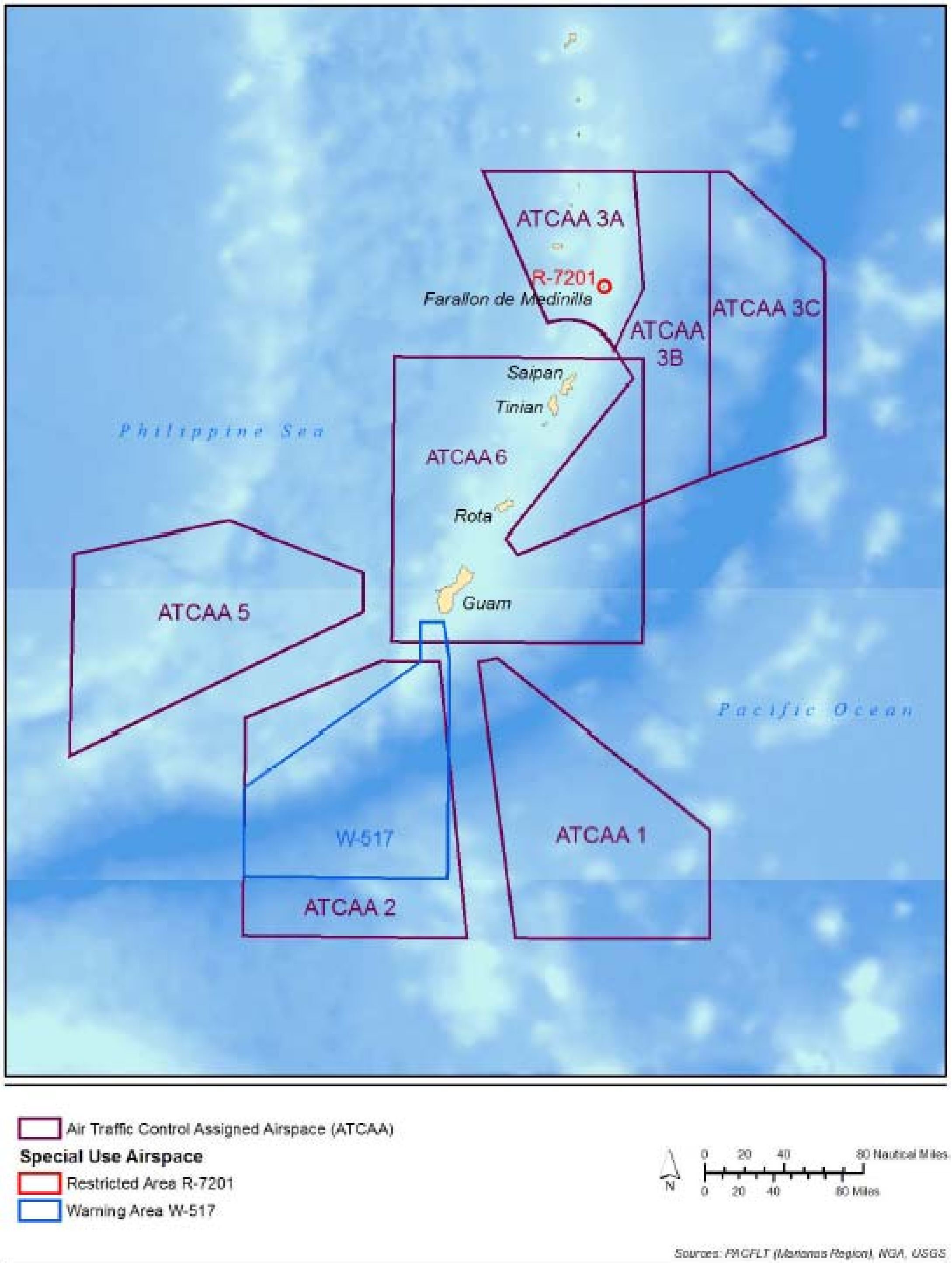
Range control consists of scheduling with operational units and notifying others of that schedule via Notice to Airmen (NOTAM) and Notice to Mariners (NOTMAR).

Table A-4 provides more detailed information about the ATCAA. Figure A-11 shows the location of the ATCAA.

Table A-4. FAA Air Traffic Controlled Assigned Airspace

Training Area				
Air Traffic Controlled Assigned Airspace:				
Airspace	**nm²**	**Lower limit**	**Upper limit**	**Over Land?**
ATCAA 1	10,250	Surface	Unlimited	No
ATCAA 2	13,750	Surface	Unlimited	No
ATCAA 3A	5,000	Surface	Unlimited	No, except for FDM
ATCAA 3B	7,750	Surface	FL300	No
ATCAA 3C	8,000	Surface	Unlimited	No
ATCAA 5	10,500	Surface	FL300	No
ATCAA 6	15,300	FL390	FL430	No
W-517 lies mostly within ATCAA 2. R-7201 lies within ATCAA 3A.				

Sources: Commander, Naval Forces Marianas; Federal Aviation Administration



Source: ManTech-SRS

Figure A-11. Mariana Islands Range Complex ATCAAs

A.1.4 OTHER MIRC TRAINING ASSETS

Other MIRC training areas include training facilities controlled and managed by the AR-Marianas and the Guam Army National Guard (GUARNG) and the Government of the CNMI.

Table A-5 provides more detailed information about these other MIRC training assets. Figure A-9 locates the Army Reserve Center, Saipan. Figure A-12 locates the NSWU-1 leased pier space and lay down area on Rota.

Table A-5. Other MIRC Training Assets

Sub complex Name/Training Area	Detail/Description
Guam:	
Army Reserve Center	Located on Barrigada Communications Annex, and supporting approximately 1,200 Army reservists. Contains an indoor small arms range (9mm).
Guam Army National Guard Center	Located on Barrigada Communications Annex and supports approximately 1,000 Guam Army National Guard personnel. Contains armory, classrooms, administrative areas, maintenance facilities, and laydown areas.
Saipan:	
Army Reserve Center	Saipan Army Reserve Center (Figure 2-8) contains armory, classrooms, administrative areas, maintenance facilities, and laydown areas and supports C2, logistics, AT/FP, bivouac, and other headquarter activities.
Commonwealth Port Authority	The Navy has access to approximately 100 acres of Port Authority area including wharf space which supports VBSS, AT/FP, and NSW training activities.
East Side of northern Saipan (Marpi Pt. area)	With the coordination of the Army Reserve Unit Saipan and the approval of CNMI government, land navigation training is conducted on non-DoD lands.
Rota: Rota (Figure A-12), which is about 40 miles from Guam, is an ideal site for supporting long-range NSW missions between Guam, Tinian, and FDM. Boat refueling is conducted at commercial marinas on Rota, as well as Saipan and Tinian.	
Commonwealth Port Authority	The Navy has access to Angyuta Island seaward of Song Song's West Harbor as a Forward Staging Base/overnight bivouac site. The island is adjacent to the commercial port facility and leased space is used for boat refueling and maintenance.
Municipality of Rota	Certain types of special warfare training including hostage rescue, NEO, and MOUT are conducted with local law enforcement, on non-DoD lands.

Source: ManTech-SRS

Figure A-13. Rota

A.2 NO ACTION – CURRENT TRAINING ACTIVITIES WITHIN THE MIRC

The No Action Alternative is the continuation of training activities, RDT&E activities, and continuing base activities. This includes all multi-Service training activities on DoD training areas, including either a joint expeditionary warfare exercise or a joint multi-strike group exercise. The current military training in the MIRC was initially analyzed in the 1999 Final Environmental Impact Statement Military Training in the Marianas and in several EAs (e.g., OEA Notification for Air/Surface International Warning Areas and Valiant Shield OEA) for more specific training events or platforms. As such, evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 (Preferred Alternative), and Alternative 2, as described in the following subsections.

While the No Action Alternative meets a portion of the Service's requirements, it does not meet the purpose and need. This Alternative does not provide for training capabilities for ISR/Strike, undersea warfare improvements, or increased training activities within the MIRC. With reference to the criteria identified in Section 2.2.1 of the EIS/OEIS, the No Action Alternative does not satisfy criteria 7, 8, and 9 (relating to support for the full spectrum of training requirements).

A.2.1 DESCRIPTION OF CURRENT TRAINING ACTIVITIES WITHIN THE MIRC

Each military training activity described in this EIS/OEIS meets a requirement that can be traced ultimately to requirements from the National Command Authority (NCA) composed of the President of the United States and the Secretary of Defense. Based upon NCA requirements, the Joint Staff develops a set of high-level strategic warfighting missions, called the Universal Joint Task List (UJTL). The Joint Forces Command (JFCOM) and each military Service uses the UJTL to develop specific statements of required tactical tasks. Each Service derives its tactical tasks from the UJTLs. These Service-level tactical task lists are in turn applied to training requirements that the MIRC is to support with range and training area capabilities. Service tactical tasks that encompass the current training activities within the MIRC are listed in Table A-7, are briefly described below in Service-specific groupings, and are described in greater detail in Appendix D of the EIS/OEIS. The source for these lists is the MIRC Range Complex Management Plan (RCMP).

A.2.1.1 Army Training

Surveillance and Reconnaissance (S&R). S&R are conducted to evaluate the battlefield and enemy forces, and to gather intelligence. For training of assault forces, opposition forces (OPFOR) units may be positioned ahead of the assault force and permitted a period of time to conduct S&R and prepare defenses against an assaulting force. S&R training has occurred at urban training facilities at Finegayan and Barrigada on Guam, and both the Exclusive Military Use Area (EMUA) and the Lease Back Area (LBA) on Tinian.

Field Training Exercise (FTX). An FTX is an exercise wherein the battalion and its combat and combat service support units deploy to field locations to conduct tactical training activities under simulated combat conditions. A company or smaller-sized element of the Army Reserve, GUARNG, or Guam Air National Guard (GUANG) will typically accomplish an FTX within the MIRC, due to the constrained environment for land forces. The headquarters and staff elements may simultaneously participate in a Command Post Exercise (CPX) mode. FTXs have occurred on Guam at Polaris Point Field, Orote Point Airfield/Runway, NLNA, Andersen Air Force Base Northwest Field, and Andersen South Housing Area, and on Tinian at the EMUA.

Live-Fire. Live-fire training is conducted to provide direct fire in support of combat forces. Limited live-fire training has occurred at Pati Pt. CATM Range.

Parachute Insertions and Air Assault. These air training activities are conducted to insert troops and equipment by parachute and/or by fixed or rotary wing aircraft to a specified objective area. These training activities have occurred at Orote Point Triple Spot, Polaris Point Field, and the Ordnance Annex Breacher House. Additionally, Orote Point Airfield/Runway supports personnel, equipment, and Container Delivery System (CDS) airborne parachute insertions.

Military Operations in Urban Terrain (MOUT). MOUT training activities encompass advanced offensive close quarter battle techniques used on urban terrain conducted by units trained to a higher level than conventional infantry. Techniques include advanced breaching, selected target engagement, and dynamic assault techniques using organizational equipment and assets. MOUT is primarily an offensive operation, where noncombatants are or may be present and collateral damage must be kept to a minimum. MOUT can consist of more than one type. One example might be a "raid," in which Army Special Forces or Navy SEALs use MOUT tactics to seize and secure an objective, accomplish their mission, and withdraw. Another example might be a Marine Expeditionary Force (MEF) using MOUT tactics to seize and secure an objective for the long term. Regardless of the type, training to neutralize enemy forces must be accomplished in a built-up area featuring structures, streets, vehicles, and civilian population. MOUT training involves clearing buildings; room-by-room, stairwell-by-stairwell, and keeping them clear. It is manpower intensive, requiring close fire and maneuver coordination and extensive training. Limited, non–live-fire, MOUT training is conducted at the OPCQC House, Ordnance Annex Breacher House, Barrigada Housing, and Andersen South Housing Area. Additionally, the OPCQC supports "raid" type MOUT training on a limited basis.

A.2.1.2 Marine Corps Training

Ship to Objective Maneuver (STOM). STOM is conducted to gain a tactical advantage over the enemy in terms of both time and space. The maneuver is not aimed at the seizure of a beach, but builds upon the foundations of expanding the battlespace. STOM has occurred at the EMUA on Tinian.

Operational Maneuver. This training exercise supports forces achieving a position of advantage over the enemy for accomplishing operational or strategic objectives. These exercises have occurred at NLNA and SLNA.

Non-Combatant Evacuation Order (NEO). NEO training activities are conducted when directed by the Department of State, the DoD, or other appropriate authority whereby noncombatants are evacuated from foreign countries to safe havens or to the United States, when their lives are endangered by war, civil unrest, or natural disaster. NEO training activities have occurred at the EMUA on Tinian.

Assault Support (AS). AS exercises provide helicopter support for C2, assault escort, troop lift/logistics, reconnaissance, search and rescue (SAR), medical evacuation (MEDEVAC), reconnaissance team insertion/extract and Helicopter Coordinator (Airborne) duties. Assault support provides the mobility to focus and sustain combat power at decisive places and times. It provides the capability to take advantage of fleeting battlespace opportunities. Polaris Point Field and OPKDR provide temporary sites from which the MEU commander can provide assault support training to his forces within the MIRC. Assault support training activities have also occurred on Tinian at the EMUA.

Reconnaissance and Surveillance (R & S). R&S is conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, OPFOR units may be positioned ahead of the assault force and permitted a period of time to conduct R&S and prepare defenses to the assaulting force. These types of training activities have occurred on Tinian at the EMUA.

Military Operations in Urban Terrain (MOUT). Marine Corps MOUT training is similar in nature and intent to Army MOUT training. MOUT training is conducted at the Ordnance Annex Breacher House. Additionally, the OPCQC supports "raid" type MOUT training on a limited basis.

Direct Fire. Direct Fire, similar in nature and content to Navy Marksmanship exercises, is used to train personnel in the use of all small arms weapons for the purpose of defense and security. Direct Fire training activities are strictly controlled and regulated by specific individual weapon qualification standards. These training activities have occurred at FDM and OPKDR. Another form of Marine Corps Direct Fire exercises involves the use of aircraft acting as forward observers for Naval Surface Fire Support (NSFS). During this training, Marine aircraft will act as spotters for the ships and relay targeting and battle hit assessments information. These types of training activities utilize FDM and ATCAA 3A airspace.

Exercise Command and Control (C2). This type of exercise provides primary communications training for command, control, and intelligence, providing critical interpretability and situation awareness information. C2 exercises have occurred at Andersen AFB.

Protect and Secure Area of Operations (Protect the Force). Force protection training activities increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures. Force protection training activities have occurred at Northwest Field on Andersen Air Force Base.

A.2.1.3 Navy Training

Anti-Submarine Warfare (ASW) Training. ASW training engages helicopter and sea control aircraft, ships, and submarines, operating alone or in combination, in training to detect, localize, and attack submarines. ASW training involves sophisticated training and simulation devices utilizing sonobuoys, ship sonar systems, submarine sonar systems, and helicopter dipping sonar systems utilizing both passive and active modes. Underwater targets which emit sound through the water are also used. When the objective of the exercise is to track the target but not attack it, the exercise is called a Tracking Exercise (TRACKEX). A Torpedo Exercise (TORPEX) takes the training activity one step further, culminating in the release of an actual torpedo, which can be either a running Exercise Torpedo (EXTORP) or non-running Recoverable Exercise Torpedo (REXTORP). All torpedoes used in such training have inert warheads.

- *ASW Training Targets*. ASW training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices:
    - Acoustic projectors emanating sounds to simulate submarine acoustic signatures;
    - Echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and
    - Magnetic sources to trigger magnetic detectors.

Two anti-submarine warfare targets are used in the Study Area. The first is the MK-30 Mobile ASW Training Target. The MK-30 target is a torpedo-like, self-propelled, battery powered underwater vehicle capable of simulating the dynamic, acoustic, and magnetic characteristics of a submarine. The MK-30 is 21 inches in diameter and 20.5 feet in length. These targets are launched by aircraft and surface vessels and can run approximately four hours dependent on the programmed training scenario. The MK 30 is recovered after the exercise for reconditioning and subsequent reuse.

- *MK-84 Range Pingers*. MK-84 range pingers are used in association with the Portable Underwater Tracking Range and are active acoustic devices that allow ships, submarines, and target simulators to be tracked by means of deployed hydrophones. The signal from a MK-84 pinger is very brief (15 milliseconds) with a selectable frequency at 9.24 kHz, 12.93 kHz, 33.15 kHz, or 36.95 kHz and a source level of approximately 190 dB Sound Pressure Level (SPL).

Air Warfare (AW) Training. AW training includes one or more of the following training activities.

- *Surface-to-Air Missile Exercise (S-A MISSILEX).* Missiles are fired from either aircraft or ships against aerial targets.
- *Air-to-Air Missile/Gun Exercises (A-A MISSILEX/GUNEX).* Involve a fighter or fighter/attack aircraft and may involve firing missiles/guns at an aerial target. The missiles fired are not recovered.
- *Surface-to-Air Gunnery Exercises (S-A GUNEX)*. S-A GUNEX does not occur in the MIRC due to a requirement for commercial air service to tow targets.
- *Chaff/Flare Exercises (CHAFFEX/FLAREX).* Ship and aircraft crews practice defensive maneuvering while expending chaff and/or flares to evade targeting by a simulated missile threat. Chaff consists of thin metallic strips that reflect radio frequency energy, confusing radar. No ordnance used only chaff and flares.
- *Air Combat Maneuver (ACM).* Two to eight fighter aircraft engage in aerial combat, typically at high altitudes, far from land.

Surface Warfare (SUW) Training. SUW training includes one or more of the following training activities.

- *Surface-to-Surface Gunnery Exercise (S-S GUNEX)*: S-S GUNEX activities take place in the open ocean to provide gunnery practice for Navy and Coast Guard ships utilizing shipboard gun systems and small craft crews supporting NSW, EOD, and Mobile Security Squadrons (MSS) utilizing small arms. GUNEX training activities conducted in W-517 involve only surface targets such as a MK-42 Floating At Sea Target (FAST), MK-58 marker (smoke) buoys, or 55 gallon drums. The systems employed against surface targets include the 5-inch, 76mm, 25mm chain gun, 20mm Close In Weapon System (CIWS), .50 caliber machine gun, 7.62mm machine gun, small arms, and 40mm grenade.
- *Air-to-Surface Gunnery Exercise (A-S GUNEX)*: A-S GUNEX training activities are conducted by rotary-wing aircraft against targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would use either 7.62mm or .50 caliber door-mounted machine guns. GUNEX training occurs in the MIRC Offshore Areas including W-517.

- *Visit Board Search and Seizure (VBSS)*: These exercises involve the interception of a suspect surface ship by a Navy ship and are designed to train personnel to board a ship, other vessel or transport to inspect and examine the ship's papers or examine it for compliance with applicable laws and regulations. Seizure is the confiscating or taking legal possession of the vessel and contraband (goods or people) found in violation of laws and regulations. A VBSS can be conducted both by ship personnel trained in VBSS or by NSW SEAL teams trained to conduct VBSS on uncooperative vessels. Employment onto the vessel designated for inspection is usually done by small boat or by helicopter.
- *Sinking Exercise (SINKEX):* A SINKEX is typically conducted by aircraft, surface ships, and submarines in order to take advantage of a full-size ship target and an opportunity to fire live weapons. The target is typically a decommissioned combatant or merchant ship that has been made environmentally safe for sinking. SINKEX conducted in the MIRC have been conducted in deep water and beyond 50nm of land in a location where it will not be a navigation hazard to other shipping. Ship, aircraft, and submarine crews typically are scheduled to attack the target with coordinated tactics and deliver live ordnance to sink the target. Inert ordnance may be used during the first stages of the event so that the target may be available for a longer time. The duration of a SINKEX is unpredictable because it ends when the target sinks, but the goal is to give all forces involved in the exercise an opportunity to deliver their live ordnance. Sometimes the target will begin to sink immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons. Typically, the exercise lasts for 4 to 8 hours and possibly over 1 to 2 days, especially if inert ordnance, such as 5-inch gun projectiles or MK-76 dummy bombs, is used during the first hours. A SINKEX is conducted under the auspices of a permit from the U.S. Environmental Protection Agency (EPA).

Strike Warfare (STW) Training. STW training consists of the following training activity.

- *Air to Ground Bombing Exercises (Land) (BOMBEX-Land)*: BOMBEX (Land) allows aircrews to train in the delivery of bombs and munitions against ground targets. The weapons commonly used in this training on FDM are inert training munitions (e.g., MK-76, BDU-45, BDU-48, and BDU-56), and live MK-80-series bombs and precision guided munitions (Laser Guided Bombs [LGBs] or Laser Guided Training Round [LGTRs]). Cluster bombs, fuel-air explosives, and incendiary devices are not authorized on FDM. Depleted uranium rounds are not authorized on FDM. BOMBEX exercises can involve a single aircraft, a flight of two, four, or multiple aircraft. The types of aircraft that frequent FDM are F/A-18, F-22, F-15, F-16, B-1B, B-2, B-52, and H-60, and possibly UAVs. FDM is an uncontrolled and un-instrumented, laser certified range with fixed targets, which includes Container Express (CONEX) boxes in various configurations within the live-fire zones, high fidelity anti aircraft missiles, and gun-shape targets within the inert-only zone. COMNAVMAR is the scheduling authority. All aircraft without aid of an air controller must make a clearance pass prior to engaging targets as instructed in the FDM Range Users Manual (COMNAVMAR Instruction [COMNAVMARINST] 3502.1).
- *Air to Ground Missile Exercises (A-G MISSILEX)*: A-G MISSILEX trains aircraft crews in the use of air-to-ground missiles. On FDM it is conducted mainly by H-60 Aircraft using Hellfire missiles and occasionally by fixed-wing aircraft using Maverick missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire the target, and launch the missile. The

missile is launched in forward flight or at hover at an altitude of 300 feet Above Ground Level (AGL).

Naval Special Warfare (NSW) Training. NSW forces train to conduct military operations in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. Specific training events in the MIRC include:

- *Naval Special Warfare (NSW).* NSW personnel perform special warfare training using tactics that are applicable to the specific tactical situations where the NSW personnel are employed. They are specially trained, equipped, and organized to conduct special operations in maritime, littoral, and riverine environments. Several general training activities and scenarios are called out in this EIS, and while there is a baseline of special operation exercises, training is always evolving to meet the tactical requirements and special weapons required to complete the mission assigned. Exercises involving NSW personnel include, but are not limited to the following:
    - Amphibious Warfare Exercises
    - BOMBEX (Air-to-Ground)
    - Breaching
    - Close Air Support (CAS)
    - Direct Action
    - Escape and Evasion
    - High Mobility Multipurpose Wheeled Vehicle (HMMWV) Training
    - Insertion/Extraction
    - Immediate Action Drills
    - Land Demolitions
    - Land Navigation
    - Maritime Training Activities
    - Marksmanship
    - MOUT
    - Nearshore Hydrographic Reconnaissance
    - NSW Physical Conditioning Training Exercises
    - Over-the-Beach
    - Over-the-Beach Stalk
    - Special Boat Team Training Activities
    - Swimmer/CRRC Over-the-Beach
    - UAV OPS
    - Unmanned Underwater Vehicles (UUV) OPS
    - Underwater Detonation
    - VBSS

References to NSW training activity contained in the list above will be discussed as they occur within the text of this document.

- *Airfield Seizure.* Airfield Seizure training activities are used to secure key facilities in order to support follow-on forces, or enable the introduction of follow-on forces. An airfield seizure consists of a raid/seizure force from over the horizon assaulting across a hostile territory in a combination of helicopters, vertical takeoff and landing (VTOL aircraft), and other landing craft with the purpose of securing an airfield or a port. NSW teams have conducted this training at Northwest Field on Andersen Air Force Base.

- *Breaching.* Breaching training teaches personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This enables a force to maintain its mobility by removing or reducing natural and man-made obstacles. In the NSW sense, breacher training activities are designed to provide personnel experience knocking down doors to enter a building or structure. During the conduct of a normal breach activity, battering rams or less than 1 pound net explosive weight (NEW) is used to knock down doors. Training has occurred at OPCQC House and the Ordnance Annex Breacher House (OABH) (Maximum charge permitted at the OABH is no more than 3 pounds NEW.) However, explosives at OPCQC are not permitted, which limits the value of conducting this training at OPCQC.

- *Direct Action*. NSW Direct Action is either covert or overt directed against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. Training activities are small-scale offensive actions including raids; ambushes; standoff attacks by firing from ground, air, or maritime platforms; designate or illuminate targets for precision-guided munitions; support for cover and deception operations; and sabotage inside enemy-held territory. Units involved are typically at the squad or platoon level staged on ships at sea. They arrive in the area of operations by helicopter or CRRC across a beach. NSW teams are capable of using small craft to island hop from Guam to Rota, Rota to Tinian, Tinian to Saipan, and Saipan to FDM; however, this is not a frequent event. Once at FDM, small arms, grenades, and crew-served weapons (weapons that require a crew of several individuals to operate) are employed in direct action against targets on the island. Participation in Tactical Air Control Party/Forward Air Control (TACP/FAC) training in conjunction with a BOMBEX-Land also occurs. NSW and visiting Special Forces training in the MIRC will frequently include training that utilizes the access provided by Gab Gab Beach to Apra Harbor and Orote Point training areas, as well as training in the OPCQC.

- *Insertion/Extraction*. Insertion/extraction activities train forces, both Navy (primarily Special Forces and EOD) and Marine Corps, to deliver and extract personnel and equipment. These activities include, but are not limited to, parachute, fast rope, rappel, Special Purpose Insertion/Extraction (SPIE), CRRC, and lock-in/lock-out from underwater vehicles. Training activities have been conducted at Outer Apra Harbor, Inner Apra Harbor, Gab Gab Beach (western half), Reserve Craft Beach, and Polaris Point Field. Additionally, parachute, fast rope, and rappel training have been conducted at Orote Point Airfield/Runway, Orote Point Triple Spot, OPCQC House, Dan Dan Drop Zone, OPKD Range, and the Ordnance Annex Breacher House.

- *Military Operations in Urban Terrain (MOUT)*. NSW MOUT training is similar in nature and intent to Army and Marine Corps MOUT training, but typically on a smaller scale. MOUT training is conducted at the Ordnance Annex Breacher House. Additionally, the OPCQC supports "raid" type MOUT training on a limited basis.

- *Over the Beach (OTB)*. NSW personnel use different methods of moving forces from the sea across a beach onto land areas in order to get closer to a tactical assembly area or target depending on threat force capabilities. A typical OTB exercise would involve a squad (8 personnel) to a platoon (16 personnel) or more of NSW personnel being covertly inserted into the water off of a beach area of hostile territory. However, the insertion could be accomplished by other means, such as fixed-winged aircraft, helicopter, submarine, or surface ship. From the insertion point several miles at sea, the SEALs may use a CRRC, Rigid Hull Inflatable Boat (RHIB), SEAL

Delivery Vehicle (SDV), Advanced SEAL Delivery System (ASDS), or swim to reach the beach, where they will move into the next phase of the exercise and on to the objective target area and mission of that phase of the exercise.

Amphibious Warfare (AMW) Training. AMW training includes individual and crew, small unit, large unit, and Marine Air Ground Task Force (MAGTF)-level events. Individual and crew training include operation of amphibious vehicles and naval gunfire support training. Small-unit training activities include events leading to the certification of a MEU as "Special Operations Capable" (SOC). Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Larger-scale amphibious exercises are carried out principally by MAGTFs or elements of MAGTFs embarked with Expeditionary Strike Groups (ESG); and include the following training exercises.

- *Naval Surface Fire Support (FIREX Land.* FIREX (Land) on FDM consists of the shore bombardment of an Impact Area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed. On FDM, spotting may be conducted from the special use "no fire" zone or provided from a helicopter platform. No one may land on the island without the express permission of COMNAVMAR (COMNAVMARINST 3502.1).
- *Marksmanship*. Marksmanship exercises are used to train personnel in the use of small arms weapons for the purpose of ship self defense and security. Basic marksmanship training activities are strictly controlled and regulated by specific individual weapon qualification standards. Small arms include but are not limited to 9mm pistol, 12-gauge shotgun, and 7.62mm rifles. These exercises have occurred at Orote Point and Finegayan small arms ranges, and OPKD Range.
- *Expeditionary Raid*. An Expeditionary Raid (Assault) is an attack involving swift incursion into hostile territory for a specified purpose. The attack is then followed by a planned withdrawal of the raid forces. A raid force can consist of varying numbers of aviation, infantry, engineering, and fire support forces. Expeditionary Raids conducted in support to movement of operational forces are normally directed against objectives requiring specific outcomes not possible by other means. A key influence in every raid is the ability to insert, complete the assigned mission, and extract without providing the enemy force with opportunity to reinforce their forces or plan for counter measures. The expeditionary raid is the foundation for all MEU SOC operational missions and is structured based upon mission requirements, situational settings, and force structure. Reserve Craft Beach is capable of supporting a small Expeditionary Raid training event followed by a brief administrative buildup of forces ashore. In Fiscal Year (FY) 2003, up to 300 31^{st} MEU personnel and pieces of equipment were moved ashore at Reserve Craft Beach via LCAC.
- *Hydrographic Surveys*. Hydrographic Reconnaissance is conducted to survey underwater terrain conditions and report findings to provide precise analysis typically in support of amphibious landings and precise ship and small craft movement through cleared routes (Q-Routes). Exercises involve the methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and to determine the feasibility of landing an amphibious force on a

particular beach. Hydrographic Survey exercises have also occurred at Outer Apra Harbor and Tipalao Cove.

Mine Warfare (MIW) Training

- *Land Demolition.* Training activities using land demolition training are designed to develop and hone EOD detachment mission proficiency in location, excavation, identification, and neutralization of buried land mines. During the training, teams transit to the training site in trucks or other light-wheeled vehicles. A search is conducted to locate inert (nonexplosively filled) land mines or Improvised Explosive Devices (IEDs) and then designate the target for destruction. Buried land mines and Unexploded Ordnance (UXO) require the detachment to employ probing techniques and metal detectors for location phase. Use of hand tools and digging equipment is required to excavate. Once exposed and/or properly identified, the detachment neutralizes threats using simulated or live explosives. Land demolition training is actively conducted throughout the MIRC. Explosive Ordnance Disposal Mobile Unit (EODMU)-5 is stationed at Main Base and EOD Detachment, Marianas (DET MARIANAS) is a small unit of EOD personnel who are permanently attached to COMNAVBASE MARIANAS and are actively involved in disposing of old munitions and UXO found throughout the MIRC. Land demolition training activities have occurred at Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC House, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, and Barrigada Housing.
- *Underwater Demolition*. Underwater demolitions are designed to train personnel in the destruction of mines, obstacles, or other structures in an area to prevent interference with friendly or neutral forces and noncombatants. It provides NSW and EOD teams experience detonating underwater explosives. Outer Apra Harbor supports this training near the Glass Breakwater at a depth of 125 feet and with up to a 10-pound net explosive weight (NEW) charge. Piti and Agat Bay Floating Mine Neutralization areas also support this type of training, with up to a 20-pound NEW charge.

Logistics and Combat Services Support. Logistics and combat services support include the following training activities.

- *Combat Mission Area Training.* Special Forces and EOD units conduct mission area training that supports their own and other services combat service needs in both the water and on land. At Orote Point Airfield/Runway, this task includes providing patrolling, scouting, observation, imagery, and air control services and training.
- *Command and* Control *(C2).* C2 training activities provide primary communications for command, control, and intelligence, providing critical interpretability and situation awareness information. EOD personnel have provided USMC C2 support at Reserve Craft Beach.

Combat Search and Rescue (CSAR). CSAR activities train rescue forces personnel in the tasks needed to be performed to affect the recovery of distressed personnel during war or military operations other than war. These training activities could include aircraft, surface ships, submarines, ground forces (NSW and Marine Corps), and their associated personnel in the execution of training events. North Field on Tinian has supported night vision goggle (NVG) familiarization training for CSAR personnel.

Protect and Secure Area of Operations. The following training activities are included in this training category.

- *Embassy Reinforcement (Force Protection)*. Force protection training increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers; detection and assessment of threats; delay or denial of access of the adversary to their target; appropriate response to threats and attack; and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures. Base Naval Security Forces and Marine Support Squadrons frequently conduct force protection training throughout the Main Base, but all forces will participate in force protection training to some degree in multiple locations throughout the MIRC, including: Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Airfield/Runway, Orote Point Close Quarters Combat House, Orote Point Radio Tower, and Orote Point Triple Spot.
- *Anti-Terrorism (AT).* AT training activities concentrate on the deterrence of terrorism through active and passive measures, including the collection and dissemination of timely threat information, conducting information awareness programs, coordinated security plans, and personal training. The goal is to develop protective plans and procedures based upon likely threats and strike with a reasonable balance between physical protection, mission requirements, critical assets and facilities, and available resources to include manpower. AT training activities may involve units of Marines dedicated to defending both U.S. Navy and Marine Corps assets from terrorist attack. The units are designated as the Fleet Anti-Terrorism Security Team, or FAST. FAST Company Marines augment, assist, and train installation security when a threat condition is elevated beyond the ability of resident and auxiliary security forces. They are not designed to provide a permanent security force for the installation. They also ensure nuclear material on submarines is not compromised when vessels are docked. FAST Companies deploy only upon approval of the Chief of Naval Operations (CNO). USMC Security Force FAST Platoons stationed in Yokuska, Japan have conducted AT training with Base Naval Security, NSW, and EOD support in multiple locations within the MIRC, includin: Inner Apra Harbor, Polaris Point Site III, Ordnance Annex Breacher House, and Orote Annex Emergency Detonation Site.

Major Exercise — Training would also include either a joint expeditionary warfare exercise or a joint multi-strike group exercise. This exercise consists of combining the individual training activities described in the No Action Alternative in such a manner as to provide multi-Service and multi-national participation in realistic maritime and expeditionary training activity. This is designed to replicate the types of operations and challenges that could be faced during real-world contingency operations. Major exercises provide training for command elements, submarine, ship, aircraft, expeditionary, and special warfare forces in tactics, techniques, and procedures.

A.2.1.4 Air Force Training

Counter Land. Counter Land is similar in nature and content to the Navy's BOMBEX (Land). These activities have occurred at FDM and utilize ATCAA 3.

Counter Air. Counter air is single to multiple aircraft engaged in advanced, simulated radar, infrared (IR), or visual air-to-air training. During this training, aircraft may dispense chaff and flares as part of missile defense training. Flares are high incendiary devices meant to decoy IR missiles. Burn time for flares usually lasts from 3 to 5 seconds. Chaff exercises train aircraft and/or shipboard personnel in the use of chaff to counter anti-ship and anti-aircraft missile threats. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, which are used to reflect echoes to deceive radars. During a chaff exercise, the chaff layer combines aircraft maneuvering with deployment of multiple rounds of chaff to confuse incoming missile threats. In an integrated Chaff Exercise scenario, ships/helicopters/fixed wing craft will deploy ship- and air-launched, rapid bloom offboard chaff in preestablished patterns designed to enhance missile defense. Chaff exercises have been conducted in W-517 and ATCAA 1 & 2.

Airlift. Airlift operations provide airlift support to combat forces. Airlift operations and training activity have occurred at Andersen Air Force Base and Northwest Field.

Air Expeditionary. This type of training provides air expeditionary operations support to forward deployed forces. Northwest Field on Andersen Air Force Base is used in support of forward/expeditionary training and is available as an alternate landing and laydown site for short field capable aircraft. Andersen South is utilized to support MOUT type training.

Force Protection. This type of training is to provide force protection to individuals, buildings, and specific areas of interest. Force protection training has occurred on Andersen Air Force Base at Northwest Field, Pati Pt. CATM Range, and Main Base.

A.2.1.5Research, Development, Test and Evaluation Activities

The Services may conduct RDT&E, engineering, and fleet support for command, control, and communications systems and ocean surveillance in the MIRC. These activities may include ocean engineering, missile firings, torpedo testing, manned and unmanned submersibles testing, UAV tests, EC, and other DoD weapons testing.

A.3 ALTERNATIVE 1— CURRENT TRAINING, INCREASED TRAINING SUPPORTED BY MODERIZATION AND UPGRADES/MODIFICATIONS TO EXISTING CAPABILITIES, TRAINING ASSOCIATED WITH ISR/STRIKE, AND MULTI-NATIONAL AND/OR JOINT EXERCISES

Alternative 1 is a proposal designed to meet the Services' current and foreseeable training requirements. If Alternative 1 were to be selected, in addition to accommodating the No Action Alternative, it would include increased training as a result of upgrades and modernization of existing capabilities, and include establishment of a danger zone and restricted area around FDM (a 10-nm zone around FDM to be established in accordance with C.F.R. Title 33 Part 334; see Figure A-4). Alternative 1 also includes training associated with ISR/Strike and other Andersen AFB initiatives. Training will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range (PUTR) capabilities. PUTR trains personnel in undersea warfare including conducting TRACKEX and TORPEX activities. Helicopter, ship, and submarine sonar systems will use this capability. Small arms range capability improvements and MOUT training facility improvements would also increase training activities. Table A-8 summarizes these increases in training activities. These increased capabilities will result in increased multi-national and/or joint exercises.

Alternative 1 meets the Proposed Action's purpose and need; however this Alternative does not optimize the training capabilities of the MIRC.

A.3.1 MAJOR EXERCISES

Training would increase to include additional major exercises involving multiple strike groups and expeditionary task forces (see Table A-6). Major exercises provide multi-Service and multi-national participation in realistic maritime and expeditionary training that is designed to replicate the types of operations and challenges that could be faced during real-world contingency operations. Major exercises provide training for command elements, submarine, ship, aircraft, expeditionary, and special warfare forces in tactics, techniques, and procedures.

(Note: the *Guam and CNMI Military Relocation EIS/OEIS* is being prepared for the relocation of Marine Corps forces from Okinawa to Guam. The Military Relocation EIS/OEIS examines the potential impact from activities associated with the Marine Corps units' relocation, including training activities and infrastructure changes on and off DoD lands. Since the MIRC EIS/OEIS covers DoD training on existing DoD land and training areas in and around Guam and the CNMI, there will be overlap between the two EIS/OEISs in the area of land usage. These documents are being closely coordinated to ensure consistency.)

A.3.2 ISR/STRIKE

The Air Force has established the ISR/Strike program at Andersen AFB, Guam. ISR/Strike will be implemented in phases over a planning horizon of FY2007–FY2016. ISR/Strike force structure consists of up to 48 fighter, 12 aerial refueling, six bomber, and six unmanned aircraft with associated support personnel and infrastructure. Aircraft operations and training out of Andersen AFB ultimately will increase by 45 percent over the current level (FY2006). Environmental impacts associated with ISR/Strike have been analyzed in the *2006 Establishment and Operation of an Intelligence, Surveillance and Reconnaissance/Strike, Andersen Air Force Base, EIS*. The anticipated 45 percent increase in aircraft operations and training out of and into Andersen AFB requires improved range infrastructure to accommodate this increased training tempo, newer aircraft, and weapon systems commensurate with ISR/Strike force structure. There will be increased activity on all the current training areas supporting Air Force training activities: W-517, ATCAAs, and FDM/R-7201. The ISR/Strike EIS analyzed environmental impacts related to the infrastructure improvements required. This EIS/OEIS analyzes the impacts of the increased training resulting from the ISR/Strike implementation.

A.3.3 FDM

Public access to FDM is strictly prohibited and there are no commercial or recreational activities on or near the island. During training exercises, marine vessels are restricted within a 3-nm (5-km) radius. Notice to Mariners (NOTMAR) and Notice to Airmen (NOTAM) are issued at least 72 hours in advance of potentially hazardous FDM range events and may advise restrictions beyond 3 to 30 nm (5-56 km) from FDM or greater for certain training events. These temporary advisory restrictions are used to maintain the safety of the military and the public during training sessions by providing public notice of potentially hazardous training activity and temporary danger zones and restriction areas.

As usage of FDM increases under implementation of either Alternative 1 or Alternative 2, a danger zone and restricted area would be established to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area. Development of a 10-nm (18-km) danger zone and restricted area would be an established restriction, supplemented by temporary advisory notices as required.

A.3.4 MODERNIZATION AND UPGRADES OF TRAINING AREAS

Anti-Submarine Warfare (ASW). ASW describes the entire spectrum of platforms, tactics, and weapon systems used to neutralize and defeat hostile submarine threats to combatant and non-combatant maritime forces. A critical component of ASW training is the Underwater Tracking Range (UTR). This is an instrumented range that allows near real-time tracking and feedback to all participants. The tracking range should provide for both a shallow water and deep water operating environment, with a variety of bottom slope and sound velocity profiles similar to potential contingency operating areas. Guam-homeported submarine crews, as well as crews of transient submarines, require ASW training events to maintain qualifications. A MIRC instrumented ASW PUTR, target support services, and assigned torpedo retriever craft would meet support requirements for TORPEX and TRACKEX activities in the MIRC in support of Fast Attack Submarine (SSN) and Ballistic Missile Submarine (SSBN) and other deployed forces.

Military Operations in Urban Terrain (MOUT). MOUT training is conducted within a facility that replicates an urban area, to the extent practicable. The urban area includes a central urban infrastructure of buildings, blocks, and streets; an outlying suburban residential area; and outlying facilities. Suburban area structures should represent a local noncombatant populace and infrastructure. The MIRC will need to repair and upgrade the existing MOUT facilities to support training requirements of units stationed at or deployed to the MIRC.

A.4 ALTERNATIVE 2— CURRENT TRAINING, INCREASED TRAINING SUPPORTED BY MODERIZATION AND UPGRADES/MODIFICATIONS TO EXISTING CAPABILITIES, TRAINING ASSOCIATED WITH ISR/STRIKE, AND INCREASED MULTI-NATIONAL AND/OR JOINT EXERCISES; INCLUDING ADDITIONAL UNDERSEA EXERCISES

Implementation of Alternative 2 would include all the actions proposed for MIRC in Alternative 1 and increased training activity associated with major at-sea exercises (see Tables A-6 and A-7). Additional major at-sea exercises would provide additional ships and personnel maritime training including additional use of sonar that would improve the level of joint operating skill and teamwork between the Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures required in carrying out the primary mission areas of maritime forces. The additional maritime exercises would take place within the MIRC and would focus on carrier strike group training and ASW activities similar to training conducted in other Seventh Fleet locations, including a Fleet Strike Group Exercise, an Integrated ASW Exercise, and a Ship Squadron ASW Exercise.

Major Exercise. The Fleet Strike Group Exercise and an additional Integrated ASW exercise would be conducted in the MIRC by forward-deployed Navy Strike Groups to sustain or assess their proficiency in conducting tasking within the Seventh Fleet. Training would be focused on conducting Strike Warfare or ASW in the most realistic environment, against the level of threat expected in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of the Navy Strike Group. Although these exercises would emphasize Strike or ASW, there is significant training value inherent in all at-sea exercises and the opportunity to exercise other mission areas. Each exercise would last a week or less.

The Ship Squadron ASW Exercise overall objective is to sustain and assess surface ship ASW readiness and effectiveness. The exercise typically involves multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less. Maximizing opportunities to collect high-quality data to support quantitative analysis and assessment of training activities is an additional goal of this training.

Table A-6. Major Exercises in the MIRC Study Area

MIRC EIS/OEIS		Major Exercises							
Exercise		Joint Expeditionary Exercise (CSG + ESG)	Joint Multi-strike Group Exercise (3 CSG + USAF)	Fleet Strike Group Exercise (CSG)	Integrated ASW Exercise (CSG)	Ship Squadron ASW Exercise (CRU DES)	MAGTF Exercise (STOM/ NEO)	SPMAGTF Exercise (HADR/ NEO)	Urban Warfare Exercise
Exercise Sponsor		US PACOM	US PACOM	C7F	C7F	C7F	III MEF	III MEF; MEU/UDP	III MEF; MEU/ UDP
Alternative: No Action		1 of the above		0	0	0	1	0	2
Alternative 1		1	1	0	0	0	4	2	5
Alternative 2		1	1	1	1	1	4	2	5
Primary Training Site		Tinian	MI Maritime >12 nm	MI Maritime >12 nm	MI Maritime >3 nm	MI Maritime >3 nm	Tinian	Guam	Guam
Secondary Training Sites		Nearshore to OTH: Guam: Rota; Saipan; FDM	FDM	FDM	FDM	N/A	Nearshore to OTH: Guam: Rota; Saipan; FDM	Tinian, Rota, Saipan	Tinian, Rota, Saipan
Exercise Footprint	Activity Days per Exercise	10	10	7	5	5	10	10	7-21
NAVY SHIPS	CVN	1	3	1	1	0	0	0	0
	CG	1	3	1	1	1	0	0	0
	FFG	2	3	1	1	1	1	0	0
	DDG	5	12	3	3	3	2	0	0
	LHD/ LHA	1	0	1	0	0	1	1	1
	LSD	2	0	0	0	0	2	1	1
	LPD	1	0	0	0	0	1	1	1
	TAOE	1	3	1	0	0	0	0	N/A
	SSN	1	5	1	1	1	0	0	N/A
	SSGN	1	0	0	0	0	1	0	0
	TR	N/A	N/A	0	0	0	N/A	N/A	N/A
Partner National Ships	CG	1	0	0	0	0	0	0	N/A
	DDG	2	0	0	0	0	0	0	N/A
	SS	1	1	0	0	0	0	0	N/A
FIXED WING	F/A-18	4 Squadrons	12 Squadrons	4 Squadrons	4 Squadrons	N/A	N/A	N/A	N/A
	EA-6B	1 Squadron	3 Squadrons	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A
	E-2	1 Squadron	3 Squadrons	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A
	MPA (P-3)	3	5	3	3	3	N/A	N/A	N/A
	AV-8B	1 Squadron	N/A	1 Squadron	N/A	N/A	N/A	N/A	N/A
	C-130	2	N/A	N/A	N/A	N/A	1	1	1
	USAF Bomber	N/A	1 Squadron	N/A	N/A	N/A	N/A	N/A	N/A
	F-15/16/22	N/A	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A	N/A
	A-10	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	E-3	1	1	1	N/A	N/A	N/A	N/A	N/A
	KC-10/135/130	1	2	1	N/A	N/A	N/A	N/A	N/A

Table A-6. Major Exercises in the MIRC Study Area (continued)

MIRC EIS/OEIS		Major Exercises							
Exercise		Joint Expeditionary Exercise (CSG + ESG)	Joint Multi-strike Group Exercise (3 CSG + USAF)	Fleet Strike Group Exercise (CSG)	Integrated ASW Exercise (CSG)	Ship Squadron ASW Exercise (CRU DES)	MAGTF Exercise (STOM/ NEO)	SPMAGTF Exercise (HADR/ NEO)	Urban Warfare Exercise
ROTARY	MH-60R/S	4	12	4	4	4	2	N/A	N/A
	SH-60H	4	12	4	4	4	N/A	N/A	N/A
	HH-60H	4	12	4	4	N/A	N/A	N/A	N/A
	SH-60F	3	9	3	3	N/A	N/A	N/A	N/A
	CH-53	4	N/A	4	N/A	N/A	4	4	4
	CH-46	12	N/A	12	N/A	N/A	12	12	12
	AH-1	4	N/A	4	N/A	N/A	4	4	4
	UH-1	2	N/A	2	N/A	N/A	2	2	2
	MV-22 FY10 (replace CH-46)	10	N/A	10	N/A	N/A	10	10	10
UAS	Ship Based	2	3	1	1	0	1	0	0
	Ground Based	2	1	0	0	0	2	1	1
Landing Craft	LCAC	3-5	N/A	N/A	N/A	N/A	3-5	3	N/A
	LCU	1-2	N/A	N/A	N/A	N/A	1-2	1	N/A
	CRRC	18	N/A	N/A	N/A	N/A	18	18	0
GCE	AAV	14	N/A	N/A	N/A	N/A	14	3	3
	LAV	13	N/A	N/A	N/A	N/A	5	5	5
	HMMWV	78	N/A	N/A	N/A	N/A	78	16	16
	Ground Personnel	1200	N/A	N/A	N/A	N/A	1200	250	250
LCE	Trucks	36	N/A	N/A	N/A	N/A	36	8	8
	Dozer	2	N/A	N/A	N/A	N/A	2	1	1
	Forklift	6	N/A	N/A	N/A	N/A	6	2	2
	ROWPU	2	N/A	N/A	N/A	N/A	2	1	1
	RHIB	2	N/A	N/A	N/A	N/A	2	2	2
	Ground Personnel	300	N/A	N/A	N/A	N/A	300	60	60

Table A-7. Annual Training Activities in the MIRC Study Area

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Anti-Submarine Warfare (ASW)						
ASW TRACKEX (SHIP)	CG/ DDG / FFG SUB/ MK-30/ EMATT	SQS-53C/D SQS-56	10	30	60	PRI: W-517 SEC: MI Maritime, >3 nm from land
ASW TRACKEX (SUB)	SSN; SSGN MK-30	BQQ	5	10	12	PRI: Guam Maritime, >3 nm from land SEC: W-517
ASW TRACKEX (HELO)	SH-60B, SH-60F SUB/ MK-30/ EMATT	AQS-22 DICASS	9	18	62	PRI: W-517 SEC: MI Maritime, >3 nm from land
ASW TRACKEX (MPA)	FIXED WING MPA SUB/ MK-30/ EMATT	DICASS EER/IEER/AEER	5	8	17	PRI: W-517 SEC: MI Maritime, >3 nm from land
ASW TORPEX (SUB)	SSN; SSGN MK-30 TRB / MH-60S	BQQ MK-48 EXTORP	5	10	12	PRI: Guam Maritime, >3 nm from land SEC: W-517
ASW TORPEX (SHIP)	CG/ DDG / FFG SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	SQS-53C/D SQS-56 REXTORP	0	3	6	PRI: Guam Maritime, >3 nm from land SEC: W-517
ASW TORPEX (MPA / HELO)	MPA / SH-60B/F, SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	AQS-22 / DICASS REXTORP	0	4	8	PRI: Guam Maritime, >3 nm from land SEC: W-517

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
MineINE WarfareARFARE (MIW)						
MINEX	B-1/ B-2/ B-52/ FA-18	MK-62 / MK-56	2	3	3	PRI: W-517 SEC: MI Maritime, >12 nm from land
Underwater Demolition	RHIB	Bottom/mid-moored mine shape 5 – 20 lb NEW	22	30	30	PRI: Agat Bay SEC: Apra Harbor (10lb max)
Floating Mine Neutralization	RHIB	Floating mine shape 5 – 20 lb NEW	8	20	20	PRI: Agat Bay SEC: Piti
Surface Warfare (SUW)						
SINKEX	Ship hulk or barge	HARM [2] SLAM-ER [14] HARPOON [5] 5" Rounds [400] HELLFIRE [2] MAVERICK [8] GBU-12 [10] GBU-10 [4] MK-48 [1] Underwater Demolitions [2 -100lb]	1	2	2	PRI: W-517 SEC: MI Maritime, >50 nm from land; ATCAAs
BOMBEX (Air to Surface)	FA-18; AV-8B; MPA (MK 58 Smoke tgt. or towed sled)	MK 82 I; BDU-45; MK 76 (Inert Rounds)	16 (48 rounds)	24 (72 rounds)	30 (90 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs
GUNEX Surface-to-Surface (Ship)	LHA, LHD, LSD, and LPD. Barrel, Inflatable tgt.	.50 cal MG	1 (2,400 rounds)	5 (12,000 rounds)	5 (12,000 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land
		.25 mm MG	1 (1,600 rounds)	5 (8,000 rounds)	5 (8,000 rounds)	
	CG and DDG. Barrel or Inflatable tgt. or towed sled.	5" gun	4 (160 rounds)	8 (320 rounds)	10 (400 rounds)	
	FFG. Barrel or Inflatable tgt. or towed sled.	76 mm	2 (60 rounds)	4 (120 rounds)	5 (150 rounds)	

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Surface Warfare (SUW) (continued)						
GUNEX Surface-to-Surface (Small arms)	Ship, RHIB, small craft. Barrel or Inflatable tgt.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm TP)	24 (12,000 rounds)	32 (16,000 rounds)	40 (20,000 rounds)	PRI: MI Maritime, >3 nm from land SEC: W-517
GUNEX Air-to-Surface	SH-60; HH-60; MH-60R/S; UH-1; CH-53; FA-18; AH-1W; F-15; F16; F-22; AV-8B; A-10 (Barrel or MK-58 smoke tgt.)	7.62 mm MG	150 (30,000 rounds)	200 (40,000 rounds)	200 (40,000 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs
		.50 cal MG	10 (2,000 rounds)	20 (4,000 rounds)	20 (4,000 rounds)	
		20 mm cannon	50 (5,000 rounds)	100 (10,000 rounds)	100 (10,000 rounds)	
		25 mm cannon	10 (1,000 rounds)	40 (4,000 rounds)	40 (4,000 rounds)	
		30 mm cannon	0	15 (1,500 rounds)	15 (1,500 rounds)	
Visit, Board, Search and Seizure/Maritime Interception Operation (VBSS/MIO)	RHIB, Small Craft, Ship, H-60	n/a	3	6	8	PRI: Apra Harbor SEC: MI Maritime
Electronic Combat						
CHAFF Exercise	SH-60; MH-60; HH-60; MH-53	RR-144A/AL	12 sorties (360 rounds)	14 sorties (420 rounds)	14 sorties (420 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
	FA-18; EA-18; AV-8B; MPA; EA-6	RR-144A/AL	16 sorties (160 rounds)	32 sorties (320 rounds)	48 sorties (500 rounds)	
	F-15; F-16; C-130	RR-188	150 sorties (1,500 rounds)	500 sorties (5,000 rounds)	550 sorties (5,500 rounds)	
	CG, DDG, FFG, LHA, LHD, LPD, LSD	MK 214 (seduction); MK 216 (distraction)	12 (72 canisters)	16 (90 canisters)	20 (108 canisters)	

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Electronic Combat (EC) (continued)						
FLARE Exercise	SH-60; MH-60; HH-60; MH-53	MK 46 MOD 1C; MJU-8A/B; MJU-27A/B; MJU-32B; MJU-53B; SM-875/ALE	12 sorties (360 flares)	14 sorties (420 rounds)	14 sorties (420 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
	FA-18; EA-18; AV-8B; MPA; EA-6		16 sorties (160 rounds)	32 sorties (320 rounds)	48 sorties (500 rounds)	
	F-15; F-16; C-130	MJU-7; MJU-10; MJU-206	4 sorties (1,500 rounds)	500 sorties (5,000 rounds)	550 sorties (5,500 rounds)	
Strike Warfare (STW)						
BOMBEX (LAND)	FA-18; AV-8B; B-1; B-2; B-52; F-15; F-16; F-22; A-10	High Explosive Bombs ≤ 500 lbs	400 annually	500 annually	600 annually	FDM (R-7201)
		High Explosive Bombs: 750 / 1,000 lbs / 2,000 lbs	1,600 annually	1,650 annually	1,700 annually	
		Inert Bomb Training Rounds ≤ 2,000 lbs	1,800 annually	2,800 annually	3,000 annually	
		Total Sorties (1 aircraft per sortie):	1,000 sorties	1,300 sorties	1,400 sorties	
MISSILEX A-G	FA-18; AV-8B; F-15; F-16; F-22; A-10; MH-60R/S; SH-60B; HH-60H; AH-1	TOW; MAVERICK; HELLFIRE; ROCKETS ≤ 5”	30 annually	60 annually	70 annually	FDM (R-7201)
GUNEX A-G	FA-18; AV-8B; F-15; F-16; F-22; A-10; MH-60R/S; SH-60B; HH-60H; AH-1; AC-130	20 OR 25 MM CANNON	16,500 rounds	20,000 rounds	22,000 rounds	FDM (R-7201)
		30 MM CANNON (A-10)	0	1,500 rounds	1,500 rounds	
		40mm or 105mm CANNON (AC-130)	100 rounds	200 rounds	200 rounds	
Combat Search aAnd Rescue (CSAR)	SH-60; MH-60; HH-60; MH-53; CH-53; C-17; C-130; V-22	NIGHT VISION	30 sorties	60 sorties	75 sorties	PRI: Tinian North Field: Guam Northwest Field SEC: Orote Point Airfield; Rota Airport
Air Warfare (AW)						
Air Combat Manuevers (ACM)	FA-18; AV-8B; F-15; F16.	Captive Air Training Missile (CATM) or Telemetry Pod	360 sorties of 2-4 aircraft per sortie	720 sorties of 2-4 aircraft per sortie	840 sorties 2-4 aircraft per sortie	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
Air Intercept Control	FA-18; F-15	Search and Fire Control Radars	40 sorties (2-4 aircraft) 20 events	80 sorties (2-4 aircraft) 40 events	100 sorties (2-4 aircraft) 50 events	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Air Warfare (AW) (continued)						
MISSILEX / GUNEX Air-to-Air	FA-18; EA-18; AV-8B. TALD tgt.	AIM-7 Sparrow (Non Explosive). 20mm or 25 mm cannon.	4 sorties (2-4 aircraft) (4 missiles; 1,000 rounds)	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	8 sorties (2-4 aircraft) (8 missiles; 2,000 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
		AIM-9 Sidewinder (HE)/AIM-120 (HE or Inert). 20mm or 25 mm cannon.AIM-9 Sidewinder (HE). 20mm or 25 mm cannon.	4 sorties (2-4 aircraft) (4 missiles; 1,000 rounds)	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	8 sorties (2-4 aircraft) (8 missiles; 2,000 rounds)	
MISSILEX Ship-to-Air	CVN, LHD, CG, DDG; BQM-74E.	RIM-7 Sea Sparrow RIM-116 RAM RIM-67 SM-II ER	1 (1 missile)	2 (2 missile)	2 (2 missile)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
Amphibious Warfare (AMW)						
FIREX (Land)	CG, DDG	5” Guns and (HE) shells	4 (400 rounds)	8 (800 rounds)	10 (1,000 rounds)	FDM (R-7201)
Amphibious Assault Marine Air Ground Task Force (MAGTF)	1 LHA or LHD, 1 LPD, 1 LSD, 1 CG or DDG, and 2 FFG.	4-14 AAV/EFV or LAV/LAR; 3-5 LCAC; 1-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	1 event (assault, offload, backload)	5 events (assault, offload, backload)	5 events (assault, offload, backload)	PRI: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field. SEC: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Sumay Cove and MWR Ramp
Amphibious Raid Special Purpose MAGTF	1 LHA or LHD, 1 LPD, and 1 LSD. Tailored MAGTF.	4-14 AAV/EFV or LAV/LAR; 0-5 LCAC; 0-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	0	2 events (raid, offload, backload)	2 events (raid, offload, backload)	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

<table>
<tr><th>Range Activity</th><th>Platform</th><th>System or Ordnance</th><th>No Action Alternative</th><th>Alternative 1</th><th>Alternative 2</th><th>Location</th></tr>
<tr><td colspan="7">Expeditionary Warfare</td></tr>
<tr><td rowspan="4">Military Operations in Theater (MOUT) Training</td><td>USMC Infantry Company: AH-1, UH-1; H-46 or MV-22; H-53; AAV, LAV, HMMWV, TRUCK</td><td rowspan="4">5.56 mm blanks/Simulations</td><td>2 events, 7-21 days/event</td><td>5 events of 7-21 days/event</td><td>5 events of 7-21 days/event</td><td rowspan="4">PRI: Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Northwest Field SEC: Tinian; Rota; Saipan</td></tr>
<tr><td>USAF RED HORSE SQUADRON: TRUCK, HMMWV; MH-53; H-60</td><td>2 events, 3-5 days/event</td><td>4 events, 3-5 days/event</td><td>4 events, 3-5 days/event</td></tr>
<tr><td>Navy NECC Company: HMWWV, TRUCK</td><td>2 events, 3-5 days/event</td><td>4 events, 3-5 days/event</td><td>4 events, 3-5 days/event</td></tr>
<tr><td>Army Reserve/GUARNG Company; HMWWV, TRUCK</td><td>2 events, 3-5 days/event</td><td>4 events, 3-5 days/event</td><td>4 events, 3-5 days/event</td></tr>
<tr><td colspan="7">Special Warfare</td></tr>
<tr><td rowspan="2">Direct Action</td><td>SEAL Tactical Air Control Party (TAC-P); RHIB; Small Craft.</td><td>M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm HE)</td><td>2 (2,000 rounds)</td><td>3 (3,000 rounds)</td><td>3 (3,000 rounds)</td><td>FDM (R-7201)</td></tr>
<tr><td>SEAL Platoon/Squad; NECC Platoon/Squad; USMC Platoon/Squad; ARMY Platoon/Squad; USAF Platoon/Squad</td><td>5.56 mm blanks/Simulations 9mm (Orote Pt. Combat Qualification Center - OPCQC) 1.5 lb NEW C4 (Navy Munitions Site Breaching House)</td><td>32 (12,500 9mm) (10.5 lb NEW C4)</td><td>40 (15,000 9mm) (15 lb NEW C4)</td><td>48 (17,500 9mm) (19.5 lb NEW C4)</td><td>PRI: OPCQC and Navy Munitions Site Breacher House SEC: Tarague Beach CQC and Navy Munitions Site Breacher House.</td></tr>
</table>

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special Warfare (SW) (ccontinued)						
Military Operations iln Theater (MOUT) Training	SEAL Platoon/Squad; EOD Platoon/Squad; HMWWV; TRUCK	5.56 mm blanks/Simulations	6 events of 3-5 days/event	8 events of 3-5 days/event	10 events of 3-5 days/event	PRI: Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Navy Munitions Site Breaching House SEC: Tinian; Rota; Saipan
Parachute Insertion	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad USAF Platoon/Squad; C-130; CH-46; H-60	Square Rig or Static Line	6	12	12	PRI: Orote Pt. Airfield; Northwest Airfield; Orote Pt. Triple Spot SEC: Finegayan DZ; Apra Harbor; Navy Munitions Site Breacher House
Insertion/ Extraction	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad; USAF Platoon/Squad: RHIB; Small Craft; CRRC; H-60; H-46 or MV-22	Square Rig or Static Line; Fastrope; Rappel; SCUBA	104	150	150	PRI: Orote Pt. Airfield; Northwest Field; Orote Pt. Triple Spot; Apra Harbor; Gab Gab Beach SEC: Orote Pt. CQC; Finegayan DZ; Haputo Beach; Munitions Site Breacher House; Polaris Pt. Field; Orote Pt. KD Range
Hydrographic Surveys	SEAL Platoon/Squad; EOD Platoon/Squad; USMC Platoon/Squad; Small Craft; RHIB; CRRC; H-60	SCUBA	3	6	6	PRI: FDM; Tinian; Tipalao Cove SEC: Haputo Beach; Gab Gab Beach; Dadi Beach
Breaching (Buildings, Doors)	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad;	Breach House (1 lbs NEW C4 max/door)	10 (15 lbs NEW C4)	20 (30 lbs NEW C4)	20 (30 lbs NEW C4)	Navy Munitions Site Breacher House

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special/Expeditionary Warfare						
Land Demolitions (IED Discovery/ Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	IED Shapes	60	120	120	PRI: Guam, Orote Pt. Airfield; Orote Pt. CQC; Polaris Pt. Field; Andersen South; Northwest Field SEC: Northern/Southern Land Navigation Area; Munitions Site Breacher House; Tinian MLA
Land Demolitions (UXO Discovery/ Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	UXO	100	200	200	PRI: Navy Munitions Site EOD Disposal Site (limit 3000 lbs NEW per UXO event) SEC: AAFB EOD Disposal Site (limit 100 lbs per event)
Seize Airfield	SEAL Company/ Platoon USMC Company/ Platoon ARMY Company/ Platoon USAF Squadron C-130; MH-53; H-60; HMWWV; TRUCK	5.56 mm blank/Simulationsimunitions	2	12	12	PRI: Northwest Field SEC: Orote Pt. Airfield; Tinian North Field
Airfield Expeditionary	USAF RED HORSE Squadron. NECC SEABEE Company. USMC Combat Engineer Company USAR Engineer Dozer, Truck, Crane, Forklift, Earth Mover, HMMWV. C-130; H-53.	Expeditionary Airfield Repair and Operation	1	12	12	PRI: Northwest Field SEC: Orote Pt. Airfield; Tinian North Airfield

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special/Expeditionary Warfare (cContinued)						
Intelligence, Surveillance, Reconnaissance (ISR)	SEAL Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad; USAF Platoon/Squad	Night Vision; Combat Camera; 5.56 mm blanks/Simunition	12	16	16	PRI: Guam; Northwest Field; Barrigada Housing; Finegayan Comm. Annex; Orote Pt. Airfield. SEC: Tinian, Rota, Saipan
Field Training Exercise (FTX)	ARMY Company/ Platoon NECC SEABEE Company/ Platoon	Tents; Trucks; HMMWV; Generators	100 events, 2-3 days per event	100 events, 2-3 days per event	100 events, 2-3 days per event	PRI: Guam, Northwest Field; Northern Land Navigation Area SEC: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field.
Non-Combatant Evacuation Operation (NEO)	Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 or MV-22	1 event, 3-5 days	2	2	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.
MANEUVER (Convoy; Land Navigation)	USMC Company/Platoon Army Company/Platoon	Trucks; HMWWV;AAV/LAV	8	16	16	PRI: Northwest Field; AAFB South; Northern and Southern Land Navigation Area; Tinian MLA SEC: Finegayan Annex; Barrigada Annex; Orote Pt. Airfield;

Table A-7. Annual Training Activities in the MIRC Study Area (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special/Expeditionary Warfare (continued)						
Humanitarian Assistance/ Disaster Relief Operation (HADR)	Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 or MV-22	1 event, 3-5 days	2	2	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.
Force Protection / Anti-Terrorism						
Embassy Reinforcement	SEAL Platoon ARMY Platoon USMC Company/ Platoon Trucks; HMMWV; C-130; H-60; H-53	5.56 mm blanks/Simulationsmunitions	42 events, 1-2 days per event	50 events, 2-3 days per event	50 events, 2-3 days per event	PRI: Orote. Pt. Airfield Inner Apra Harbor; Northern and Southern Land Navigation Area SEC: Orote Pt. Triple Spot; Orote Pt. CQC; Kilo Wharf
Force Protection	USAF Squadron/ Platoon NECC SEABEE Company/ Platoon USAR Engineer Company/ Platoon Tents; Trucks; HMMWV; Generators	5.56 mm blanks/Simulations	60 events, 1-2 days per event	75 events, 1-2 days per event	75 events, 1-2 days per event	PRI: Guam, Northwest Field; Northern Land Navigation Area; Barrigada Annex SEC: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field.
Anti- Terrorism	Navy Base Security USAF Security Squadron USMC FAST Platoon Trucks; HMMWV; MH-60	5.56 mm blanks/Simulations	80 events, 1 day/event	80 events, 1 day/event	80 events, 1 day/event	PRI: Tarague Beach Shoot House and CATM Range; Polaris Pt.; Northwest Field. SEC: Kilo Wharf; Finegayan Comm. Annex; Navy Munitions Site; AAFB Munitions Site

Table A-8: Summary of Ordnance Use by Training Area in the MIRC Study Area[1]

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
FDM (R-7201)			
Bombs (HE) ≤ 500 lb	400	500	600
Bombs (HE) 750 / 1000 / 2000 lb	1,600	1,650	1,700
Inert Bomb Training Rounds ≤ 2000 lb	1,800	2,800	3,000
Missiles [Maverick; Hellfire; TOW]	30	60	70
Cannon Shells (20 or 25 mm)	16,500	20,000	22,000
Cannon Shells (30 mm)	0	1,500	1,500
AC-130 Cannon Shells (40mm or 105mm)	100	200	200
5-inch Gun Shells	400	800	1,000
Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]	2,000	3,000	3,000
PRI: Guam Maritime > 3 nm from land SEC: W-517			
MK-48 EXTORP	20	40	48
MK-46 or MK-50 REXTORP	0	7	14
MK-84 SUS (Signal Under Surface Device, Electro-Acoustic)	20	40	48

Table A-8. Summary of Ordnance Use by Training Area in the MIRC Study Area[1] (continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
PRI: W-517 **SEC: Marianas Maritime > 12 nm; ATCAAs**			
Air Deployed Mines [MK-62; MK-56]	320	480	480
Inert Bomb Training Rounds [MK-82 I; BDU-45; MK-76]	48	72	90
5-inch" Gun Shells	160	320	400
76 mm Gun Shells	60	120	150
.50 cal MG	4,400	16,000	16,000
25 mm MG	1,600	8,000	8,000
7.62 mm MG	30,000	40,000	40,000
20 mm; 25 mm; 30 mm Cannon Shells	8,000	18,500	19,500
RR-144A/AL Chaff Canisters	520	740	920
RR-188 Chaff Canisters	1,500	5,000	5,500
MK-214; MK-216 Chaff Canisters	72	90	108
MK-46 MOD 1C; MJU-8A/B; MJU-27A/B; MJU-32B; MJU-53B; SM-875/ALE Flares	520	740	920
MJU-7; MJU-10; MJU-206 Flares	1,500	5,000	5,500
AIM-7 Sparrow	4	6	8
AIM-9 Sidewinder	4	6	8
AIM-120 AMRAAM	4	6	8
RIM-7 Sea Sparrow/ RIM-116 RAM / **RIM-67 SM II ER**	12	24	26
PRI: Marianas Maritime > 3 nm **SEC: W-517**			
EER/IEER/AEER	103	106	115
5.56 mm; 7.62 mm; .50 cal; 40 mm	12,000	16,000	20,000

Table A-8. Summary of Ordnance Use by Training Area in the MIRC Study Area[1] (continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
PRI: W-517 **SEC: Marianas Maritime > 50 nm; ATCAAs**	**SINKEX**		
HARM	2	4	4
SLAM-ER	14	28	28
HARPOON	5	10	10
5-inc"h Gun Shells	400	800	800
HELLFIRE	2	4	4
MAVERICK	8	16	16
GBU-12	10	20	20
GBU-10	4	8	8
MK-48	1	2	2
Underwater Demolitions [100 lb NEW]	2	4	4
PRI: Agat Bay (20 lb NEW max) **SEC: Apra Harbor (10 lb NEW max)**	**Underwater Demolition**		
5 – 20 lb NEW	22	30	30
PRI: Agat Bay (20 lb NEW max) **SEC: Piti (20 lb NEW max)**	**Floating Mine Neutralization**		
5 – 20 lb NEW	8	20	20

[1.] Baseline ordnance expenditure estimates were made from review of FY2003-2007 Service records, databases, schedules, and estimates.

Table A-9. Summary of Sonar Activity by Exercise Type in the MIRC Study Area

Exercise Type	No Action	Alternative 1	Alternative 2
Multi-Strike Group: One; [3] CSG; April – September; [10] Days	Activity Guidelines Per CSG: [34] SQS-53C/D; [1] SQS-56 ; [2] Dips per hour; [1] EER/IEER/AEER per hour until 72100; [16] DICASS per hour; Reset Time -12 hours		
Events Per Year	0 or 1 (One Multi-Strike Group Exercise or One Joint Expeditionary Exercise)	1	1
SQS-53C/D	1705 hours	1705 hours	1705 hours
SQS-56	77 hours	77 hours	77 hours
AQS-21&1322	288 dips	288 dips	288 dips
DICASS	1282	1282	1282
Sub BQQ	00	00	00
EER/IEER/AEER	98	98	98
SINKEX : Two [2] Day Event	Activity Guidelines: Sonar Hours in TRACKEX/TORPEX below		
Events Per Year	1	2	2
DICASS	100	200	200
MK-48 (HE)	1	2	2
Joint Expeditionary: One [1] CSG + ESG; [10] Days	Activity Guidelines: [3] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below		
Events Per Year	0 or 1 (One Multi-Strike Group Exercise or One Joint Expeditionary Exercise)	1	1
Fleet Strike Group: One [1] CSG; [7] Days	Activity Guidelines: [34] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below		
Events Per Year	0	0	1
Integrated ASW: One [1] CSG; [5] Days	Activity Guidelines: [34] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below		
Events Per Year	0	0	1

Table A-9. Summary of Sonar Activity by Exercise Type in the MIRC Study Area (continued)

Exercise Type	No Action	Alternative 1	Alternative 2
Ship Squadron ASW: One [1] DESRON; [5] Days	Activity Guidelines: [4] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below		
Events Per Year	0	0	1
MAGTF Exercise (STOM/NEO)	Activity Guidelines: [2] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below		
Events Per Year	1	4	4
ASW TRACKEX (SHIP) : One [1] Reset, One [1] Day Event	Activity Guidelines: [2] SQS-53C/D, [1] SQS-56; Reset Time - 8 hours (sub target), 4 hours (non-sub target); [3] 53C/D, ½ Time Active, [1] 56, ¼ Time Active		
Events Per Year	10	30	60
SQS-53 C/D	120 hours	360 hours	720 hours
SQS-56	20 hours	60 hours	120 hours
ASW TRACKEX (HELO) : One [1] Reset, One [1] Day Event	Activity Guidelines: [2] SH-60B; [1] SH-60F 2 dips per hour; Reset Time - 8 hours (sub target), 4 hours (non-sub target)		
Events Per Year	9	18	62
AQS-22	144 dips	288 dips	576 dips
DICASS	36	72	144
ASW TRACKEX (MPA) : One [1] Reset, [1] Day Per Event	Activity Guidelines: [1] MPA; Reset Time - 8 hours (sub target), 4 hours (non-sub target)		
Events Per Year	5	8	17
DICASS	50	80	170
EER/IEER/AEER	5	8	17
ASW TORPEX (SUB) : One [1] Reset, [1] Day Per Event; [1] EXTORP Per Event	Activity Guidelines: [1] SSN or SSGN; Reset Time - 8 hours (sub target), 4 hours (non-sub target)		
Events Per Year	5	10	12
Sub BQQ	6 hours	12 hours	15 hours
MK-48 EXTORP	20	40	48

Table A-9. Summary of Sonar Activity by Exercise Type in the MIRC Study Area (continued)

Exercise Type	No Action	Alternative 1	Alternative 2
ASW TORPEX (SHIP) : One [1] Reset, [1] Day pPer Event; [1] REXTORP	Activity Guidelines: [32] SQS-53C/D, [1] SQS-56; Reset Time - 8 hours (sub target), 4 hours (non-sub target); ½ Time Active[1] Ship ½ Time, [2] Ship ½ Time		
Events pPer Year	0	3	6
SQS-53 C/D	0	8 hours	16 hours
SQS-56	0	4 hours	8 hours
REXTORP	0	03	6
ASW TORPEX (MPA/HELO) : One [1] Reset, One [1] Day Event; [1] REXTORP	Activity Guidelines: [2] SH-60B; [1] SH-60F; [1] MPA; Reset Time - 8 hours (sub target), 4 hours (non-sub target)		
Events pPer Year	0	4	8
AQS-21&1322	0	16 dips	32 dips
DICASS	0	20	40
REXTORP	0	4	8

APPENDIX B

Essential Fish Habitat

APPENDIX B
LIST OF FIGURES

APPENDIX B
LIST OF FIGURES
(Continued)

CORAL REEF ECOSYSTEM MANAGEMENT UNIT SPECIES

Acanthuridae (Surgeonfishes)

Status - Twenty-four of the 25 species of surgeonfish managed in Micronesia as part of the CHCRT by the WPRFMC (2001) occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, another 14 species of surgeonfishes are found in the MIRC study and have EFH designated under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if surgeonfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Surgeonfish are an important food source and are typically caught by spearfishing or nets as part of the traditional fishery in the insular and coastal region with coral reefs (Randall 2001a). They are also valuable in the aquarium trade. Aquarium species are discussed further as part of a separate management unit species assemblage (WPRFMC 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Surgeonfish are found circumtropically around coral reefs with the majority of the species occurring in the Pacific and Indian Oceans (Allen and Steene 1987).

Habitat Preferences - Surgeonfish are diurnal herbivores and planktivores seeking shelter on the reef at night. These fishes are associated with many of the major coral reef habitat types including mid-water, sand patch, subsurged reef, and seaward or surge zone reef. As juveniles, surgeonfish are found in reef areas until mature. Adults are found throughout coral reef habitats and are typically associated with subsurge reef habitats. They are found at depths from 0 to 150 m, but are commonly found between 0 and 30 m deep (WPRFMC 2001).

Life History - Many species of surgeonfish form large single-species or mixed-species schools (some numbering in the thousands) which are often associated with spawning or feeding behavior. Certain species of Acanthurids migrate 500 to 600 m daily for feeding (WPRFMC 2001). Spawning activities are often associated with the lunar cycle and occur throughout the year with peak activity during the winter and early spring (Myers 1999). Surgeonfish may also spawn during a new moon or full moon depending on species and geography (Kuiter and Debelius 2001). Generally, spawning occurs at dusk involving groups, pairs, or both (Myers 1999). Surgeonfish eggs and larvae have a wide distribution and are found in pelagic waters (Myers 1999).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Adult and Juveniles</u> - All bottom habitat and the adjacent water column from 0 to 100 m.

Blastulae (Triggerfish's)

Status - Nine species of triggerfish are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Eight additional species of triggerfish are found in the MIRC study area and have EFH designated under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if triggerfish's of the CHCRT are approaching an overfished situation (NMFS 2004a). Triggerfish are an important food fish in western Pacific and some of the more colorful species are popular as aquarium fish (Myers 1999). None of the species found in the MIRC study area are *listed on the IUCN Red List of threatened species (IUCN 2004).*

Distribution - Triggerfish are predominately tropical reef dwellers found in the Atlantic, Indian, and Pacific Oceans (Allen and Steene 1987).

Habitat Preferences - Habitat preferences for triggerfish's includes protected lagoons, high-energy surge zones, ledges and caves of deep drop-offs, sand bottoms, and rocky coral areas. Adults prefer steeply sloping areas with high coral cover and a lot of caves and crevices. Depth preferences depending on species range from shallow sub tidal zones to waters as deeper than 100 m (Myers 1999).

Life History - There is little information on the spawning and migrational patterns of triggerfish in the western Pacific. Triggerfish are generally solitary, but do form pairs during spawning. Balastid spawning events show some correlation to lunar cycles and eggs are typically deposited in shallow pits excavated by the parents. Larvae are pelagic with prejuveniles often being associated with floating algae (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Adult and Juveniles</u> - All bottom habitat and the adjacent water column from 0 to 100 m.

Carangidae (Jacks)

Status - Two species of carangids, the big eye scad (*Selar crumenophthalmus*) and the mackerel scad (*Decapterus macarellus*), are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). Both species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004b). In addition, the remaining 26 species of jacks found in the MIRC study area are designated as EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if the bigeye and mackerel scads of the CHCRT are approaching an overfished situation (NMFS 2004a). Both of these fishes are economically important food fish on many of the U.S. Pacific Islands and there is a small seasonal fishery for bigeye scad in the Mariana archipelago (Uchida 1983; WPRFMC 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The Carangids are a large family represented in all tropical and temperate seas with the majority being found in coral reef waters (Allen and Steene 1987; Myers 1999). The mackerel scad is a circumtropical species and is widespread throughout the Indian Ocean. This species ranges from the Indo-West Pacific to the Marquesas Islands in the east, and from Japan in the north, south to Australia (Smith-Vaniz 1999). The mackerel scad can be found from the Carolines to the Marianas in Micronesia (Myers 1999). Bigeye scad range from Japan and the Hawaiian Islands in the north, south to New Caledonia and Rapa, and throughout Micronesia (Myers 1999). This species can be found off the coast of Guam year round but is scarce in July and August, which may be due to spawning (Uchida 1983).

Habitat Preferences - Carangid eggs are planktonic and larvae are common in nearshore waters. Juveniles can be found in nearshore and estuarine waters and occasionally form small schools over sandy inshore reef flats (Myers 1999). Adults are widely distributed in shallow coastal waters, estuaries, shallow reefs, deep reef slopes, banks, and seamounts (WPRFMC 2001). Adult Carangids can range from reef habitats to deep slope habitats at depths of 0 to 350 m (WPRFMC 2001). Mackerel scad are a schooling species that are most often found in open water and frequently in insular habitats. This species can be found near the surface, but is commonly taken at depths from 40 to 200 m (Froese and Pauly 2004). Small to large schools of bigeye scad are typically found inshore or in shallow-water and occasionally over shallow reefs in turbid water to depths of 170 m (Smith-Vaniz 1999). Large schools of bigeye scad appear seasonally in the Marianas from August to November in shallow sandy lagoons, bays, and channels (Myers 1999).

Life History - Carangid species spawn in pairs within larger aggregations associated with the lunar cycle. Little is known about the reproduction of these species but peak spawning occurs between May and August (WPRFMC 2001). *Decapterus* spp. and *Selar* spp. tend to spawn in pelagic environments. Eggs are also found in pelagic waters and after hatching, larvae and juvenile fish remain in the pelagic environment where they frequently form large aggregating schools. Juvenile aggregations have been identified as far as 90 miles (mi) offshore. Larval and juvenile fish remain in offshore pelagic waters for the first several months of their life, after which they migrate to the nearshore adult habitat. Spawning occurs from March to August, peaking from May to July (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs and Larvae - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Adult and Juveniles - All bottom habitat and the adjacent water column from 0 to 100 m.

Carcharhinidae (Requiem Sharks)

Status - Five carcharhinid sharks are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the four other species of requiem sharks found in the MIRC study area have EFH designated under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if requiem sharks of the CHCRT are approaching an overfished situation (NMFS 2004a). Of the nine sharks managed under CHCRT/PHCRT in the MIRC study area, five are listed on the IUCN Red List of threatened species

The grey reef shark (*C. amblyrhynchos*), blacktip reef shark (*C. melanopterus*), whitetip reef shark (*Triaenodon obesus*), and Galapagos shark (*Carcharinus galapagensis*) are categorized by the IUCN as a lower risk but near threatened species; whereas the tiger shark (*Galeocerdo cuvier*) is near threatened (Heupel 2000; Simpfendorfer 2000; Smale 2000a, 2000b; Bennett et al. 2003). All of the requiem sharks are afforded protection under the Shark Finning Protection Act (NMFS 2002).

Distribution - The requiem sharks comprise one of the largest and most important shark families. These species are common, wide-ranging, and can be found in all warm and temperate seas (WPRFMC 2001).

In the western Pacific, the grey reef shark ranges from southern China to northern Australia and the Tuamoto Archipelago (Compagno 1984).

The silvertip shark ranges from off southern Japan to northern Australia and French Polynesia (Compagno 1984).

The Galapagos shark is circumtropical in distribution with a preference for waters surrounding oceanic islands. In the tropical regions of the Pacific, the Galapagos shark can be found around Lord Howe Island, the Tuamoto Archipelago, Middleton and Elizabeth Reefs, Hawaii, Revillagigedo, Clipperton, Cocos, and the Galapagos Islands (Compagno 1984).

In the western Pacific, the blacktip reef shark ranges from South Africa, the Red Sea, Pakistan, and India eastward to the western Central Pacific (Compagno 1984).

The whitetip reef shark is common in Polynesia, Melanesia, and Micronesia, northward to the Hawaiian Islands, and southwest to the Pitcairns (Compagno 1984).

Habitat Preferences - Most species of requiem sharks inhabit tropical continental coastal and offshore waters, but several species prefer coral reefs and oceanic islands (Compagno 1984). Requiem sharks inhabit a wide variety of coral reef habitats with no apparent preference.

Grey reef sharks prefer open water, above reefs, particularly along steep outer slopes or dropoffs at depths from 1 to 274 m. This species is common around the islands of the northern Marianas and Micronesian atolls where it frequents lagoons, channels, and seaward reefs (Myers 1999).

Silvertip sharks are typically found over dropoffs and offshore banks at depths of 30 to 400 m but have been observed in lagoons, deep channels, and surface waters (Myers 1999).

Adult Galapagos sharks can be found over steep outer reef slopes and offshore banks at depths of 30 to 180 m. Juveniles are more commonly found in waters between 2 and 25 m (Myers 1999).

Blacktip reef sharks are common inshore and occasionally offshore on continental and insular shelves. This species is generally associated with reef flats, shallow lagoons, and reef margins (Compagno and Niem 1998).

The whitetip reef shark is one of the most common sharks in lagoons and over seaward reefs and is frequently found resting on the bottom over sand patches. This species is generally found at depths greater than 3 m and has been observed as deep as 300 m (Compagno and Niem 1998; Myers 1999).

Life History - Carcharhinid sharks reproduce by internal fertilization, and all but one species (tiger shark) in this family are placental viviparous (embryos are nourished by a placenta like organ in the female) (WPRFMC 2001). Juvenile carcharhinids are often associated with inshore areas such as bays, seagrass beds and lagoon flats but move into deeper waters as they mature. Adult sharks frequent inshore areas during mating or birthing events and on occasion for foraging (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u>—N/A

<u>Adult and Juveniles</u> - All bottom habitat and the adjacent water column from 0 to 100 m to the outer extent of the EEZ.

Holocentridae (Soldierfishes/Squirrelfishes)

Status - Seventeen of the 19 holocentrid species (nine soldierfish and eight squirrelsfish) that are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and are reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 16 holocentrid species found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if soldierfishes/squirrelfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). These fish are commonly sold in fish markets and are popular aquarium fish (Allen and Steene 1987). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Squirrelfish and soldierfish are found throughout the tropical Atlantic, Indian, and Pacific Oceans, with most species occurring in the Indo-Pacific region (Allen and Steene 1987).

Habitat Preferences - Soldierfish and squirrelfish occupy relatively shallow-water over coral reefs or rocky bottoms (Randall and Greenfield 1999). Most holocentrid fishes are nocturnally active and occupy the water column above the reef at night (Myers 1999). During the day, they can be found along dropoffs, in or near caves and crevices, under rocks or coral overhangs, or among branching corals. Holocentrid fishes are found from shallow-water down to approximately 40 m, with some species occurring as deep as 235 m (WPRFMC 2001). Adults are usually demersal and larvae are planktonic for several weeks (Froese and Pauly 2004).

Life History - Little is known about the embryonic development and larval cycles of Holocentrids. In one species of Holocentridae, the brick soldierfish (Myripristis amaena), spawning occurs in open water and peaks in early April to early May, with a secondary peak in September. Spawning for this species is correlated with the lunar cycle (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> – The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Adult and Juveniles</u> - All rocky and coral areas and the adjacent water column from 0 to 100 m.

Kuhliidae (Flagtails)

Status - One flagtail species, the barred flagtail, Kuhlia mugil, is managed in Micronesia as part of the CHCRT by the WPRFMC (2001). This species has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and has EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining two flagtail species found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if the barred flagtail of the CHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Flagtails are distributed throughout the Indo-Pacific region (WPRFMC 2001). In the Indo-Pacific, the barred flagtail ranges in the west from the Red Sea and East Africa to the eastern Pacific, and from southern Japan in the north, south to New South Wales and Lord Howe Island (Carpenter 2001a).

Habitat Preferences - Adult flagtails are usually found in shallow-waters and form schools on the outer edge of surge-swept reefs where they aggregate under ledges, in holes, or in caves during the day (WPRFMC 2001; Froese and Pauly 2004). At night the schools break up and the fish forage in the water column above the reef (Froese and Pauly 2004). Juveniles are found individually or in small aggregations in tidal pools or along shallow shoreline areas (Froese and Pauly 2004). Flagtails can tolerate a wide range of salinities and can be found in freshwater, brackish water, or salt water (WPRFMC 2001). The barred flagtail is found in tropical waters from 32°N to 32°S at depths from 3 to 18 m (Froese and Pauly 2004).

Life History - Information is lacking on the life history of this family (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-12, B-15, and B-18; Table 4-5)

<u>Eggs and Larvae</u> - The water column from the shoreline to the outer limits of the EEZ to a depth of 100 m.

<u>Adult and Juveniles</u> - All bottom habitat and the adjacent water column from 0 to 46 m.

Kyphosidae (Rudderfishes)

Status - Three species of the family Kyphosidae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and are reported as occurring in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and Micronesia (2005). All three species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the one remaining rudderfish species found in the MIRC study area has designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if rudderfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). These species are highly valued food-fish and are taken by handline, gill net, and spear fishing (Sakai 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Rudderfish are found in the Atlantic, Indian, and Pacific oceans (Froese and Pauly 2004). In the Indo-Pacific, this family is found throughout tropical and subtropical waters from Easter Island westward to the Red Sea (WPRFMC 2001).

Habitat Preferences - Rudderfish are found near shore over rocky bottoms or associated with coral reefs along exposed coasts (Froese and Pauly 2004; WPRFMC 2001). Adults are usually found swimming several meters above the bottom. The blue sea chub (*Kyphosus. cenerascens*) occurs at depths of at least 24 m (WPRFMC 2001). Eggs, larvae, and juveniles are found in the upper layer of pelagic waters. Juveniles are often found far out at sea associated with floating debris (Myers 1999; WPRFMC 2001).

The grey rudderfish, *K. bigibbus*, is found in tropical waters from 35°N to 28°S typically associated with reefs (Froese and Pauly 2004).

The highfin rudderfish, *K. cinerascens*, is found in tropical waters from 35°N to 30°S at depths from 1 to 24 m (Froeses and Pauly 2004).

The lowfin rudderfish, *K. vaigiensis*, is found in tropical waters from 30°N to 28°S at depths from 1 to 24 m (Froese and Pauly 2004).

Life History - Very little information is available on the spawning and migration of rudderfish. Eggs and larvae are both subject to advection by ocean currents (WPRFMC 2001). Adults spawn in large numbers in pelagic waters (Froese and Pauly 2004).

EFH Designations - (WPRFMC 2001; Figures B-13, B-16, and B-19; Table 4-5)

Eggs, Larvae, and Juvenile - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Adult - All rocky and coral bottom habitat and the adjacent water column from 0 to 27 m.

Labridae (Wrasses)

Status - Twenty of the 22 species of the family Labridae that are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All 20 species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 65 wrasse species found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if wrasses of the CHCRT are approaching an overfished situation (NMFS 2004a). Very little information exists on the commercial harvest of labrids in Guam or the Northern Marianas. However, wrasses make up a small percentage of the commercial fish trade in numbers, value, and weight for both areas (WPRFMC 2001).

One species of wrasse found in the MIRC study area, *Cheilinus undulatus* (humphead wrasse), is listed by the IUCN Red List as "Endangered" (IUCN 2004). The humphead wrasse was also listed as a "Species of Concern" by the NOAA Fisheries Office of Protected Resources in 2004 (NMFS 2004d). According to IUCN, a taxon is "Endangered" when the best available evidence indicates: (1) an observed, estimated, inferred, or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is longer, where the reduction or its causes may not have ceased, may not be understood, or may not be reversible; and (2) a population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is longer (up to a maximum of 100 years), based on the index of abundance appropriate to the taxon and actual or potential levels of exploitation (Cornish et al. 2004). The humphead wrasse was once an economically important reef fish in Guam but is rarely seen around reefs or reported in inshore survey catch results (WPRFMC 2001). Factors influencing the decline of this species include: (1) intensive and species-specific removal in the live reef food-fish trade, (2) spearfishing at night using SCUBA gear, (3) lack of coordinated, consistent national and regional management, (4) illegal, unregulated, or unreported fisheries, and (5) loss of habitat (NMFS 2004d).

Distribution - Wrasses are found in shallow tropical and temperate seas of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004). This species is distributed throughout the shallow areas of the western Pacific (WPRFMC 2001). The humphead wrasse can be found in the Indo-Pacific region from the Red Sea in the west to the Tuamotus in the east, and from the Ryukyus in the north, including China and Chinese Taipei, east to Wake Island, south to New Caledonia, and throughout Micronesia (Myers 1999).

Habitat Preferences - Labrids prefer shallow-waters closely associated with coral reefs (WPRFMC 2001). They inhabit steep outer reef slopes, channel slopes, and lagoon reefs. Wrasses can be found in virtually every habitat on tropical reefs, including rubble, sand, algae, seaweeds, rocks, flats, tidepools, crevices, caves, fringing reefs, and patch reefs (Allen and Steene 1987; WPRFMC 2001). Most wrasses are found in relatively calm waters between about 3 and 20 m, however, some species occur at depths greater than 200 m (Allen and Steene 1987; WPRFMC 2001). Adults roam the coral reefs during the day keeping close to coral or rocky cover (Froese and Pauly 2004). At night, they may rest in caves or under coral ledges, bury themselves in the sand, or lie motionless on the bottom (WPRFMC 2001; Froese and Pauly 2004). Labrid eggs and larvae are pelagic and are routinely found in the open ocean (WPRFMC 2001). Juveniles, like adults, inhabit a wide range of habitats from shallow lagoons to deep reef slopes (WPRFMC 2001).

Humphead wrasses occur along steep outer reef slopes, channel slopes, and occasionally on lagoon reefs, at depths from 1 to 60 m (WPRFMC 2001; Froese and Pauly 2004). Adults are usually solitary and can be found roaming the coral reefs by day and resting in reef caves and under coral ledges at night (Froese and Pauly 2004). Juveniles are associated with coral-rich areas of lagoon reefs, usually among thickets of Acropora corals (Froese and Pauly 2004). The eggs and larvae of this species are pelagic (Sadovy et al. 2003).

Life History - Wrasses are pelagic spawners and schooling behavior is usually associated with reproduction. In tropical waters, spawning occurs year-round along the outer edge of the patch reef or along the outer slope of more extensive reefs. Many labrids migrate to prominent coral or rock outcrops to spawn. Wrasses may spawn in large aggregations or in pairs depending on the maturity of the individuals (WPRFMC 2001).

The humphead wrasse may spawn in small or large groupings and spawning coincides with certain phases of the tidal cycle. This species is a daily spawner that does not migrate far from its spawning area (resident spawner) (Sadovy et al. 2003). Humpheads may spawn during several or all months of the year associated with a range of different reef habitats (Sadovy et al. 2003).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs, Larvae, Juvenile, and Adult—The water column and all bottom habitats extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Mullidae (Goatfishes)

Status - Eleven of the 13 species of the family Mullidae that are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All 11 have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining three species of goatfishes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if goatfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). A number of goatfish are commercially important in the western Pacific and most of the catch is marketed fresh (Randall 2001b). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Goatfish are found in tropical and subtropical regions of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004). The majority of species in this family can be found in the Indo-West Pacific region (Allen and Steene 1987).

Habitat Preferences - Generally, goatfish are found over sandy areas in shallow-waters adjacent to reefs at depths at about 10 m (Allen and Steene 1987; WPRFMC 2001). However, some species have been reported as deep as 140 m (WPRFMC 2001). Goatfish eggs and larvae are pelagic and adults and juveniles are found in demersal habitats associated with coral reefs, rocks, sand, mud, crevices, and ledges (WPRFMC 2001).

Life History - Goatfish are commonly found schooling and may spawn either in groups or pairs (WPRFMC 2001). Goatfish are pelagic spawners and aggregations of 300 to 400 individuals are common for certain species (Allen and Steene 1987).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs and Larvae - The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile and Adult - All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 100 m.

Mugilidae (Mullets)

Status - Three species of the family Mugilidae (Mullets) are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All three have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining two species of mugulids found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if mullets of the CHCRT are approaching an overfished situation (NMFS 2004a). Several species of mullets are of moderate to major importance to fisheries in the western Pacific and smallscale, subsistence fisheries are probably also relatively prominent (Harrison and Senou 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The family Mugilidae can be found in all tropical and temperate seas but are most speciose in the Indo-West Pacific region (Harrison and Senou 1999; Foese and Pauly 2004). The kanda, *Valamugil engeli*, is found in the Indo-Pacific region from East Africa to the Marquesan and Tuamoto islands and north to the Yaeyamas (Froese and Pauly 2004). The acute-jawed mullet, *Neomyxus leuciscus*, is found in the Pacific Ocean around southern Japan and the Mariana, and Bonin Islands east to the Hawaiian, Line, and Ducie Islands. In Micronesia this species is found around the Ifaluk, Mariana, and Marshal Islands (Froese and Pauly 2004).

The fringelip mullet, *Crenimugil crenilabis*, is found in the Indo-Pacific region from the Red Sea and East Africa to the Line and Tuamoto islands, north to southern Japan, and south to Lord Howe Island (Harrison and Senou 1999).

Habitat Preferences **-** Most species of mullet are euryhaline and occupy diverse habitats including marine, brackish lagoons, estuaries, and freshwater environments (Harrison and Senou 1999). Some species more typically inhabit brackish waters. Mullets are generally found feeding over reefs or sandy bottoms at depths around 20 m (Harrison and Senou 1999; WPRFMC 2001). The kanda is found in tropical waters from 25°N to 24°S usually associated with coral reefs. Adults usually inhabit sandy to muddy areas of reef flats and shallow lagoons while juveniles are generally found in tide pools (Froese and Pauly 2004). The acute-jawed mullet is found in tropical waters between 30°N and 30°S at depths from 0 to 4 m. This species inhabits sandy shores, tide pools, and rocky surge areas. The acute-jawed mullet tends to move inshore to surface waters at night (Froese and Pauly 2004). The fringelip mullet inhabits tropical waters from 32°N to 32°S at depths from 0 to 20 m. This species is found in coastal waters, over sandy or muddy areas of lagoons, reef flats and tide pools (Froese and Pauly 2004).

Life History - Very little information concerning the spawning and migration of these species is available. It is presumed that the eggs and larvae are dispersed by advection. The acute-jawed mullet is a schooling species. The fringelip mullet forms large schools before spawning. Spawning occurs in June over the shallow, open areas of the lagoon slope and spawning events usually take place after dark in large aggregations (Froese and Pauly 2004).

EFH Designations - (WPRFMC 2001; Figures B-12, B-15, and B-18; Table 4-5)

<u>Eggs/Larvae</u> - The water column from the shoreline to the outer limits of the EEZ to a depth of 100 m.

<u>Juvenile/Adult</u> - All sand and mud bottoms and the adjacent water column from 0 to 46 m.

Muraenidae (Moray Eels)

Status - Three species of the family Muraenidae (Moray eels) are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All three species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 43 species of moray eels found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if moray eels of the CHCRT are approaching an overfished situation (NMFS 2004a). There is no commercial fishery for morays and most are taken as incidental catch but they are sold in fish markets and readily eaten in the western Pacific (Bohlke et al. 1999). These species are also targets of the aquarium trade. None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Morays are found worldwide in tropical and subtropical waters (Froese and Pauly 2004).

The yellow-edged moray, *Gymnothorax flavimarginatus*, ranges throughout the Indo-Pacific from the Red Sea and South Africa eastward to the Tuamoto and Austral islands, north to the Ryukyu and Hawaiian Islands and south to New Caledonia (Froese and Pauly 2004).

The giant moray, *G. javanicus*, can be found throughout the Indo-Pacific from the Red Sea and East Africa to the Marquesas and Oeno Atoll (Pitcairn Group), north to the Ryukyu and Hawaiian Islands, south to New Caledonia and the Austral Islands (Froese and Pauly 2004).

The undulated moray, *G. undulatus*, is distributed throughout the Indo-Pacific from the Red Sea and East Africa, including Walter Shoal, to French Polynesia, north to southern Japan and the Hawaiian Islands, south to the southern Great Barrier Reef (Froese and Pauly 2004).

Habitat Preferences - Most species of moray are benthic and can be found in shallow-waters around rocks or reefs. Some species are associated with sand or mud bottoms and have been caught as deep as 500 m (Bohlke et al. 1999). Juvenile and adult morays lurk in holes and crevices during the day and emerge at night to search the reef for food (Waikiki Aquarium 1999a). Moray eggs pelagic and the leptocephalic larvae are epipelagic (WPRFMC 2001; Forese and Pauly 2004).

The yellow-edged moray inhabits tropical waters between 30°N and 24°S at depths from 1 to 150 m. This species can be found along drop-offs and in coral or rocky areas of reef flats and protected shorelines to seaward reefs (Froese and Pauly 2004).

The giant moray inhabits tropical waters between 30°N and 25°S at depths from 0 to 50 m. This species is found in lagoons and seaward reefs and is frequently found along drop-offs and slopes in Indonesian waters. Juveniles tend to inhabit intertidal reef flats (Froese and Pauly 2004).

The undulated moray inhabits tropical waters from 32°N to 28°S at depths from 0 to 30 m. This species is common on reef flats among rocks rubble or debris and in lagoons and seaward reefs to depths greater than 26 m (Froese and Pauly 2004).

Life History - Information is lacking on the life history of this family (WPRFMC 2001). Migration has been observed in some species of morays but most tropical species remain in their home territories or congregate in small groups in certain areas (Debelius 2002).

EFH Designations - (WPRFMC 2001; Figures B-10, A-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Juvenile and Adult</u> - All rocky coral areas and the adjacent water column and the adjacent water column from 0 to 100 m.

Octopodidae (Octopuses)

Status - Two species of Octopus are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and are reported as occurring in CNMI and Guam (Ward 2003). Both species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 22 species of octopus found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if octopuses of the CHCRT are approaching an overfished situation (NMFS 2004a). These species are primarily harvested for human consumption but are also used as bait in other fisheries (Norman 1998). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Members of the family Octopodidae occur in all the oceans of the world from the equator to polar latitudes (Norman 1998, Waikiki Aquarium 1998a). The day octopus, *Octopus cyanea*, and the night octopus, *O. ornatus*, are found widely throughout the shallow-waters of the Indo-West Pacific from Hawaii in the east to the east African coast in the west. This species has been reported as far north as Japan and as far south as New South Wales, Australia (Norman 1998).

Habitat Preferences - Reef-associated octopuses are bottom-dwelling species that usually occupy holes and crevices or coral areas. These species are found from the shallowest part of the reef down to approximately 50 m (WPRFMC 2001). Octopuses occur on a wide range of substrates including coral and rock reefs, seagrass beds, sand, and mud. Octopus eggs are demersal and typically attached in clusters within the rocky depths of the reef (WPRFMC 2001).

The day octopus and night octopus are found from intertidal reefs, shallow reef flats and reef slopes to depths of at least 25 m and are associated with both live and dead corals. As the name implies the day octopus is more active throughout day with peak activities at dusk and dawn (Norman 1998). The night octopus is nocturnal, resting by day and foraging at night (Waikiki Aquarium 1998a).

Life History - Life history information is lacking for these species of octopus (WPRFMC 2001). Eggs are demersal and females tend the eggs until they hatch. Octopuses may migrate up to 100 m in search of food (Norman 1998, Waikiki Aquarium1998a).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, A-14, B-17, and B-20; Table 4-5)

Eggs, Juvenile, and Adult—EFH for the adult, juvenile phase and demersal eggs are defined as all coral, rocky, and sand-bottom areas from 0 to 100 m.

Polynemidae (Threadfins)

Status - One species, the sixfeeler threadfin (*Polydactylus sexfilis*), of the family Polynemidae is managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). EFH has been designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c) for this species. Currently, no data are available to determine if the sixfeeler threadfin of the CHCRT is approaching an overfished situation (NMFS 2004a). This species is highly valued as food-fish (WPRFMC 2001). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The sixfeeler threadfin is found throughout the tropical waters of the Atlantic and Indo- Pacific Oceans from 30°N to 0°N (WPRFMC 2001; Froese and Pauly 2004). In the Indo-Pacific this species ranges from India to the Hawaiian, Marquesan, and Pitcairn Islands, north to the Yaeyama and Bonin Island, and throughout Micronesia (Myers 1999).

Habitat Preferences - Adult sixfeeler threadfin are found near reef areas and inhabits turbid waters along sandy shorelines and over sandy lagoon bottoms usually associated with high-energy surf zones (Myers 1999; Feltes 2001; WPRFMC 2001). This species is most common at depths from 20 to 50 m (Feltes 2001). Sixfeeler threadfin eggs and larvae are pelagic but after larval metamorphosis they enter nearshore habitats such as surf zones, reefs, and stream entrances (WPRFMC 2001). Juvenile sixgill threadfin are found from the shoreline breaker to 100 m depth (WPRFMC 2001).

Life History - Spawning occurs close to shore for three to six days per month and is associated with the lunar cycle (Myers 1999; WPRFMC 2001). In Hawaii, the sixfeeler threadfin spawns from June to September, with a peak in July and August (WPRFMC 2001). Spawning may occur year round in tropical locations (WPRFMC 2001). Both eggs and larvae are subject to advection by ocean currents (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> - The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Juvenile and Adult</u> - All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 100 m.

Priacanthidae (Bigeyes)

Status - Two species of the family Priacanthidae (Bigeyes) are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and are reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). Both species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 4 species of bigeyes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if bigeyes of the CHCRT are approaching an overfished situation (NMFS 2004a). These species are excellent food-fish but are not important in most fishery areas (Starnes 1999; Amesbury and Myers 2001). These two species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Priacanthids can be found in the tropical and subtropical waters of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004).

The glasseye, *Heteropriacanthus cruentatus*, is located circumtropically north to Ryukyu, Bonin, and Hawaiian Islands, and south to Lord Howe and Easter Island. This species is located throughout Micronesia (Myers 1999).

The moontail bullseye, *Priacanthus hamrur*, can be found in the Indo-Pacific from the Red Sea and southern Africa to southern Japan and Australia, and throughout the central Pacific to French Polynesia (Froese and Pauly 2004).

Habitat Preferences - Bigeyes are typically epibenthic and are usually associated with rock formations or coral reefs. This family prefers shaded overhangs, caves, and crevices near the reef during the daytime (WPRFMC 2001). Occasionally, bigeyes may be associated with more open areas at depths of 5 to 400 m (Starnes 1999). Eggs larvae and early juvenile stages are pelagic (Froese and Pauly 2004).

The glasseye is a subtropical species that ranges from 33°N to 32°S at depths from 3 to 300 m (Froese and Pauly 2004). This species is commonly associated with lagoons or seaward reefs below the surge zone, generally around islands (Froese and Pauly 2004; Myers 1999). Glasseyes are found singly or in small groups under or near ledges during the day forming larger groups at dusk to forage. Juveniles of this species are pelagic (Froese and Pauly 2004).

The moontail bullseye is a tropical species ranging from 32°N to 24°S at depths from 8 to 250 m (Froese and Pauly 2004). This is a relatively uncommon species that inhabits the outer reef slopes and deep lagoons at depths from 8 m to greater than 80 m and is probably most common from 30 to 50 m (Starnes 1999; Froese and Pauly 2004).

Life History - Spawning for this species has not been observed (WPRFMC 2001). Daily migrations usually occur above and away from the reef in search of food (Myers 1999).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs and Larvae - The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile and Adult - All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to -9100 m.

Scombridae (Mackerels)

Status - One mackerel species, the dogtooth tuna (*Gymnosarda unicolor*), is managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). EFH has been designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c) for this species. Currently, no data are available to determine if the dogtooth tuna of the CHCRT is approaching an overfished situation (NMFS 2004a). The dogtooth tuna is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The dogtooth tuna is widely distributed throughout much of the Indo-Pacific faunal region from the Red Sea eastward to French Polynesia (Collette and Nauen 1983).

Habitat Preferences - The dogtooth tuna is an offshore species mainly found around coral reefs. This species may be found in deep lagoons and passes, shallow pinnacles, and off outer reef slopes occurring in mid-water, form the surface to depths of approximately 100 m (Collette and Nauen 1983). Dogtooth tuna prefer water temperatures ranging from 20° to 28°C (WPRFMC 2001). Dogtooth tuna larvae are found in surface and subsurface tows, generally concentrated at depths from 20 to 30 m (WPRFMC 2001).

Life History - Spawning activities for dogtooth tuna have been observed during the summer months in Fiji and Papua New Guinea. Various authors have noted evidence of summer spawning events for this species (WPRFMC 2001). Diurnal migrations have been observed in older larvae, making their way to the surface at night (WPRFMC 2001). Spawning is believed to occur year round in tropical locations (WPRFMC 2001). Dogtooth tuna are generally solitary species but may occur is small schools of six or less (Froese and Pauly 2004).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs, Larvae, Juvenile, and Adult - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Scaridae (Parrotfishes)

Status - Four species of the family Scaridae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and are reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). Each species has EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 21 species of parrotfishes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if parrotfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Parrotfish are not a major commercial catch but they are an important food-fish and are frequently found in fish markets (Westneat 2001; Froese and Pauly 2004). There are no species of parrotfish listed on the IUCN Red List of threatened species but the bumphead parrotfish, *Bolbometopon muricatum*, was listed as a “Species of Concern” by the NOAA Fisheries Office of Protected Resources in 2004 (IUCN 2004; NMFS 2004d).

The bumphead parrotfish is one of the most desirable and most vulnerable nearshore reef fish in the U.S. Western Pacific Islands. Bumphead parrotfish are an important species in the live reef fish trade as well as the aquarium trade. This species has all but disappeared from Guam's reefs and has shown significant declines throughout its range. Reasons attributing to the decline of this species include 1) overexploitation and destructive fishing techniques; 2) degradation and loss of coral reef habitats; and 3) a vulnerable life history (NMFS 2004d).

Distribution - Parrotfish are mainly a tropical species occurring in the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004). The majority of these species are found inhabiting the coral reefs of the Indian and western Pacific Oceans.

The bumphead parrotfish, *Bolbometopon muricatum*, can be found throughout the Indo-Pacific from the Red Sea and East Africa in the east to the Line Islands and Samoa in the west, north to Yaeyama, south to the Great Barrier Reef and New Caledonia. In Micronesia, this species can be found from Palau to the Caroline, Mariana, and Wake Islands (Froese and Pauly 2004).

Habitat Preferences - Parrotfish are commonly found around coral reefs, and are usually most abundant in shallow-waters to a depth of 30 m (Westneat 2001). This species occupies a variety of coral reef habitats including seagrass beds, coral-rich areas, sand patches, rubble or pavement fields, lagoons, reef flats, and upper reef slopes (Myers 1999). Parrotfish sleep under ledges or wedged against coral or rock at night (Myers 1999).

The bumphead parrotfish can be found in tropical waters from 30° N to 24° S from 1 to 30 m deep (Froese and Pauly 2004). Adults are found in small groups in clear outer lagoons and around seaward reefs and are often located on reef crests or fronts (WPRFMC 2001; Froese and Pauly 2004). Adults may utilize a wide range of coral and shallow-water habitat types, but juveniles are usually found in lagoons (WPRFMC 2001).

Life History - Parrotfish spawn in pairs and groups with group spawning frequently occurring on reef slopes associated with high current speeds. Paired spawning has been observed at the reef crest or reef slope during peak or falling tides. Parrotfish may migrate into lagoons or to the outer reef slope in order to spawn. Some parrotfish are diandric, forming schools and spawning groups often after migration to specific sites, while others are monandric and are strongly site specific and practice haremic, pair spawning. The eggs and larvae of these species are pelagic and subject to dispersal by ocean currents (WPRFMC 2001). At this time, no reliable data are available on the spawning and migration of the bumphead parrotfish (Myers 1999; WPRFMC 2001; Froese and Pauly 2004).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> - The water column from the shoreline to the outer limit of the EEZ to a

depth of 100 m.

<u>Juvenile and Adult</u> - All bottom habitat and the adjacent water column from 0 to 100 m.

Siganidae (Rabbitfish)

Status - Four of the 6 species of the family Siganidae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001). All 6 occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). The remaining 2 species of rabbitfish found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if rabbitfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Rabbitfish are a highly esteemed food-fish and may make up a large portion of marketable reef fish is some areas of the western Pacific (Myers 1999). The more colorful the species in this family, the more popular they are in the aquarium trade (Froese and Pauly 2004). There are no species of rabbitfish listed on the IUCN Red List of threatened species located within the MIRC study area (IUCN 2004).

Distribution - Rabbitfish are found throughout the Indo-Pacific and eastern Mediterranean (Froese and Pauly 2004).

Habitat Preferences - Rabbitfish are usually associated with shallow coastal waters to a depth of approximately 50 m. Some species live in pairs among corals, while others live in schools around rock and coral reefs, mangroves, estuaries, and brackish lagoons (Woodland 2001). Rabbitfish are common on reef flats, around small, scattered coral heads, and near grass flats at depths less than 15 m. Juveniles of certain species are estuarine and larvae are pelagic (WPRFMC 2001). Eggs are usually adhesive and demersal but at least one species the schooling rabbitfish (*S. aregenteus*), is known to have pelagic eggs (WPRFMC 2001). Rabbitfish can be divided into schooling species and pairing species. Schooling species of rabbitfish tend to occupy a wide range of habitats, whereas, pairing species tend to remain in one area usually among branches of hard corals (WPRFMC 2001).

Life History - Rabbitfish spawning typically corresponds to a lunar cycle with peak activity in the spring and early summer (May to June). The timing of the spawning may be influenced by the variation of environmental factors including water temperature, photoperiod, and food abundance (Takemura et al. 2004). Spawning may occur in pairs or groups on outgoing tides either at night or early in the morning. Spawning rabbitfish generally migrate to specific spawning sites such as mangrove stands, shallow reef flats, the outer reef crest, or the deeper reef (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

<u>Eggs and Larvae</u> - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Juvenile and Adult</u> - All bottom habitat and the adjacent water column from 0 to 100 m.

Sphyraenidae (Barracudas)

Status - Two species of the family Sphyraenidae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001). Both species are reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 4 species of barracudas found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if barracudas of the CHCRT are approaching an overfished situation (NMFS 2004a). In the western Pacific, barracudas are marketed fresh, frozen, dried, salted, or smoked (Senou 2001). There are no species of barracuda listed on the IUCN Red List of threatened species located within the MIRC study area (IUCN 2004).

Distribution - Barracudas can be found in tropical and subtropical waters in the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004).

Heller's barracuda, *Sphyraena helleri*, can be found from southern Japan south to the Coral Sea and east to French Polynesia. This species is common around the oceanic islands of the Pacific (Forese and Pauly 2004).

The great barracuda, *S. barracuda*, is found in the Indo-Pacific from the Red Sea and east coast of Africa to the Hawaiian, Marquesan, and Tuamoto Islands. This species is found throughout Micronesia (Froese and Pauly 2004).

Habitat Preferences - Barracudas are pelagic to demersal fish, most of which inhabit shallow coastal waters such as bays, estuaries, or the vicinity of coral reefs. This family may also be found at the surface of open oceans down to depths greater than 100 m (Senou 2001).

Barracudas may be found within lagoons and mangrove areas, over coral reefs or sand or mud bottoms, or off of deep outer reef slopes (Senou 2001)

Heller's barracuda is a subtropical species found from 30°N to 25°S at depths from 15 to 60 m (Froese and Pauly 2004). This species occurs in lagoons and over seaward reefs (Myers 1999).

The great barracuda is a subtropical species found from 30°N to 30°S at depths from 0 to 100 m. Adults occur from murky inner harbors to open seas, usually at or near the surface (Froese and Pauly 2004). Juveniles occur among mangroves and in shallow sheltered inner reefs (WPRFMC 2001).

Life History - Barracuda migrate in very large numbers to specific spawning areas at reef edges or in deeper water. Eggs, larvae and juveniles are pelagic and may be carried long distances by ocean currents (WPRFMC 2001). Heller's barracuda can be found in large school during the day, whereas, the great barracuda is diurnal and solitary (Froese and Pauly 2004).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs, Larvae, Juvenile, and Adult - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Turbinidae (Turban shells)

Status - The family Turbinidae is managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occurs in CNMI and Guam (Smith 2003). All species within this subfamily have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). The main species of turban shells harvested are the green snail (*Turbo marmoratus*), the rough turban (*T. setosus*), and the silver-mouth turban (*T. Argyrostomus*). Only the latter two species are found in the MIRC study area (Smith 2003). Currently, no data are available to determine if turban shells of the CHCRT are approaching an overfished situation (NMFS 2004a). There are no species of turban shells listed on the IUCN Red List of threatened species located within the MIRC study area (IUCN 2004).

Distribution - Turban shells are distributed throughout the Indo-Pacific region extending into the South Pacific (WPRFMC 2001).

Habitat Preferences - Turban shells are found in shallow-waters of warm temperate and tropical seas (Poutiers 1998a). These species prefer healthy coral reef habitats, which receive a constant flow of oceanic water. Juveniles can be found on shallow reef crests while adults prefer deeper habitats (WPRFMC 2001).

Life History - Very little information is available about the reproduction of these species. Eggs and larvae are dispersed by ocean currents, while juveniles and adults are demersal (WPRFMC 2001).

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs and Larvae - The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile and Adult - All bottom habitat and the adjacent water column from 0 of 100 m.

Aquarium Taxa/Species

Fish species harvested for the aquarium trade are managed as part of CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All taxa within this management unit have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). All aquarium species are managed as a unit, and the EFH designations for the lifestages of each species are identical and listed below. Limited harvest of aquaria species occurs within the MIRC study area due to the prohibition of the commercial export of live aquarium fishes in the Marianas. Guam allows the export of aquarium species but only has one commercial operation at this time (WPRFMC 2001). The EFH designations for all aquarium species managed as CHCRT are described in the following paragraphs.

EFH Designations - (WPRFMC 2001; Figures B-10, B-11, B-14, B-17, and B-20; Table 4-5)

Eggs and Larvae - All waters from 0 to 100 m from the shoreline to the limits of the EEZ.

Juvenile and Adult - All coral, rubble, or other hard-bottom features and the adjacent water column from 0 to 100 m.

Acanthuridae (Surgeonfishes)

A complete summary of the family Acanthuridae including EFH and HAPC designations is provided earlier in the CHCRT section. The following three surgeonfishes will be addressed individually.

Yellow Tang *(Zebrasoma flavescens)*

Status - The yellow tang is managed in Micronesia as part of the CHCRT by the WPRFMC (2001), has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and has EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the yellow tang is approaching an overfished situation (NMFS 2004a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The yellow tang can be found in the Pacific Ocean associated with Ryukyu, Mariana, Marshall, Marcus, Wake, and Hawaiian Islands (Froese and Pauly 2004).

Habitat Preferences - Yellow tangs inhabit coral-rich areas of lagoons and seaward reefs from below the surge to approximately 46 m. This species can be found in tropical waters from 30°N to 15°N in water temperatures ranging from 24° to 28°C at depths between 2 and 46 m (Froese and Pauly 2004).

Life History - At this time, information on the life stages of the yellow tang is limited. The yellow tang may spawn in groups or pairs (Myers 1999).

Yellow-eyed Surgeon Fish *(Ctenochaetus strigosus)*

Status - The yellow-eyed surgeonfish is managed in Micronesia as part of the CHCRT by the WPRFMC (2001), has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and has EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the yelloweyed surgeonfish of the CHCRT is approaching an overfished situation (NMFS 2004a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The yellow-eyed surgeonfish can be found in the Indo-Pacific region from east Africa to the Hawaiian, Marquesan, and Ducie Islands. Its range is bounded to the north by the Bonin Islands and to the south by the Great Barrier Reef and New Caledonia. This species can be found throughout Micronesia (Myers 1999).

Habitat Preferences - The yellow-eyed surgeonfish inhabit coral-rich areas of lagoons and seaward reefs. This species can be found in tropical waters from 30°N to 30°S in water temperatures ranging from 21° to 27°C at depths between 1 and 113 m (Froese and Pauly 2004).

Life History - Very little information exists on the life history of the yellow-eyed surgeonfish. This species has been observed spawning in pairs (Myers 1999).

Achilles Tang (*Ancanthurus achilles*)

Status - The Achilles tang is managed in Micronesia as part of the CHCRT by the WPRFMC (2001), has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and has EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the Achilles tang of the CHCRT is approaching an overfished situation (NMFS 2004a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The Achilles tang can be found distributed throughout the tropical Indo-Pacific from the western Caroline Islands, Parece Vela, and the Torres Strait east to the Hawaiian, Marquesan, and Ducie Islands. This species ranges as far north as the Marcus Islands and south to New Caledonia. The Achilles tang can be found throughout Micronesia including the Caroline, Mariana, and Marshall Islands (Myers 1999).

Habitat Preferences - The Achilles tang inhabits clear seaward reefs from the surge zone to a depth of 4 m (Myers 1999). This species can be found in tropical waters from 28°N to 26°S in water temperatures ranging from 26° to 28°C at depths between 0 and 10 m (Froese and Pauly 2004).

Life History - There is very little information available on the life history of the Achilles tang at this time (WPRFMC 2001).

Zanclidae (Moorish Idol)

Status - The Moorish idol (*Zanclus cornutus*), a sole member of this monotypic family, is an aquarium taxa that is managed in Micronesia as part of the CHCRT by the WPRFMC (2001), has been reported as occurring in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and has EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the Moorish idol of the CHCRT is approaching an overfished situation (NMFS 2004a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The Moorish idol can be found distributed throughout the Indo-pan-Pacific from the Gulf of Aden and eastern Africa east to Mexico. This species ranges as far north as southern Japan and the Hawaiian Islands and south to Lord Howe, the Kermadecs, Rapa, and Ducie Islands. The Moorish idol tang can be found throughout Micronesia (Myers 1999).

Habitat Preferences - The Moorish idol inhabits areas of hard substrates from turbid inner harbors and reef flats to clear seaward reefs as deep as 182 m (Myers 1999). This species can be found in tropical waters from 30°N to 35°S in water temperatures ranging from 24° to 28°C at depths between 3 and 182 m (Froese and Pauly 2004).

Life History - The Moorish idol is usually found in small groups but may occur in schools numbering over 100 individuals (Myers 1999).

Pomacanthidae (Angelfishes)

Status - Two species of aquarium taxa in the family Pomacanthidae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). Both species have EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining

15 species of angelfishes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if angelfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Although harvested as food-fish, the primary value of angelfish is through the ornamental marine aquarium trade, where they are the second most-frequently exported fish by number and highest in total value of all families of aquarium fishes in trade (Pyle 2001a). These species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The angelfish can be found throughout the tropical waters of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004).

The mango angelfish, *Centropyge shepardi*, is found only around the Marianas, Bonins, and Palau (Myers 1999).

The lemonpeel angelfish, *C. flavissima*, is found in the Indo-Pacific from Cocos-Keeling Atoll in the west, east to the Line, Marquesan, and Ducie Islands. This species ranges north to the Ryukyus and south to New Caledonia and Rapa. The lemonpeel angelfish is found throughout Micronesia (Froese and Pauly 2004).

Habitat Preferences - Angelfish are usually found near coral reefs in shallow-waters less than 20 m deep (Myers 1999).

The mango angelfish is found on outer reef slopes and occasionally in clear lagoon reefs (Froese and Pauly 2004). This species prefers areas of mixed living and dead coral with numerous shelter holes and passages. The mango angelfish can be found in tropical waters from 28°N to 15°N at depths from 1 to 56 m (Froese and Pauly 2004). In the Marianas, this is the most common species of angelfish between 18 and 56 m (Myers 1999).

The lemonpeel angelfish is found in coral-rich areas of shallow lagoons and exposed seaward reefs from the lower surge zone to depths greater than 25 m (Myers 1999). This species can be found in tropical waters from 35°N to 30°S at depths from 3 to 50 m (Froese and Pauly 2004). In the Marianas, this is the most common species of angelfish from 0 to 20 m (Myers 1999).

Life History - Angelfish exhibit paired spawning in pelagic waters typically around sunset (Myers 1999; Froese and Pauly 2004).

Cirrhitidae (Hawkfishes)

Status - Two species of aquarium taxa in the family Cirrhitidae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). Both species have EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining seven species of hawkfishes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if hawkfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Some hawkfishes are occasionally used as food and are valued aquarium fishes (Randall 2001c). These species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Hawkfishes can be found from the tropical western and eastern Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2004).

The longnose hawkfish, *Oxycirrhites typus*, can be found from the Red Sea in the west to Panama in the east. This species ranges from southern Japan and Hawaii in the north to New Caledonia in the south and throughout Micronesia (Myers 1999).

The flame hawkfish, *Neocirrhites armatus*, can be found from Ryukyus in the east to the Line Islands in the west. This species ranges from the Pitcairn group in the north to the Great Barrier

Reef and Australs in the south. In Micronesia the flame hawkfish can be found in the Carolines, Marianas, and Wake Islands (Myers 1999).

Habitat Preferences - Hawkfishes are generally found associated with rocks and corals (Randall 2001c).

The longnose hawkfish prefers steep outer reef slopes exposed to strong currents. This species if found associated with large gorgonians and black corals. In Micronesia, it is confined to depths below 30 m (Myers 1999).

The flame hawkfish is found along surge swept reef fronts and submarine terraces to a depth of about 11 m. This species is most often associated with coral such as *Stylophora mordax*, *Pocillopora elegans*, *P. eydouxi*, or *P. verrucosa* (Myers 1999).

Life History - Spawning occurs throughout the year in tropical waters and only during warmer months in temperate areas. These species usually spawns at dusk or during early nighttime (Myers 1999).

Chaetodontidae (Butterflyfishes)

Status - Four aquarium species in the family Chaetodontidae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). Each species has EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 27 species of butterflyfishes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if butterflyfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Although harvested as food-fish, the primary value of the butterflyfish is through the ornamental marine aquarium trade, where they are the third most-frequently exported fish by number and second highest in total value of all families of aquarium fishes in trade (Pyle 2001b). None of the four aquarium species are listed on the IUCN Red List of threatened species (IUCN 2004). The yellow-crowned butterflyfish, *Chaetodon flavocoronatus*, is listed as vulnerable on the IUCN Red List of threatened species in the MIRC study area (Roberts 1996).

Distribution - Chaetodontids can be found in the tropical to temperate waters of the Atlantic, Indian, and Pacific Oceans but are most abundant in the Indo-West Pacific region (Froese and Pauly 2004).

The threadfin butterflyfish, *Chaetodon auriga*, can be found from the west Red Sea and east Africa to the Hawaiian, Marquesan, and Ducie Islands in the west. This species ranges from southern Japan in the north to Lord Howe and Rapa Islands in the south and throughout Micronesia (Froese and Pauly 2004).

The raccoon butterflyfish, *C. lunula*, can be found in the Indo-Pacific from east Africa in the west to the Hawaiian, Marquesan, and Ducie Islands in the east. This species ranges from southern Japan south to Lord Howe and Rapa Islands and throughout Micronesia (Froese and Pauly 2004).

The black-backed butterflyfish, *C. melannotus*, can be found from the Red Sea in the west to Samoa in the east. This species ranges from Japan, south to Lord Howe Island and throughout Micronesia (Myers 1999).

The saddled butterflyfish, *C. ephippium*, can be found distributed throughout the tropical Indo-Pacific from the Cocos-Keeling Islands in the west to the Hawaiian, Marquesan and Tuamoto Islands in the east. This species ranges as far north as the southern Japan and south to Rowley Shoals and New South Wales, Australia (Froese and Pauly 2004).

Habitat Preferences - Butterflyfish are diurnal species that are generally found near coral reefs (Froese and Pauly 2004). Juveniles tend to occupy shallower, more sheltered habitats than adults. Butterfly fish eggs are planktonic (WPRFMC 2001).

The threadfin butterflyfish can be found in a variety of habitats from rich coral reefs to weedy and rubble covered areas. They may be found on seaward reefs at depths greater than 30 m (Myers 1999). This species inhabits tropical waters from 30°N to 20°S at depths between 1 and 35 m (Froese and Pauly 2004).

The raccoon butterflyfish inhabits shallow reef flats of lagoons and seaward reefs to depths of over 30 m (Froese and Pauly 2004). This species is common in exposed rocky areas of high vertical relief (Myers 1999). The raccoon butterflyfish can be found in tropical waters from 30°N to 32°S at depths between 0 and 30 m (Froese and Pauly 2004). Juveniles prefer rocks of inner reef flats and tide pools (Froese and Pauly 2004). This is the only nocturnally active butterflyfish, spending its days hovering inactively in aggregations between boulders (Myers 1999).

The black-backed butterflyfish inhabits coral-rich areas of reef flats, lagoons and seaward reefs to a depth of over 15 m (Myers 1999). This species can be found in tropical waters from 30°N to 30°S at depths between 4 and 20 m (Froese and Pauly 2004).

The saddled butterflyfish inhabits lagoons and seaward reefs to a depth of 30 m and prefers areas of rich coral growth and clear water (Myers 1999). This species can be found in tropical waters from 30°N to 30°S at depths between 0 and 30 m (Froese and Pauly 2004).

Life History - The threadfin butterflyfish may be found singly or in pairs and forms aggregations that roam long distances in search of food (Froese and Pauly 2004). Very little information is known about the spawning and migration of the other three butterflyfishes (Myers 1999; WPRFMC 2001; Froese and Pauly 2004).

Pomacentridae (Damselfishes)

Status - Three aquarium species in the family Pomacentridae are managed in Micronesia as part of the CHCRT by the WPRFMC (2001) and occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All three species have EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). In addition, the remaining 46 species of damselfishes found in the MIRC study area have designated EFH under the PHCRT (WPRFMC 2001). Currently, no data are available to determine if damselfishes of the CHCRT are approaching an overfished situation (NMFS 2004a). Their most important commercial use is as aquarium fishes, especially the anemone fish (Allen 2001). None of these aquarium species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Damselfish can be found in all tropical seas but are most abundant in the Indo-West Pacific region (Froese and Pauly 2004).

The blue-green chromis (*Chromis viridis*) can be found distributed throughout the tropical Indo-Pacific from the Red Sea in the west to the Line, Marquesan, and Tuamoto Islands in the east. This species ranges as far north as Ryukyu Islands and south to New Caledonia (Froese and Pauly 2004).

The humbug dascyllus (*Dascyllus aruanus*) can be found distributed throughout the tropical Indo-West Pacific from the Red Sea and east Africa in the west to the Line, Marquesan, and Tuamoto Islands in the east. This species ranges as far north as southern Japan and south to Sydney, Australia (Froese and Pauly 2004).

The threespot dascyllus (*D. trimaculatus*) can be found distributed throughout the tropical Indo-West Pacific from the Red Sea and east Africa in the west to the islands of Oceania in the east excluding the Hawaiian and Marquesan Islands. This species ranges as far north as southern Japan and south to Sydney, Australia (Froese and Pauly 2004).

Habitat Preferences - Damselfish typically occur in shallow-water or coral or rock substrata associated with shelter (Myers 1999).

The blue-green chromis is found above thickets of branching coral in sheltered areas such as subtidal reef flats and lagoons. This species can be found in subtropical waters from 35°N to 35°S at depths between 10 and 12 m (Froese and Pauly 2004).

The humbug dascyllus inhabits shallow lagoons and subtidal reef flats. This species can be found in large aggregations above staghorn, *Acropora*, thickets and in smaller groups above isolated coral heads (Froese and Pauly 2004). This species can be found in tropical waters from 30°N to 30°S at depths from 0 and 20 m. The larvae of this species are pelagic (Froese and Pauly 2004).

The threespot dascyllus inhabits lagoon and seaward reefs at depths of 1 to > 55 m. This species typically occurs in small groups around pronounced coral mounds or large isolated rocks (Myers 1999). The threespot dascyllus is found in tropical waters from 30°N to 30°S at depths from 1 and 55 m. Juveniles are associated with sea anemones, sea urchins, or small coral heads (Froese and Pauly 2004).

Life History - The blue-green chromis is non-migratory and spawning occurs on sand and rubble (Froese and Pauly 2004). Very little information is known about the spawning and migration of the humbug and threespot dascyllus (Myers 1999; WPRFMC 2001; Froese and Pauly 2004).

Scorpaenidae (Scorpionfishes)

Status - Thirty species of the family Scorpaenidae are managed as aquarium taxa in Micronesia as part of the CHCRT by the WPRFMC (2001). Twenty-five of these species occur in CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designation within the boundaries of the MIRC study area (WPRFMC 2001: NMFS 2004c). Currently, no data are available to determine if scorpionfishes of CHCRT are approaching an overfished situation (NMFS 2004a). Most species in the Western Central Pacific are small and dangerous to handle and do not form the basis of large fisheries (Poss 1999a). These species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Scorpaenids can be found in all tropical and temperate sea (Froese and Pauly 2004).

Habitat Preferences - Scorpionfish and lionfish may be found swimming well above the bottom but smaller, more cryptic species of the subfamily Scorpaeninae are typically found on the bottom usually associated with rubble areas in shallow-water. Scorpaenids are commonly found in shallow-waters but may be found at depths greater than 50 m (WPRFMC 2001). The eggs are pelagic and larvae of this species are planktonic (Froese and Pauly 2004).

Life History - Most scorpionfishes are ovoviparous, producing between a few hundred and a few thousand eggs, although, some are viviparous (Poss 1999a).

Sabellidae (Feather-duster Worms)

Status - The family Sabellidae is managed as aquarium taxa in Micronesia as part of the CHCRT by the WPRFMC (2001). Four species occur in CNMI and Guam (Bailey-Brock 2003) and have EFH designation within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). These species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Feather-duster worms are common throughout the world in shallow-water (Waikiki Aquarium 1998b).

Habitat Preferences - In the western Pacific, feather-duster worms are common on reef flats and in quiet bays and harbors where they are associated with hard surfaces to which they attach (Bailey- Brock 1995; Hoover 1998; Waikiki Aquarium 1998b). Feather-duster worms prefer turbid water (Hoover 1998). They are occasionally found in high energy environments and clear water, usually at depths greater than 30 m (Hoover 1998; WPRFMC 2001).

Life History - Feather-duster worms are dioecious (separate sexes) and fertilization of eggs is external (Hawaii Biological Survey 2001a). Fertilized eggs develop into trochophore larvae (type of larva with several bands of cilia) that are plantonic for a short time before settling on the reef substrate to mature (primarily a complex reef habitat; Bailey-Brock 2003). Feather-duster worms can also propagate by fragmentation. They can also regenerate body parts (Hawaii Biological Survey 2001a).

Potentially Harvested Coral Reef Taxa

The PHCRT are managed under the FMP for the CRE by the WPRFMC (2001). Taxa included under PHCRT consist of thousands of coral reef associated species, families, or subfamilies that encompass fish, invertebrate, and sessile benthos MUS (WPRFMC 2001). These MUS are limited to those families/species known or believed to occur in association with coral reefs during some phase of their life cycle (WPRFMC 2001). Since little information is available about life histories and habitat of this biota beyond general taxonomic and distributional descriptions, WPRFMC has adopted a precautionary approach in designating EFH for PHCRT.

EFH for all life stages of PHCRT is designated as the water column and bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 100 m (Figure B-10, B-11, B-14, B-17, and B-20; Table 4-5; WPRFMC 2001).

A complete list of the PHCRT occurring in the MIRC study area is found in Table 4-1. All of the family, subfamily, or species that are listed in the CHCRT also occur on the PHCRT list. Descriptions of these taxa will be presented only in the CHCRT section. Descriptions of the individual families, subfamilies, or species comprising the fish, invertebrate, and sessile benthos MUS are described in the following paragraphs.

Sphyrnidae (Hammerhead Sharks)

Status - Two species of hammerhead sharks are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Only the scalloped hammerhead (Sphyrna lewini) has been reported from the CNMI and Guam (Myers and Donaldson 2003) and has EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, there is no data available to determine if the scalloped hammerhead of the PHCRT is approaching an overfished situation (NMFS 2004a). Hammerhead sharks are generally caught in low numbers as part of longline fishery (NMFS-PIR 2001) and are readily available to inshore primitive and small commercial fisheries (Compagno 1998). This species is listed on the IUCN Red List of threatened species as near threatened (Kotas 2000).

Distribution - Hammerheads are wide-ranging, coastal-pelagic, and semi-oceanic sharks that inhabit tropical and warm temperate waters which occur over continental and insular shelves (Compagno 1984, 1998).

Habitat Preferences - Hammerhead sharks are found in a wide variety of coral reef habitats (Hennemann 2001). They are very active swimmers occurring in pairs, in schools or solitary, ranging from the surface, surfline, and intertidal region down at least 275 m depth (Compagno 1984). Juveniles often occur in schools frequently inhabiting inshore areas such as bays, seagrass beds, and lagoon flats for foraging near the bottom before moving into deeper waters as adults (WPRFMC 2001). As adults, they can be found in shallow inshore areas during mating or birthing events (Compagno 1984).

Life History - Hammerhead sharks make long seasonal, north-south migrations to warmer waters in the winter and cooler waters in the summer (Hennemann 2001). They are viviparous, having a gestation period of about 12 months (WPRFMC 2001). The scalloped hammerhead produces an offspring of 15 to 31 pups per liter and utilizes shallow, turbid coastal waters (e.g., Guam's inner Apra Harbor) as nursery areas (Compagno 1984; Myers 1999).

Dasyatididae, Myliobatidae, and Mobulidae (Whiptail Stingrays, Eagle Rays, and Manta Rays)

Status - Six species of rays (four stingrays, the spotted eagle ray [*Aetobatis narinari*] and the manta ray [*Manta birostris*]) are managed in Micronesia as part of PHCRT by the WPRFMC (2001). All six species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if rays of the PHCRT are approaching an overfished situation (NMFS 2004a). The white-spotted eagle ray is taken as a by-catch, while the manta ray is neither a fisheries nor a by-catch species (Cavanagh et al. 2003). Eagle rays and devil rays are attractive and desirable as captives in large aquaria and oceanaria (Compagno and Last 1999a, 1999b). Both of the above species are listed on the IUCN Red List of threatened species as data deficient (Ishihara 2000; Ishihara et al. 2002). In addition, the porcupine stingray (*Urogymnus asperrimus*) is listed as vulnerable on the IUCN Red List (Compagno 2000).

Distribution - Stingrays range throughout the Indo-Pacific region, while the spotted eagle and manta rays are worldwide occurring in tropical and subtropical seas and warm temperate and tropical oceans, respectively (Myers 1999; Hennemann 2001).

Habitat Preferences - Habitat preferences for most rays include sand and mud bottoms of continental shelves with a few species occurring on coral reefs (Myers 1999). Juveniles inhabit a variety of habitats from shallow clear lagoons to outer reef slopes. Nursery areas are associated with seagrass beds, mangroves, and shallow sand flats (WPRFMC 2001). Adults utilize shallow clear lagoons to outer reef slopes at depths ranging from 0 to 100 m (Myers 1999) or deeper (e.g., eagle rays: 527 m, sting rays: 480 m) (Compagno and Last 1999a; Last and Compagno 1999).

Life History - Stingrays are viviparous (Last and Compagno 1999), whereas eagle rays and manta rays are ovoviviparous (WPRFMC 2001). Stingrays produce a litter with two to six young with a 12- month gestation period (Last and Compagno 1999). The spotted eagle ray produces an average of four pups per liter after a gestation period of about 12 months (Bester 2004), while the manta ray may give birth to one pup during a breeding season (Passarelli and Piercy 2004). During the winter, manta rays migrate to warmer areas, deeper waters or disperse offshore (Passarelli and Piercy 2004). Some species of eagle rays breed in shallow bays and lagoons (Compagno and Last 1999a).

Serranidae (Groupers)

Status - More than 40 species of groupers are managed in Micronesia as part of BMUS and PHCRT by the WPRFMC (1998, 2001). All 40 species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if groupers of the PHCRT are approaching an overfished situation (NMFS 2004a). Groupers are most highly priced food fishes and are actively caught by commercial and sport fishermen (Heemstra and Randall 1999). The following groupers within the MIRC study area have been listed on the IUCN Red List of threatened species: giant grouper (*Epinephelus lanceolatus*) as vulnerable (Sadovy 1996); brown-marbled grouper (*E. fuscoguttatus*) as near threatened (Cabanban 2004); and humpback grouper (*Cromileptes atlivelis*) as data deficient (Samoilys and Pollard 2000).

Distribution - Groupers are robust-bodied, long-lived, benthic fishes with a worldwide distribution and occur in tropical and semitropical seas of the Indo-Pacific region (Debelius 2002). Their wide geographic distribution is thought to be due to the relatively long pelagic phase as larvae (Allen et al. 2003).

Habitat Preferences - Serranids inhabit a wide variety of habitats (Myers 1999). Larvae tend to be more abundant over the continental shelf than oceanic waters, avoid surface waters during the day, are evenly distributed vertically in the surface water column at night, and may be influenced by oceanic currents (Leis 1987; Rivera et al. 2004). Juveniles are found in shallow-water reef areas (seagrass beds and tide pools) and estuarine habitats (WPRFMC 2001). Adults utilize shallow coastal coral reef areas to deep slope rocky habitats from 0 to 400 m (Heemstra and Randall 1993). Regardless of size, groupers are typically ambush predators, hiding in crevices and among coral and rocks (WPRFMC 2001). Most species of groupers are solitary fishes with a limited home range (Heemstra and Randall 1993).

Life History - Spawning in groupers is typically seasonal and synchronized by lunar phase (Grimes 1987) with some species of groupers migrating several kilometers to spawn (Heemstra and Randall 1993). Groupers tend to spawn in predictable, dense aggregations (some species spawn in pairs) with individual males spawning multiple times during the breeding season (Myers 1999; Rivera et al. 2004).

Lethrinidae (Emperors)

Status - Lethrinids are managed in Micronesia as part of BMUS and PHCRT by the WPRFMC (1998, 2001). Numerous species have been reported from the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Emperors are commonly taken by bottom handline fishing in Guam (Amesbury and Myers 2001) and are of moderate to significant importance in commercial, recreational, and artisanal fisheries throughout the tropical Pacific (WPRFMC 1998). Currently, no data are available to determine if emperor fishes of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The emperor fish is widely distributed over the Indo-Pacific in tropical and sub-tropical waters with a few species ranging into warm-temperate waters (Debelius 2002).

Habitat Preferences - Little is known about the biology of the emperor fish (WPRFMC 2001). Emperors are known to occur in the deeper waters of coral reefs and adjacent sandy areas from 0 to 350 m (WPRFMC 2001). Some lethrinid species are found inhabiting coastal waters, including coral and rocky reefs, sand flats, seagrass beds, and mangrove swamps (Debelius

2002). Most species occur either singly or in schools to feed primarily at night on or near reefs (Myers 1999).

Life History - Spawning behavior of lethrinids is poorly documented (WPRFMC 1998). Based on available data, spawning occurs throughout the year and is preceded by localized migrations during crepuscular periods (Carpenter 2001b). Peak spawning events occur on or near the new moon. Spawning occurs near the surface as well as near the bottom of reef slopes (WPRFMC 2001).

Chlopsidae, Congridae, Moringuidae, and Ophichthidae (False Morays, Conger and Garden Eels, Spaghetti Eels, and Snake Eels)

Status - Forty species of eels are managed in Micronesia as part of PHCRT by the WPRFMC (2001). More than half of the managed eel species (60%) occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if eels of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Eels are distributed worldwide in tropical and temperate seas (Allen and Steene 1987).

Habitat Preferences - Both juvenile and adult eels inhabit cryptic locations in the framework of coral reefs (e.g., false moray) or softbottom habitats (e.g., spaghetti, snake, and conger/garden eels) (Myers 1999). Habitats vary between the different families from the false moray – secretive indwellers of coral heads, seaward reefs, and seagrass beds at depths of 0 to 56 m; conger/garden eels – solitary or large colonies on sand patches/flats or slopes away from reefs at depths of 7 to 53 m with strong currents; spaghetti eels – shallow sandy areas, remaining hidden beneath the surface of the sediment at depths of 36 to 105 m; and snake eels – indwellers that stay buried in the sand or mud with a few occasionally emerging to traverse sand, rubble, or seagrass habitats at depths of 16 to 68 m (Myers 1999; Smith 1999; Debelius 2002; Allen et al. 2003).

Life History - Most eel species are known to migrate for spawning (WPRFMC 2001). Individual spawning characteristics varies among the different families. False morays are known to migrate off the reef to spawn and spaghetti eels migrate to the surface to spawn with males that are pelagic (Myers 1999). Snake eels appear to be nocturnal with some species also coming to the surface to spawn (Myers 1999). Group spawning of eels has also been documented with large numbers of adults congregating at the water surface at night (WPRFMC 2001).

Apogonidae (Cardinalfishes)

Status - Fifty-eight cardinalfish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). These managed species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if cardinalfish of the PHCRT are approaching an overfished situation (NMFS 2004a). Generally, this species is not important economically, but a few species are seen in the aquarium trade or as tuna bait (Allen 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Apogonids are a very large family of small reef fishes that are distributed in shallow coastal waters of the Atlantic, Pacific, and Indian Oceans (Debelius 2002).

Habitat Preferences - Cardinalfishes are found in water depths ranging from 0 to 80 m and are typically nocturnal, remaining hidden under coral reef ledges, holes, flats, and rubble even among the spines of sea urchins (*Diadema*) or crown-of-thorns starfish (*Acanthaster*) during the day, then emerging at night to feed on the reef (Allen 2001; Amesbury and Myers 2001; Debelius 2002). Although typically solitary, in pairs or loose clusters, a few species (e.g., *Apogon fragilis*) form dense aggregations immediately above mounds of branching corals (Allen et al. 2003). Members of the genera *Apogonichthys*, *Foa*, and *Fowleria* are typically secretive, cryptic inhabitants of seagrasses, algal beds or rubble of sheltered reefs and reef flats (WPRFMC 2001).

Life History - Apogonid species display a variety of different spawning patterns including year-round, spring and fall peaks and phases of the moon (WPRFMC 2001). Courtship and spawning in cardinalfishes are always paired rather than group activities (Debelius 2002). Cardinalfish are also among the few marine fishes with oral brooding with the male carrying the eggs in his mouth until they hatch (Allen et al. 2003).

Blenniidae (Blennies)

Status - Fifty-three species of blennies are managed in Micronesia as part of PHCRT by the WPRFMC (2001). At least 80% of these managed species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if blennies of the PHCRT are approaching an overfished situation (NMFS 2004a). They have very little commercial importance because of their small size (Springer 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Blennies have a worldwide distribution occurring in tropical and temperate seas. The Indo-Pacific population consists of two subfamilies: sabretooth (Salariinae) and combtooth (Blenniinae) blennies based on dentition and diet (Myers 1999).

Habitat Preferences - Blennies are bottom-dwelling fishes that tend to shelter in small holes in the rocky, oyster, or coral reefs or sand substrate in tidepools (Springer 2001; Debelius 2002). This group exhibits complex color patterns that enable them to be well camouflaged to the surrounding habitat (WPRFMC 2001). Most of the combtooth blennies are sedentary inhabitants of rocky shorelines, reef flats or shallow seaward reefs from 1 to 30 m depths (Myers 1999). Some combtooth blennies (e.g., *Alticus*, *Istiblennius*, and *Entomacrodus*), called rockskippers, inhabit tidal zones where they are able to leap between tide pools, while others in the genus *Escenius*, generally occupy coral-rich areas, which are atypical due to their limited distribution (Allen et al. 2003). Sabretooth blennies utilize empty worm tubes or shells when they are not actively swimming above the seafloor mimicking (e.g., bluestreak cleaner wrasse, *Labroides dimidiatus*) or pursuing other fishes at depths from 1 to 40 m (Allen et al. 2003).

Life History - The reproductive biology of blennies has been studied extensively, although there are many variations, most are demersal territorial fishes that deposit adhesive eggs in or near a shelter hole that are guarded by the male (Amesbury and Myers 2001). Spawning occurs throughout the year with a peak from January to April (WPRFMC 2001).

Pinguipedidae (Sandperches)

Status - Four shallow-water sandperch species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). All managed species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if sandperches of the PHCRT are approaching an overfished situation (NMFS

2004a). A few species are large enough to be of commercial importance as food, but only of limited value (Randall 2001d). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Only the genus, *Parapercis*, occurs in the Indo-Pacific region (Myers 1999).

Habitat Preferences - This genus typically occurs on sandy bottoms near rubble, rock, or coral reefs, where they typically rest on the bottom using well-separated pectoral fins (WPRFMC 2001). Adults are found at depths ranging from 1 to 50 m with some species occurring in deeper waters (100 to 300 m) (Myers 1999).

Life History - Sandperches live in small harems with a single dominant, territorial male (Allen et al. 2003). Some are unisexual (Randall 2001d). Courtship and spawning occur just before sunset year round (Myers 1999). There is no evidence of spawning migrations (WPRFMC 2001).

Bothidae/Pleuronectidae/Soleidae (Flounders and Soles)

Status - Nine shallow-reef flatfish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Four left-eyed flounders and two soles occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Although flatfishes are among the world's important food fishes, there is currently no data available to determine if flatfishes of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Flatfishes are distributed on tropical and temperate continental shelves worldwide. Some species are associated with coral reefs in the Indo-Pacific (Myers 1999).

Habitat Preferences - Habitat for most flatfish consist of softbottoms such as sand, mud, silt, or gravel that is often associated with coral reefs (Myers 1999). Some species occur directly on the reef or with the reef framework (WPRFMC 2001). Juveniles and adults are often found in lagoons, caves, flats, and reefs (WPRFMC 2001). Flatfishes exhibit adaptive camouflage to closely match the surrounding bottom habitat (Allen et al. 2003). Some flatfishes are found in water deeper than 100 m (e.g., panther flounder, *Bothus pantheinus*), with some species being common in shallower habitats (1 to 73 m) (Myers 1999). Larvae are often found in the upper 100 m of the water column (WPRFMC 2001).

Life History - Eggs of the flounder and sole are pelagic. As larvae metamorphose into juveniles and adults they become demersal. Information on the reproductive process and the extent of spawning aggregations in the Indo-Pacific species are lacking (WPRFMC 2001).

Ostraciidae (Trunkfishes)

Status - Six trunkfish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001), all occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and all have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if trunkfishes of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Trunkfish or boxfish are distributed in both the Indo-Pacific and Indo-pan-Pacific regions of Micronesia (Myers 1999; Amesbury and Myers 2001).

Habitat Preferences - Ostraciids are solitary, slow-swimming, diurnal predators that inhabit a variety of sand and rubble bottom areas (e.g., subtidal reef flats, lagoons, bays, channels, seaward reefs) covered with moderate to heavy algae or coral growth (Myers 1999; Matsuura 2001a). These fish have been reported at depths from 1 to 100 m (Amesbury and Myers 2001). Postlarvae and juveniles are commonly collected in grassbeds and other shallow areas (WPRFMC 2001).

Life History - Trunkfish are sexually dimorphic. The species of trunkfish studied so far are haremic with males defending a large territory with non-territorial females and subordinate males. Trunkfish spawning occurs in pairs at dusk, usually above a structure (WPRFMC 2001).

Tetradontidae/Diodontidae (Pufferfishes and Porcupinefishes)

Status - Seventeen pufferfish and three porcupinefish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). All of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if pufferfishes or porcupinefishes of the PHCRT are approaching an overfished situation (NMFS 2004a). Some porcupine fishes are inflated, dried, and sold as curios (Leis 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Pufferfish and porcupinefish are distributed worldwide throughout tropical and temperate waters including brackish and some freshwater habitats (Waikiki Aquarium 1999b; Matsuura 2001b).

Habitat Preferences - Both groups have reef-associated and pelagic forms utilizing bottom types of sand, rubble, silt, coral, or rock in estuarine, mangrove, lagoon, and coral reef (e.g., reef flats, seaward reefs, patch reefs) habitats from the shoreline to 100 m (Myers 1999: WPRFMC 2001). Pufferfishes feed in the quiet shallow-waters of the reef during the day and rest in caves or crevices at night. Porcupinefishes also occur close to the reef in quiet waters during the day, often in caves or under ledges, but emerge at night to feed (Waikiki Aquarium 1999b). Most puffers are solitary but a few form small aggregations (WPRFMC 2001). Larval forms are pelagic occurring from 0 to 100 m (WPRFMC 2001).

Life History - Most information on pufferfish reproduction has been collected in temperate locations; however, some assumptions can be made about tropical species (WPRFMC 2001). All species lay demersal adhesive eggs, although the courtship often occurs near the surface (Myers 1999). At least one species, the blacksaddled goby (*Canthigaster valentini*), is haremic with males spawning at midmorning with a different female each day. Females then deposit the eggs in tufts of algae (Myers 1999). Porcupinefish may spawn pelagic or demersal eggs depending on species. As observed in one species, the spiny balloonfish (*Diodon holacanthus*) spawning takes place at the surface near dawn or dusk as pairs or groups of males with a single female. In Hawaii, porcupinefish have a peak spawning in late spring with some spawning also occurring from January to September (WPRFMC 2001).

Ephippidae (Spadefishes and Batfishes)

Status - Three species of batfish are managed in Micronesia as part of PHCRT by the WPRFMC (2001), two of which occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003). All species have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the batfishes of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Batfishes occur in tropical temperate sea worldwide with only the genus *Platax* found in the Indo-west Pacific region of Micronesia (Debelius 2002).

Habitat Preferences - Batfishes are schooling, semi-pelagic fishes which occur over muddy, silty, and/or sandy bottoms and coral reefs (WPRFMC 2001). Juveniles occur singly or in small groups among mangroves and in inner sheltered lagoons or reefs (Kuiter and Debelius 2001). Adults migrate to deeper channels and lagoons, and along deep outer reef walls where they aggregate in large schools or occur singly or in pairs to depths ranging from 20 to 30 m (Myers 1999; Debelius 2001). Juvenile *Platax* species often mimic floating leaves or crinoids, whereas adult species of *Platax* travel through open water tightly-knit schools (Kuiter and Debelius 2001).

Life History - Little information is known about the spawning or egg characteristics of Indo-Pacific ephippids (Leis and Trnski 1989). However, observations on the Atlantic spadefish *Chaetodipterus faber* suggest that members of this family may migrate offshore to spawn and could explain the formation of large schools (Kuiter and Debelius 2001).

Monodactylidae (Monofishes)

Status - Only one species of this family, the diamondfish (*Monodactylus argenteus*), is managed in Micronesia as part of PHCRT by the WPRFMC (2001). The diamondfish has been reported as occurring in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and has EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the diamondfish of the PHCRT is approaching an overfished situation (NMFS 2004a). It is of minor commercial importance, occasionally sold fresh in markets or caught for the aquarium-fish trade (Kottelat 2001). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The diamondfish ranges from the Red Sea to Samoa, north to the Yaeyamas, south to New Caledonia, and Palau to the east Carolines and Marianas in Micronesia (Allen et al. 2003).

Habitat Preferences - Diamondfish are active schoolers that occur in freshwater, brackish estuaries, and harbors but may venture over silty coastal reefs to depths of 10 m (Myers 1999; Allen et al. 2003). Juveniles and adults of this species can be found over silt, mud, sand, or coral bottoms WPRFMC 2001). This species feeds in open water during the day and night (Debelius 2001).

Life History - Diamondfish eggs are demersal and adhesive in freshwater and probably pelagic in seawater (WPRFMC 2001).

Haemulidae (Grunts)

Status - Eleven grunt species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Six of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if grunts of the PHCRT are approaching an overfished situation (NMFS 2004a). Grunts have become scarce in the heavily fished waters of Guam (Myers 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Grunts are distributed in tropical and temperate seas and in marine and brackish waters worldwide. All eleven species have been recorded from Micronesian waters (WPRFMC 2001).

Habitat Preferences - Grunts are mostly reef dwellers which shelter in caves and shipwrecks (Debelius 2001, 2002). These nocturnal predators school during the day under or near overhangs or tabular corals on sandy to muddy bottoms at depths from 1 to 100 m (WPRFMC 2001). Juveniles are commonly found in small groups on grass flats, near mangroves and in other sheltered inshore areas (e.g., lagoons, estuaries; McKay 2001). Adults generally frequent patch reefs, lagoons, channels, inshore and seaward reefs, and outer reef slopes (Myers 1999).

Life History - Little information is available on grunt reproduction in Indo-Pacific locations. Given their similarity to other roving predators (e.g., groupers or snappers), they probably migrate tospawning sites on the outer reef slope for group spawning at dusk (WPRFMC 2001).

Echineididae (Remoras)

Status - Three remora species are managed in Micronesia as part of PHCRT by the WPRFMC (2001), two of which are reported as occurring in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003), and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if remoras of the PHCRT are approaching an overfished situation (NMFS 2004a). Remoras are not considered to be of any commercial importance (Collette 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Remoras are circumglobal in their distribution and are found throughout Micronesia (WPRFMC 2001).

Habitat Preferences - Remoras occur in coastal and pelagic waters and utilize a wide variety of hosts including fishes, marine mammals, and ships/boats (Myers 1999; Debelius 2001). Species associated with coral reef dwellers are found near reefs to 50 m (Allen et al. 2003).

Life History - Information is lacking on the spawning techniques and/or locations of remoras (WPRFMC 2001). Eggs of the sharksucker (*Echeneis naucrates*) and remora (*Remora remora*) are pelagic and spherical (Leis and Trnski 1989).

Malacanthidae (Tilefishes)

Status - Five tilefish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Two of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if tilefishes of the PHCRT are approaching an overfished situation (NMFS 2004a). Tilefishes are very high quality food fishes with several species being commercially important (Dooley 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - This family is distributed worldwide in tropical and temperate seas and is represented by three genera in the Indo-Pacific region (WPRFMC 2001).

Habitat Preferences - Tilefish usually occur singly or in pairs on outer slope reefs (Myers 1999). They can be found in depths ranging from 6 to 115 m in mud, sand, rubble or talus areas of barren seaward slopes (WPRFMC 2001). Tilefish frequently build mounds under rocks in the sand or excavate burrows when facing a potential threat (Debelius 2002).

Life History - Few accounts of spawning are known, but it appears that adult pairs of tilefish make a short spawning ascent to release pelagic, spheroid eggs (Leis and Trnski 1989).

Pseudochromidae (Dottybacks)

Status - Ten dottyback species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Five of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if dottybacks of the PHCRT are approaching an overfished situation (NMFS 2004a). Some species are of commercial importance in the aquarium fish trade (Gill 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Dottybacks are distributed in the tropical Indo-Pacific being represented by two genera in Micronesian waters (Nelson 1994).

Habitat Preferences - Dottybacks are cryptic diurnal inhabitants of coral reefs and rock bottoms in shallow intertidal areas of depths of about 100 m (Gill 1999). They commonly utilize numerous small hiding places such as cracks in rock faces, boulders, small caves or dead corals overgrown by new, and in mixed algae, sponge, and coral habitats (Debelius 2002). Dottybacks usually occur singly or in pairs. Some species live in small aggregations of mixed sizes and utilize large caves as a territory (Debelius 2002).

Life History - The dottybacks are demersal spawners with some species brooding eggs in the mouth of the male, while others lay adhesive egg masses guarded by the male (WPRFMC 2001; Allen et al. 2003). Hatching typically occurs at night, shortly after sunset (WPRFMC 2001).

Plesiopidae (Prettyfins)

Status - Three species of prettyfins are managed in Micronesia as part of PHCRT by the WPRFMC (2001). All three species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if prettyfins of the PHCRT are approaching an overfished situation (NMFS 2004a). Some species are popular in the aquarium trade (Mooi 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Prettyfins are distributed in the tropical Indo-Pacific (Nelson 1994).

Habitat Preferences - Juvenile and adult prettyfins inhabit outer reef slopes and flats hiding in holes and crevices at depths ranging from 3 to 45 m (WPRFMC 2001). Most species are secretive by day but venture out at night to feed (Myers 1999). Prettyfins school in caves or overhangs, are found in loose aggregations or schools around coral heads, or occur solitary (Mooi 1999).

Life History - Prettyfin reproduction is similar to the closely related dottybacks (WPRFMC 2001). They produce demersal eggs with hair-like filaments that either entangle with one another to form a mass or adhere eggs to a hard surface (Mooi 1999). Eggs are guarded by the male in a crevice or cave and males are known to mouthbrood the eggs (Mooi 1999; Myers 1999).

Caracanthidae (Coral crouchers)

Status - Two coral croucher species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Both species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if coral crouchers of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Coral crouchers are distributed in the Indian and Pacific Oceans (Nelson 1994).

Habitat Preferences - Coral crouchers inhabit branches of certain *Stylophora*, *Pocillopora*, and *Acropora* corals at depths from 0 to 10 m where they tightly wedge themselves into the coral branched when disturbed (Myers 1999). Other than their close association with corals, little is known of their biology (Poss 1999b).

Life History - The spawning mode and development at hatching of coral crouchers is not known (WPRFMC 2001).

Grammistidae (Soapfishes)

Status - Six species of soapfish are managed in Micronesia as part of PHCRT by the WPRFMC (2001). All six species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if soapfishes of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Soapfishes are distributed in the Atlantic, Pacific, and Indian Ocean represented by five genera in Micronesia of the Indo-Pacific region (Myers 1999; WPRFMC 2001).

Habitat Preferences - Soapfishes are small, grouper-like, secretive fishes that occur on reef flats, shallow lagoon, outer reef slopes, and wave-washed seaward reefs (WPRFMC 2001). They often hide in small caves, under ledges or in holes at depths up to 150 m (Myers 1999).

Life History - The soapfish, like the grouper, are generally unisex. All species are solitary and territorial. *Liopropoma* has pelagic eggs, whereas *Pseudogramma* has large demersal eggs (WPRFMC 2001).

Aulostomidae (Trumpetfishes)

Status - One trumpetfish species, *Aulostomus chinensis*, is managed in Micronesia as part of PHCRT by the WPRFMC (2001). This species occurs in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and has EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the trumpetfish of the PHCRT is approaching an overfished situation (NMFS 2004a). It has no commercial importance, but is occasionally taken as by-catch in artisanal fisheries (Fritzsche and Thiesfeld 1999a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The trumpetfish is distributed in the tropical Atlantic and Indo-Pacific region occurring in Hawaii, Micronesia, and American Somoa (Nelson 1994; WPRFMC 2001).

Habitat Preferences - Trumpetfish occur in virtually all reef habitats except areas of heavy surge to a depth of 122 m (Myers 1999). These fish are solitary ambush predators which hover vertically among branches of corals and seagrasses, hide within schools of surgeonfishes, or use the body of a large parrotfish as cover to approach unsuspecting prey (Waikiki Aquarium 1999c).

Life History - Spawning of trumpetfishes has been reported occurring at dusk when individual males and females ascend to a depth of 5 to 8 m to release gametes before returning to the bottom (WPRFMC 2001).

Fistularidae (Cornetfishes)

Status - One cornetfish species, *Fistularia commersonnii*, is managed in Micronesia as part of PHCRT by the WPRFMC (2001). This species occurs in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and has EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if the cornetfish of the PHCRT is approaching an overfished situation (NMFS 2004a). Although not important in commercial fisheries, they are frequently taken in trawls and by various types of artisanal gear and may appear in local food markets (Fritzsche and Thiesfeld 1999b). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - The cornetfish is distributed in the tropical Atlantic, Pacific, and Indian Oceans and is represented by a shallow-water and deepwater species in Indo-Pacific region (Nelson 1994; WPRFMC 2001).

Habitat Preferences - A shallow-water species, the cornetfish occurs in virtually all reef habitats except in areas of heavy surge to a depth of 122 m (Myers 1999; Allen et al. 2003). They are usually seen in relatively open sandy areas within schools of similarly sized individuals (WPRFMC 2001) and occasionally occur in mid-water, above steep dropoffs (Myers 1999).

Life History - Cornetfish eggs are large, pelagic, and subject to advection by ocean currents (WPRFMC 2001).

Anomalopidae (Flashlightfishes)

Status - Two flashlight fish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Both species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if flashlightfishes of the PHCRT are approaching an overfished situation (NMFS 2004a). Flashlightfishes are popular species in public aquariums and a target as bait for local fisherman (Paxton and Johnson 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Flashlightfishes are scattered in warm-water localities, primarily the Indo-Pacific region (Nelson 1994).

Habitat Preferences - Flashlighfishes utilize caves and/or crevices within the coral reef habitat ranging at depths from 30 to 400 m and as shallow as 2 m (Myers 1999). Flashlightfishes are nocturnal, remaining hidden during the day and venturing out into the water column at night to feed (WPRFMC 2001). They occur in large aggregations on outer reef slopes on dark, moonless nights where they probably utilize their light organs for feeding, defense, schooling, or mating (Waikiki Aquarium 1999d; Allen et al. 2003).

Life History - The eggs of flashlightfishes are pelagic, positively buoyant, and subject to advection by ocean currents (WPRFMC 2001).

Clupeidae (Herrings, Sprats, and Sardines)

Status - Six clupeid species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Two species of sprat occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if sprat of the PHCRT are approaching an overfished situation (NMFS 2004a). In the Marianas, the blue sprat (*Spratelloides delicatulus*) is caught by butterfly (lift) nets and used as bait or food (Myers 1999). None of these species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Clupeids are distributed worldwide in freshwater and marine systems and are represented by four genera in Micronesia and the Indo-Pacific region (Nelson 1994; Myers 1999).

Habitat Preferences - Represented by the subfamily Dussumierinae, both tropical sprat species occur in coastal water habitats over sand, mud, rock, and coral reefs from the surface down to 20 m (WPRFMC 2001). The blue sprat schools near the surface of clear coastal waters, lagoons, and reef margins during feeding, whereas the sharp-nosed sprat inhabits deep lagoons and the outer reef slopes (Myers 1999).

Life History **-** Clupeid eggs are spherical and thought to be pelagic in all tropical taxa except Spratelloides which has demersal eggs (Leis and Trnski 1989).

Engraulidae (Anchovies)

Status - Seven anchovy species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Four of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if anchovies of the PHCRT are approaching an overfished situation (NMFS 2004a). Anchovies are commercially important being utilized as live bait for pole and line tuna fisheries (Myers 1999; Wongratana et al. 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Anchovies are distributed in the Atlantic, Indian, and Pacific Oceans represented by three genera in Micronesia of the Indo-Pacific region (Nelson 1994; Myers 1999).

Habitat Preferences **-** Anchovies typically inhabit estuaries and turbid coastal waters, but some occur over inner protected reefs, and at least one species, the oceanic or buccaneer anchovy (*Encrasicholina punctifer*) is found in large atoll lagoons or deep, clear bays (WPRFMC 2001). Juvenile and adult anchovies are planktivores utilizing the surface waters over sand, mud, rock, or coral reef habitats (Myers 1999). The little priest (*Thryssa baelama*) anchovy occurs in large schools in turbid waters of river mouths and inner bays (WPRFMC 2001).

Life History - Anchovy eggs are pelagic and subject to advection by ocean currents (WPRFMC 2001). In the genera *Thryssa*, eggs are spherical and small to moderate in size, whereas the genera *Encrasicholina* and *Stolephorus*, eggs are ovate to elliptical and vary from small to large (Leis and Trnski 1989).

Gobiidae (Gobies)

Status **-** In Micronesia, 159 gobies are managed as part of PHCRT by the WPRFMC (2001). At least 122 goby species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if gobies of the PHCRT are approaching an overfished situation (NMFS 2004a). Most gobies have no commercial or recreational importance other than food for larger fishes (Larson and Murdy 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution **-** Gobies are distributed worldwide in temperate and tropical seas represented by 212 genera in the Indo-Pacific region (WPRFMC 2001; Allen et al. 2003).

Habitat Preferences - Gobies occur in a variety of habitats such as rocky shorelines, coral reefs, reef flats, shallow seaward reefs, sand flats, and seagrass beds (Myers 1999). The majority of gobies utilize the coral reef habitat where they exhibit high diversity and abundance, but may occur in adjacent coastal and estuarine waters (Larson and Murdy 2001). Many gobies also occupy a wide variety of substrata ranging from mud to rock or coral or live in close association with other marine organisms such as sponges, gorgonians, or snapping shrimps at depths from 1 to 48 m (Debelius 2002). Various gobies (e.g., *Bryaninops*, *Paragobiodon*, *Gobiodon*) live within or occur in groups hovering above the branches of various coral species (*Millepora* spp., *Porites cylindrica*, *P. lutea*, *Acropora*, and *Cirrhipathes anguina*) (WPRFMC 2001). Several genera (*Amblyeleotris*, *Cryptocentrus*, *Ctenogobiops*, *Vanderhorstia*, *Lotilia*, and

Mahidolia) have a symbiotic relationship with one or more species of alpheid prawns in which the gobies occupy and/or share a burrow (Allen et al. 2003). The gobies, either singly or in pairs, act as sentinels for the snapping shrimp (Alpheus spp.) which maintains the burrow (WPRFMC 2001).

Life History - Gobies appear to spawn promiscuously with many individuals loosely organized into a social hierarchy or with individuals maintaining small contiguous territories (WPRFMC 2001). Pairing and apparent monogamy is also documented for a number of gobies (Debelius 2002). Female gobies lay a small mass of eggs in burrows, on the underside of rocks or shells, or in cavities within the body of sponges (Larson and Murdy 2001). Males guard the nesting site and eggs, which are attached to the substrate at one end by a tuft of adhesive filaments (WPRFMC 2001).

Lutjanidae (Snappers)

Status - Snapper species are managed in Micronesia as part of BMUS and PHCRT by the WPRFMC (1998, 2001). Twenty-three lutjanid species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if snappers of the PHCRT are approaching an overfished situation (NMFS 2004a). Snappers are important to artisanal fisheries where they are caught with handlines, traps, a variety of nets, and trawls (Anderson and Allen 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Snappers occur in the subtropical and tropical waters of the Atlantic, Indian, and Pacific Oceans and are represented by eight genera in Micronesia of the Indo-Pacific region (Nelson 1994; Myers 1999).

Habitat Preferences - Snappers are slow growing, long-lived fish that inhabit shallow coastal coral reef areas to deep (0 to 400 m) slope rocky habitats (Amesbury and Myers 2001; Allen et al. 2003). Snapper larvae tend to be more abundant in water over the continental shelf than the open ocean waters, are absent from surface waters during the day, and undergo nighttime vertical migrations (Leis 1987). Juveniles utilize a wide variety of shallow-water reef and estuarine habitats, whereas adults primarily utilize shallow to deep reef and rocky substrate (WPRFMC 2001). Some snapper species exhibit higher densities on the upcurrent side versus the downcurrent side of islands, banks, and atolls probably due to the increased availability of allochthonous planktonic prey (Moffitt 1993).

Life History - Snappers are batch or serial spawners, spawning multiple times over the course of the spawning season, exhibit a shorter, more well-defined spawning period, or have a protracted spawning period (Allen 1985; Parrish 1987; Moffitt 1993). They form large aggregations near areas of prominent relief and spawn with lunar periodicity coinciding with new/full moon events (Grimes 1987).

Monacanthidae (Filefishes)

Status - Seventeen filefish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Eleven of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if filefishes of the PHCRT are approaching an overfished situation (NMFS 2004a). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Filefishes occur in tropical and temperate waters of the Atlantic, Indian, and Pacific Oceans (Nelson 1994).

Habitat Preferences - Filefishes are found in lagoons, shallow coral and rocky reefs, seaward reefs with steeply sloping areas, and seagrass beds in depths ranging from 10 m to over 220 m (Myers 1999; Hutchins 2001). Adults are solitary or occur in pairs, while some juvenile species form schools (Debelius 2001).

Life History - Little is known of the reproduction of most filefish species (Debelius 2002). Some species are sexually dimorphic (WPRFMC 2001) and lay demersal eggs in nests near the base of dead corals that may be guarded by at least one of the parents (Myers 1999).

Caesionidae (Fusiliers)

Status - Ten fusilier species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Four species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if fusiliers of the PHCRT are approaching an overfished situation (NMFS 2004a). Fusiliers are important in coral-reef fisheries where they are utilized as bait fish for tuna fisheries (Carpenter 2001c). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Fusiliers occur in the tropical waters of the Indo-Pacific region (Allen et al. 2003).

Habitat Preferences - Fusiliers are schooling, planktivorous fishes that are close relatives of the lutjanid snappers (Debelius 2002). They are abundant along steep outer reef slopes and around deep lagoon pinnacles over softbottoms (Myers 1999). During the day, fusiliers typically congregate in large, fast swimming zooplankton-feeding mixed aggregations in mid-water around reefs (Allen et al. 2003). At night, fusiliers shelter in crevices and under coral heads (WPRFMC 2001).

Life History - Fusiliers have a prolonged spawning season with recruitment peaks occurring once or twice a year (WPRFMC 2001). The yellowback fusilier (*Casio teres*) has been observed spawning in large schools around a full moon. This species migrates at dusk in large groups during slack tide. During spawning they stay near the surface and subgroups within the mass swirl rapidly in circles and release gametes (Carpenter 1988).

Antennariidae (Frogfishes)

Status - Twelve frogfish species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Nine of these species occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if frogfishes of the PHCRT are approaching an overfished situation (NMFS 2004a). Aside from their value in the aquarium trade, frogfishes have no significant economic interest in the western central Pacific (Pietsch 1999). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Frogfishes occur in all subtropical and tropical waters of the Indo-Pacific region and occasionally temperate waters (Nelson 1994).

Habitat Preferences - Frogfishes are found in estuaries and turbid coastal waters, but occur in low number and are rare on most coral reefs areas (WPRFMC 2001). Habitats include seagrass beds, algae, sponge, seaward reefs, and rock or corals within tidepools and lagoon (Waikiki Aquarium 1999e).

Life History - Spawning female frogfishes lay thousands of tiny eggs within large, (raft)-shaped gelatinous masses at 3 to 4 day intervals (Myers 1999).

Syngnathidae (Pipefishes and Seahorses)

Status - In Micronesia, 37 pipefish and seahorse species are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Twenty pipefish species and the thorny seahorse (*Hippocampus histrix*) occur in the CNMI and Guam (Amesbury and Myers 2001; Myers and Donaldson 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if pipefishes or seahorses of the PHCRT are approaching an overfished situation (NMFS 2004a). Some species regularly appear in the aquarium trade (Paulus 1999). The alligator pipefish (*Syngnathoides biaculeatus*), banded pipefish (*Doryrhamphus dactyliophorous*), and the thorny seahorse have been listed on the IUCN Red List of threatened species as data deficient in the MIRC study area (Vincent 1996a, 1996b; Lourie et al. 2004).

Distribution - Pipefishes and seahorses are circumtropical and temperate in their distribution occurring in the Atlantic, Indian, and Pacific Oceans in fresh, brackish, and marine waters (Nelson 1994).

Habitat Preferences - Syngnathids are small, inconspicuous bottom dwellers that occur in a wide variety of shallow habitats from estuaries and shallow sheltered reefs to seaward reef slopes (WPRFMC 2001). Habitats include seagrasses, floating weeds, algae, corals, mud bottoms, and sand, rubble, or mixed reef substrate from tidepools to lagoon and seaward reefs (Myers 1999). Demersal syngnathid populations occur in singly or in pairs at depths ranging from a few centimeters to more than 400 m, although they are generally limited to water shallower than 50 m (Allen et al. 2003). Juveniles are occasionally found in the open sea in association with floating debris (WPRFMC 2001).

Life History - Spawning by pipefishes and seahorses involves the female depositing her eggs into a ventral pouch on the male, who carries the egg until hatching at intervals of 3 to 4 days (WPRFMC 2001). Breeding populations occur throughout the salinity range from fresh to hypersaline waters (Dawson 1985).

Invertebrate Management Unit Species

Gastropods (Sea Snails and Sea Slugs)

Status - Gastropods consisting of sea snails (prosobranchs, snails of the subclass Prosobranchia) and sea slugs (opisthobranchs, sea slugs of the subclass Opistobranchia) are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). Over 1,300 gastropod species (895 prosobranchs and 485 opisthobranchs) occur in CNMI and Guam (Carlson and Hoff 2003; Smith 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). None of Guam's prosobranchs are known to be endemic; however, several are endemic to the Marianas. The majority of the 895 prosobranchs Smith (2003) reported for Guam are marine species. The actual diversity of marine prosobranchs of Guam and the CNMI is probably much greater than currently known considering that the majority of prosobranchs less than 3.5 mm in size have yet to be described (Smith 2003). The topshell gastropod (*Trochus niloticus*) was introduced after World War II (WWII) in an effort to establish a commercial fishery (Smith 2003). Currently, it is regulated with size restrictions and strictly monitored (Hensley and Sherwood 1993). During a cursory survey of Apra Harbor, Paulay et al. (1997) found 218 gastropod species. The species diversity in Apra Harbor is expected to be greater (DoN 2005b).

Distribution - Gastropods are found worldwide in tropical, subtropical, and temperate waters of marine and freshwater ecosystems (Kay 1995).

Habitat Preferences - Gastropods inhabit all bottom econiches of coral reef ecosystems ranging from the surfaces of sediments and rocks, dead coral heads, living corals to seaweed thalloms (Sorokin 1995). The prosobranchs are the most numerous of the gastropods occupying a variety of reef habitats including soft sediments, rocky and stony littoral/sublittoral areas, reef flat rocks and outer slope rocks, lagoons of barrier reefs, trenches of rocks at the reef-flat edge and beach rocks, reef flats, and patch reefs (Sorokin 1995). The prosobranch (*Trochus niloticus*) occupies a well defined habitat from the intertidal and shallow subtidal zones on the seaward margin of coral reefs at depths ranging from 0 to 24 m (Nash 1993; DoN 2005b). Nudibranchs or sea slugs are predatory opisthobranchs inhabiting a variety of substrates including the surface of soft corals (alcyonaceans and gorgonaceans) and sponges (Colin and Arneson 1995; DoN 2005b). Sea slugs prey on diverse taxa including soft corals and sponges (Colin and Arneson 1995; DoN 2005b).

Life History - Sea snails generally have separate sexes, whereas sea slugs are unisexual. Fertilization may be external or internal in sea snails. Sea snail species that undergo internal fertilization produce eggs that may be enclosed in protective layers of gelatinous mucus or corneous capsules. The majority of sea slugs deposit eggs in ribbon-like clusters. In sea snail species, embryos hatch as free-swimming planktonic larvae or as crawling young (Poutiers 1998a).

Bivalves (Oysters and Clams)

Status - Bivalves, consisting of oysters and clams, are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). At least 339 bivalve species occur in CNMI and Guam (Paulay 2003b) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Both the commercially harvested black-lipped pearl oyster (*Pinctada margaritifera*) and giant clams (Tridacnidae) occur on Guam (Paulay 2003a). About 15 bivalve species (three of which are tridacnid clams) are harvested on Guam (Hensley and Sherwood 1993) and at least one of the giant clams (*Hippopus hippopus*) was extirpated (Paulay 2003b).

Distribution - Oysters and clams are found in all tropical and temperate seas of the world except for the giant clams, which are confined to the Indo-West Pacific region (Briggs 1974). The overall biodiversity of the malacological fauna is probably the greatest in the western central Pacific (Poutiers 1998b).

Habitat Preferences - Bivalves comprise 10% to 30% of the coral reef malacofauna utilizing rocky hard substrates for sessile and boring species and soft-bottom areas for vagile species (Sorokin 1995). Sessile bivalves inhabit reef areas such as rocky surfaces of reef-flats, dead coral heads, patch reefs, walls of trenches and channels, and on coarse sands and rubble substrates on flat and littoral areas (Sorokin 1995). Boring bivalves are extremely widespread in areas of the rocky flat and in areas of profuse coral growth hidden in coral colonies (Sorokin 1995). The sandy bottom of channels crossing the reef-flat and its outer slopes as well as on silty coral sands in the lagoons of barrier reefs are inhabited mainly by vagile bivalves (Sorokin 1995). The black-lipped pearl oyster occurs in lagoons, bays, and sheltered reef areas to around 40 m depth, but is most abundant just below the low-water (Sims 1993). Giant clams use various habitats including high- or low-islands, sandy atoll lagoon floors, fringing reefs, or exposed intertidal areas to depths less than 40 m (Munro 1993).

Life History - In the majority of bivalves, sexes are separate. Fertilization is external, giving rise to free-swimming larvae followed by a metamorphosis leading to a benthonic mode of life

(Poutiers 1998b). Some species may be unisexual. If planktonic, the larval stage is reduced or totally absent, young hatch directly as benthic organisms (Poutiers 1998b).

Cephalopods (Nautiluses, Cuttlefishes, Squids, and Octopuses)

Status - Cephalopods are managed in Micronesia as part of PHCRT by the WPRFMC (2001). Twenty-four species including one cuttlefish, one squid, and 22 octopuses have been reported from the CNMI and Guam (Ward 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if cephalopods of the PHCRT are approaching an overfished situation (NMFS 2004a). Cephalopods are of considerable ecological and commercial fisheries importance in the Western Central Pacific where the squid, cuttlefish, and octopus are harvested for food items in the subsistence fishery (WPRFMC 2001) and shells of nautiloids are used for ornamental purposes in the shell curio trade (Dunning et el. 1998). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Cephalopods are found in all tropical and temperate seas of the world except for the nautiloids whose distribution are restricted to Indo-West Pacific region (Roper et al. 1984).

Habitat Preferences - Cephalopods occur over a wide variety of habitats, including deep coral reefs (nautiloids), hole and crevices in rocky or coral areas and burrows in the sand (octopuses), and seagrass beds and nearby reef areas over sandy, muddy, and rocky bottoms (cuttlefishes and squids) (Dunning 1998a, 1998b; Norman 1998; Reid 1998). Their range of depth extends from the surface to over 5,000 m (Roper et al. 1984). Some species (e.g., nautiloids, squids) exhibit diurnal vertical migration, moving upward to feed during the night and dispersing into the deeper water during the day (Dunning 1998a, 1998b).

Life History - Cephalopods have separate sexes and reproduction occurs through copulation (Colin and Arneson 1995). Eggs are encapsulated in a gelatinous finger-like strings (squids), grape-like clusters (cuttlefishes), attached to each other (octopuses), or in a capsule (nautiloids) adhering to various substrates (e.g., rocks, shells, seagrass) (Dunning 1998a, 1998b; Norman 1998; Reid 1998). Spawning varies between the various groups of cephalopods. Nautiloids have a single annual egg laying season in shallow-water (80 to 100 m), peaking around October (Dunning 1998a; WPRFMC 2001), whereas squids and cuttlefish migrate in aggregations seasonally to spawn in response to temperature changes twice a year (Dunning 1998b; Reid 1998). Octopuses lay eggs which are tended by the female until hatching (Norman 1998).

Ascidians (Tunicates)

Status - Tunicates (sea squirts) are managed in Micronesia as part of PHCRT by the WPRFMC (2001). At least 117 species (87 colonial and 30 solitary) have been reported from Guam (Lambert 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Ascidians are of economic importance for bio-prospecting and problematic as marine fouling organisms by clogging cooling water intakes and interfering with boat operations (WPRFMC 2001).

Distribution - Ascidians are common worldwide and inhabit shallow-waters of the tropical Pacific (Colin and Arneson 1995; WPRFMC 2001).

Habitat Preferences - Solitary and colonial tunicates are important components of the reef cryptofauna ranging from high-light and high-energy environments to protected deeper water areas (Sorokin 1995; WPRFMC 2001). Ascidians attach to inert surfaces such as dead corals, stones, shells, pilings, ship bottoms and less durable surfaces of seaweeds, mangrove roots, sand, and mud, or grow epizoically on other sessile organisms (e.g., soft corals, sponges, other tunicates) (Colin and Arneson 1995). Solitary and colonial forms colonize new surfaces in disturbed areas, and are also found on outer reef slopes (WPRFMC 2001). Larval and adult sea squirts occur from intertidal areas to 120 m depth or greater (WPRFMC 2001).

Life History - Both sexual and asexual reproduction occurs in ascidians and is highly variable, both by family and genera. Solitary forms release both eggs and sperm into the water, whereas the colonial forms in ovoviviparous, releasing only larvae (Colin and Arneson 1995). The release of certain chemicals by tunicates may trigger various processes, such as spawning, larval attraction, etc. (WPRFMC 2001). Solitary and colonial ascidians are unisexual but reproduce asexually by budding (WPRFMC 2001).

Bryozoans (Moss Animals)

Status - Bryozoans are managed in Micronesia as part of PHCRT and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). While bryozoans are probably very diverse in the MIRC study area (e.g., Tilbrook 2001), only one species (*Penetrantia clinoidales*) is described on Guam (Paulay 2003c). Bryozoans are economically important for bio-prospecting and as marine fouling organisms that interfere with boat operations and clog industrial water intakes and conduits (WPRFMC 2001).

Distribution - Bryozoans are inhabitants of tropical Pacific reefs ranging from Hawaii to the Indian Ocean (Colin and Arneson 1995).

Habitat Preferences - Though widespread on tropical reefs, bryozoans are often not recognized due to the fact that they occur in mixed associations with algae, hydroids, sponges, and tunicates on older portions of coral reefs (WPRFMC 2001). These benthic sessile organisms occur from the intertidal zone to abyssal depths (WPRFMC 2001). Forming encrusting, erect branching or foliose colonies, bryozoans attach to rocks, corals, shells, other animals, mangrove roots, and algae or grow on shaded surfaces on the undersides of coral heads, rock ledges, rubble, and fill cavities within the reef structure (Sorokin 1995). Encrusting forms are found everywhere, whereas the erect and delicate branching or foliose forms are typical of more protected areas (Sorokin 1995; WPRFMC 2001; DoN 2005b).

Life History - Bryozoans are colonial animals that develop from a sexually-produced zooid (Hawaii Biological Survey 2001b). The asexual budding of the primary zooid develops a group of daughter cells which will undergo a succession of budding and production of daughter cells (i.e., bryozoans are colonies of zooids). Most marine bryozoans are hermaphroditic (produce both eggs and sperm). Bryozoans release sperm into the water column and retain fertilized eggs in a cavity where they are brooded before larvae are released into the water column (WPRFMC 2001). Bryozoans exhibit a positive phototropic reaction, but become negatively phototrophic before metamorphosis, settling in dark places on the reef. This may be dependent upon day length and temperature (WPRFMC 2001). Most bryozoans settle on hard substrates, some settle on sand (Hawaii Biological Survey 2001b).

Crustaceans (Mantis Shrimps, Lobsters, Crabs, and Shrimps)

Status - Crustaceans of the orders Stomatopoda (mantis shrimp) and Decapoda (shrimps, lobsters, and crabs) are managed in Micronesia as part of CMUS and PHCRT by the WPRFMC (1998, 2001). Over 839 crustacean species (36 stomatopods and 672 decapods) have been reported from the CNMI and Guam (WPRFMC 2001; Paulay et al. 2003a) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Currently, no data are available to determine if all crustaceans of the PHCRT are approaching an overfished situation; lobsters are probably overfished (NMFS 2004a; DoN 2005b). Stomatopods are of little economic importance due to their limited use in subsistence fisheries and ornamental trade. However, decapods are very important in commercial, recreational, and artisanal fisheries with limited use in the ornamental trade (except shrimp) throughout the tropical Pacific (WPRFMC 2001). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Crustaceans are amongst the most abundant and diverse marine organisms in waters of the Pacific tropical and subtropical islands. Crustaceans are found in all tropical and temperate seas of the world (Eldredge 1995).

Habitat Preferences - Reef crustaceans are one of the most diverse and abundant groups of the coral reef vagile and sedentary benthos (Sorokin 1995). Crustaceans occur over a wide variety of coral reef habitat and associated environs including cavities of coral and rock or smooth-walled burrows on sandy bottoms (mantis shrimps), pockets of corals, among rubble, or buried in sand on reef flats and in seagrass beds (penaeid, caridean, and stenopodid shrimps), subtidal holes or crevices of rocky and coralline bottoms (spiny, slipper, and coral lobsters), and mud or sandy bottoms in high littoral sands, crevices or burrows among subtidal rocks and coral heads, or on the surfaces of marine plants and other invertebrates (true and hermit crabs) (Chan 1998a, 1998b; Manning 1999; Ng 1998). The depth distribution of these different reef crustaceans (mantis shrimp, coral associated shrimps, lobsters, and crabs) varies from 0 to more than 100 m (WPRFMC 2001). Some crustaceans also provide symbiotic or commensal associations with other marine organisms (e.g., cleaner shrimps, crabs: camouflage, protection, etc.) (Colin and Arneson 1995).

Life History - Stomatopods lay as many as 50,000 eggs which are joined together by an adhesive secretion and held by the female in a small subchelate appendage where the eggs are constantly turned and cleaned. Besides peneids which shed their eggs directly into the water, all other decapods carry their eggs on their pleiopods (WPRFMC 2001).

Echinoderms (Sea Cucumbers and Sea Urchins)

Status - Echinoderms include sea cucumbers (holothuroids), sea urchins (echinoids), brittle and basket stars (ophuiroids), sea stars (asteroids), and feather stars/sea lilies (crinoids). This group is managed in Micronesia as part of PHCRT (WPRFMC 2001). More than 200 echinoderm species (47 holothuroids, 53 echinoids, 47 ophuiroids, 35 asteroids, and 21 crinoids) have been reported from CNMI and Guam (Kirkendale and Messing 2003; Paulay 2003d; Starmer 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). At least 196 of these species are known from Guam (Paulay 2003d). Some echinoderms have economic importance, particularly the sea cucumbers which are prized for the dried muscular body wall. Gonads of some species of sea urchins are edible (Conand 1998). However, outbreaks of the crown-of-thorns starfish (*Acanthaster planci*) since 1967 have had negative economic impacts; an *Acanthaster* outbreak devastated Guam's reefs in 1967 (Colgan 1987) and Tinian's reefs in 1969-1970 (Grigg and Birkeland 1997).

Distribution - The phylum Echinodermata is exclusively marine and distributed throughout all oceans, at all latitudes, and depths from the intertidal zone down to the deep sea (Colin and Arneson 1995). Echinoderm fauna are widely distributed across several localities of the Indo-Pacific region with few taxa being endemic (Pawson 1995).

Habitat Preferences - A small proportion of echinoderms form dense monospecific populations in shallow reef zones and play important roles in trophodynamics and nutrient regeneration. The coral reef habitat and associated environments inhabited by echinoderms include sandy bottoms of lagoons, coral sand, and reef-flat rocks (sea urchins); hardbottom biotopes of reef flats, sublittoral and patch reefs, outer reef slope, and cryptofaunal habitats (sea stars); under stones in trenches on reef flats or on seagrasses (brittle stars); weak current areas in reef-flats and outer slope trenches and caves (feathered stars); and coral slopes (passages), inner/outer lagoons, inner/outer reef-flats covered with sand and rubble (sea cucumbers) (Sorokin 1995;

Conand 1999; Miskelly 1968). Most echinoderms (e.g., brittle and feathered stars) are nocturnal, hiding in the daytime and feeding at nighttime (Sorokin 1995). They also have formed commensal relationships with small reef organism (e.g., shrimps and fishes) (Colin and Arneson 1995).

Life History - The majority of echinoderms have separate sexes, but unisexual forms occur among the sea stars, sea cucumbers, and brittle stars. Many species have external fertilization, which produce planktonic larvae, but some brood their eggs, never releasing free-swimming larvae (Colin and Arneson 1995).

Annelids (Segmented Worms)

Status - Segmented worms or polychaetes are managed in Micronesia as part of PHCRT (WPRFMC 2001). At least 76 genera and over 100 species of polychaetes have been reported from Guam (Bailey-Brock 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Polychaetes are important food resources of reef fishes and invertebrates with some species being indicators of environmental perturbation and reef condition (Bailey-Brock 2003).

Distribution - Polychaetes are primarily marine worms that are extremely abundant and widespread in tropical and temperate oceans. There are very few brackish and freshwater forms living in streams and estuaries of tropical regions (Colin and Arneson 1995). Islands in the tropical central and western Pacific region have species-rich polychaete communities that are mostly cryptic, endolithic, or infanual (Bailey-Brock 1995).

Habitat Preferences - Benthic coral reef polychaetes are associated with hard or softbottom materials or live among marine vegetation (Bailey-Brock 1995). The polychaetes occupying all these econiches in the coral reef biotopes and are classified into two groups: free-living (free-swimming) errant and sedentary (tube-dwelling) segmented worms (Sorokin 1995). Specific types of coral reef habitats frequently colonized by these polychaetes include rocky intertidal areas (e.g., tide pools and shallow sand-filled depressions associated with lava rocks, basalt, and limestone benches), mud and sand at the sediment-water interface, reef flats, sandy tops of patch reefs, sandy cays, seagrasses, mangroves, and fleshy or thalloid algae (Bailey-Brock 1995; Sorokin 1995). In addition to coral reefs, polychaetes also colonize vessel hulls, docks, and harbor walls as well as floating slippers, glass floats, and debris (Bailey-Brock 1995). Polychaetes stabilize sand on reef flats by their tube-building activities, bore into coral rock contributing to the erosion of reef materials, or are commensals of sponges, mollusks, holothurians, and hydroids (Sorokin 1995).

Life History - Most polychaetes have separate sexes, although some are unisexual and a few change sex. Fertilization of eggs takes place in the water column for species, which release their gametes into the water. Other species mate and female retain the fertilized eggs within their body cavities (Colin and Arneson 1995). Some species swarm in water during their breeding season, others spawn during the first lunar cycle, and some undergo asexual breeding by simple division of the body into several pieces (Sorokin 1995).

Sessile Benthos Management Unit Species

Algae (Seaweeds)

Status - All algae (blue-green, green, brown, and red) are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). Over 370 species of algae occur in CNMI (137 species; WPRFMC 2001) and Guam (237 species; Lobban and Tsuda 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Algae are classified as EFH because they are direct contributors to the well-being and protection of fish species, both as a source of food and protection to larvae and small fish species (WPRFMC 2001). Currently, there is no fishery for algal species in the American Flag Pacific Islands (WPRFMC 2001). Green, brown, and red algae are commonly harvested for sale at local markets or used as bait for rod and reel fishing on Guam (Hensley and Sherwood 1993). None of the species found in the MIRC study area are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution - Algae are found worldwide along most shorelines and shallow-water environments. In the Indo-Pacific they have a discontinuous distribution and a low level of endemicity (South 1993).

Habitat Preferences - Seaweeds are prominent organisms in the shallow-water photic zone ranging from the spray zone well above the high tide level to depths as great as 268 m (South 1993). From the intertidal to shallow subtidal zones, they occur on soft and/or hard substrata within a variety of marine benthic habitats such as flat reefs, sheltered bays and coves, and rocky wave-exposed areas along the shore or on the edge of the reef (Truno 1998). Algae occupy a wide range of habitats including but not limited to: sandy bottoms of lagoons; shallow, calm fringing reefs; barrier reef coral bommies; outer reef flats; and the outer reef slope (WPRFMC 2001). Coralline algae are of primary importance in constructing algal ridges that are characteristic of exposed Indo-Pacific reefs preventing oceanic waves from eroding coastal areas (WPRFMC 2001).

Life History - Both sexual and asexual reproduction occurs in the algae with predominance of one or the other being linked to type of algae and the predominant geographical and environmental conditions affecting the algal populations (WPRFMC 2001). Most unicellular and multicellular algae have asexual and sexual life cycles of varying complexity (South 1993).

Porifera (Sponges)

Status - Sponges are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). Over 120 sponge species (124 siliceous and 4 calcareous sponges) have been reported from CNMI and Guam (Kelly et al. 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Sponges are found throughout the MIRC study area (Kelly et al. 2003).

Distribution - Poriferans represent a significant component of all tropical, temperate, and polar marine benthic communities (Kelley-Borges and Valentine 1995). Sponges found in the Indo-West Pacific region are the most diverse in the world (Briggs 1974). Within the Marianas, there is considerable variation in the distribution and composition of poriferan species among neighboring reefs and islands. This was evident by the spongal faunal distribution observed on Guam (Kelly et al. 2003).

Habitat Preferences - Sponge diversity, regardless of depth, is greatest on coral reefs, in caves and vertical areas not colonized by hard corals (WPRFMC 2001). They are also abundant in seagrass beds, mangroves, and other environments (Colin and Arneson 1995). On the reef-flat and on upper zones of the reef slope, the spongal fauna consists mostly of phototropic and boring species. The more abundant and varied spongal communities inhabit the middle depths of the outer slope especially the buttress zone and the upper part of the fore-reef (Sorokin 1995). Sponges also provide homes for a huge variety of animals including shrimp, crabs, barnacles, worms, brittlestars, holothurians, and other sponges (Colin and Arneson 1995).

Life History - Reproduction among sponges is highly variable and is sexual (viviparous and oviparous) or asexual (budding, fragmentation, and gemmules) (Colin and Arneson 1995). Mass spawning and release of sperm is triggered by lunar and diurnal periodicity (WPRFMC 2001).

Corals (Hydrozoans)

Status - Hydrozoans (stinging or fire corals, lace corals, and hydroids) are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). Over 60 hydrozoan species (5 *Millepora* spp., 21 stylasterids, and 42 hydroids [80% leptothecates]) have been reported from CNMI and Guam (Kirkendale and Calder 2003; Randall 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Within the MIRC study area, hydroids are an important component of marine fouling assemblages and may be transported via ship hulls (e.g., Apra Harbor) (Kirkendale and Calder 2003). In CNMI, coral collecting is banned under regulations prohibiting collection of stony hydrozoans (Green 1997). On Guam, coral harvesting (dead or alive) is no longer allowed without a permit (except for educational or research purposes) and is enforced by strict regulations (Hensley and Sherwood 1993).

Distribution - Hydrozoan corals of the order *Milleporina* are found on reefs of the Indo-Pacific, the tropical eastern Pacific, the western Atlantic (Caribbean), and along the coastline of Brazil (Veron 2000). Among the Stylasterina hydrozoans, *Stylaster* occurs in the Indo-Pacific and Atlantic Oceans whereas *Distichopora* occurs all over the Indo-west Pacific and the Galapagos Islands (Veron 2000). Hydroids found in the MIRC study area are also found in tropical, subtropical, and temperate areas of the western and eastern Atlantic Ocean, the western and eastern Pacific Ocean, and the Indian Ocean.

Habitat Preferences - Hydrozoans are colonial, polyp-like animals that occur in cryptic habitats or have calcareous skeletons resembling scleractinian corals (e.g., *Millepora* and *Stylaster* spp.) (Colin and Arneson 1995). *Millepora* spp. are colonial and hermatypic forms that utilize the projecting parts of the reef where strong to powerful turbulent currents occur at depths from 0 to10 m, and may occur in deepwater habitats (Veron 2000; DoN 2005b) and are abundant on upper reef slopes and lagoons (WPRFMC 2001). Lace corals, *Stylaster* and *Distichopora* spp., are abundant under overhangs or on the roof of caves within the reef under low light from 10 to 20 m, occur in deep reef conditions swept by tidal currents, and in deepwater habitats (Colin and Arneson 1995; Veron 2000; DoN 2005b). The branching *Solanderia* spp. is commonly found in exposed areas on wave swept shallow outer reefs, caves, or overhanging environments at depth ranges from 0 to more than 100 m (Colin and Arneson 1995). Hydroids mostly occur on rocky substrates exposed to wave action and surge, on artificial substrates in harbors (pilings, mooring buoys), in crevices, overhangs, and caves (Hoover 1998; Kirkendale and Calder 2003).

Life History - Hydrozoans typically alternate generations between motile medusoid and sessile polypoid phases (Fautin and Romano 1997; Fautin 2002; Ball et al. 2004). Sessile colonies bear polyps specialized for reproduction that asexually produce medusa buds which develop into freeswimming dioecious medusae. The medusae spawn freely in the water column. A fertilized egg develops into a planula that settles, metamorphoses into a polyp, and develops a sessile colony (Fautin and Romano 1997; Ball et al. 2004). In some cases, however, polyp or medusa stages are entirely lacking for some hydrozoans (e.g., trachymedusans do not have a polyp stage) (Collins 2002). The primary polyp can produce other polyps asexually to form a colony (Fautin and Romano 1997).

Corals (Scleractinian Anthozoans)

Status - Stony corals are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). At least 377 scleractinian species (377 stony corals) have been reported from CNMI and Guam (Randall 2003) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). Major and minor coral (curio trade) fisheries exist within the western central Pacific (Hodgson 1998). Within the MIRC study area, coral collecting is banned in CNMI under regulations that prohibit the collection of hermatypic corals (Green 1997) and on Guam strict laws regulate harvesting dead or live corals except for educational or research purposes (Hensley and Sherwood 1993).

Distribution - Communities of scleractinian reef-building (hermatypic) and non-reef building (ahermatypic) corals grow in tropical and subtropical seas globally (Veron 1995; Veron 2000). The Pacific Ocean contains the most diverse coral fauna in the world (Colin and Arneson 1995; Veron 2000).

Habitat Preferences - Stony corals develop colonial forms that may be branching, tabulate, massive, or encrusting, or develop solitary, free-living forms (e.g., mushroom corals) (Veron 2000; WPRFMC 2001). Stony corals are found from the sea surface in nearshore environments down to the deep-sea in more than 6,000 m water depth (Veron 2000; CoRIS 2003; Freiwald et al. 2004; Roberts and Hirshfield 2004). The hermatypic coral fauna are found in a multitude of habitats including shallow surf zones and submerged areas of reef flats, lagoon patch-reef zones, patch reefs, and reef slopes (Veron 2000). Ahermatypic corals colonize areas of low scleractinian coral or algal occurrence including poorly illuminated or even dark biotopes in caves, trenches, and in deep zones of the reef (Sorokin 1995; WPRFMC 2001).

Life History - Hermatypic corals reproduce by sexual (external fertilization and development and brooded planulae, bisexual, unisexual) and asexual (brooded planulae, polyp-balls, polyp bail-out, fission, fragmentation, and re-cementation) development (Veron 2000; WPRFMC 2001; Fautin 2002). Corals may be free spawners (12 month maturation cycle) or brooders (several cycles per year) depending upon their geographic distribution (WPRFMC 2001). In the Marianas, for some corals spawning occurs 6 to 12 days following the June and July full moons (DoD 1999). Mushroom corals are asexual (budding, fragmentation or natural regeneration through fracture) or sexual (dioecious or unisexual) (Veron 2000).

Corals (Non-Scleractinian Anthozoans)

Status - Non-scleractinian anthozoans are managed in Micronesia as part of the PHCRT by the WPRFMC (2001). Over 120 non-scleractinian anthozoan species (including 79 octocorals and 37 anemones, 6 zoanthids, and 10 black corals) have been reported from CNMI and Guam (Paulay et al. 2003b) and have EFH designated within the boundaries of the MIRC study area (WPRFMC 2001; NMFS 2004c). The collection of non-scleractinian anthozoans is banned in the CNMI (Green 1997).

Distribution - The communities of non-scleractinian corals are distributed in shallow tropical and subtropical habitats worldwide (Veron 1995).

Habitat Preferences - Members of the non-scleractinian anthozoans (hexacorals and octocorals) exist only as polyps, either solitary or as colonies. Non-scleractinian hexacorals consist of anemones, zoanthids, black corals, and cerianthids (Colin and Arneson 1995). Anemones have solitary polyps that are attached to hard substrate by their basal disc, burrowed into soft substrate, or become attached to sessile and mobile reef organisms (e.g., hermit crabs) (Colin and Arneson 1995). Some species of anemones also exhibit mimicry appearing like their background or other reef entities (e.g., hard coral or algae) (WPRFMC 2001). Zooanthids have species that are either colonial or solitary often forming large monospecific patch or belt associations on biotopes of reef flats (Colin and Arneson 1995). They usually colonize rock bottom substrates in reef-crest and reef-edge zones (Palythoa), rubble areas and dead corals (Zoanthus, Isaurus) (Sorokin 1995).

Octocorals in the MIRC study area consist of gorgonians (sea fans and sea whips; Order Gorgonacea); telestaceans (Order Telestacea); soft corals (Order Alcyonacea); organ-pipe corals (Order Stolonifera); sea pens and sea pansies (Order Pennatulacea); and blue corals

(Order Helioporacea) (Paulay et al. 2003b). Few species of gorgonians occur in water depths less than 30 m within the MIRC study area. The diversity and abundance of gorgonians increases below the 30 m isobath particularly on steep and cavernous substrates exposed to strong currents. Many of the gorgonians Paulay et al. (2003b) found within the 30 to 60 m depth range in caverns of the southern Orote Peninsula also occur at deeper depths. (60 to 400 m) (Paulay et al. 2003b). The soft coral genera *Siphonogorgia* and *Dendronephthya* are more abundant and diverse in water depths deeper than 60 m in the MIRC study area (Paulay et al. 2003b). The organ-pipe coral (*Tubipora musica*) can be found in many habitats ranging from shallow lagoons to reef slopes (Colin and Arneson 1995; WPRFMC 2001). The blue coral (*Heliopora coerulea*) is typically observed on the intertidal reef flat and fore reef slope within the 1 m to 30+ m depth range (WPRFMC 2001; Paulay et al. 2003b).

Life History - Propagation of non-scleractinian anthozoans is mainly achieved by asexual (vegetative) reproduction (Fautin 2002). Internal brooding (vegetative embryogenesis) is common among anthozoans. In some cases, actinians (anemones) and octocorals asexually produce planulae by parthenogenesis. Polyps of black corals can produce planulae asexually (planuloids) that differ morphologically from sexually-produced planulae. A planuloid can develop into a polyp. Some actinians reproduce asexually by tentacle budding, and by tentacular autotomy and regeneration (the actinian will sever, ingest, and incubate its own tentacles to produce small individuals). Other modes of propagation include transverse fission (a polyp producing a polyp) which occurs in cerianthids, actinians, and zoanthids; longitudinal fission, a mode of asexual propagation commonly used by anemones and by some octocorals and corallimorpharia; and fragmentation which is used by soft corals (Order Alyonacea) and anemones (Order Actinaria) (Lasker 1988; Dahan and Benayahu 1997; Fautin 2002; Ball et al. 2004). Some soft corals produce stolons considered as a budding mechanism (Dahan and Benayahu 1997; Fautin 2002). Sexual reproduction of non-scleractinian anthozoans typically involves the production and release of gametes by the separate sexes, the fertilization of an egg, the development into a planula which will eventually develop tentacles and settle on the seafloor (Ball et al. 2004). Gorgonians and soft corals participate in mass spawning (Fautin 2002).

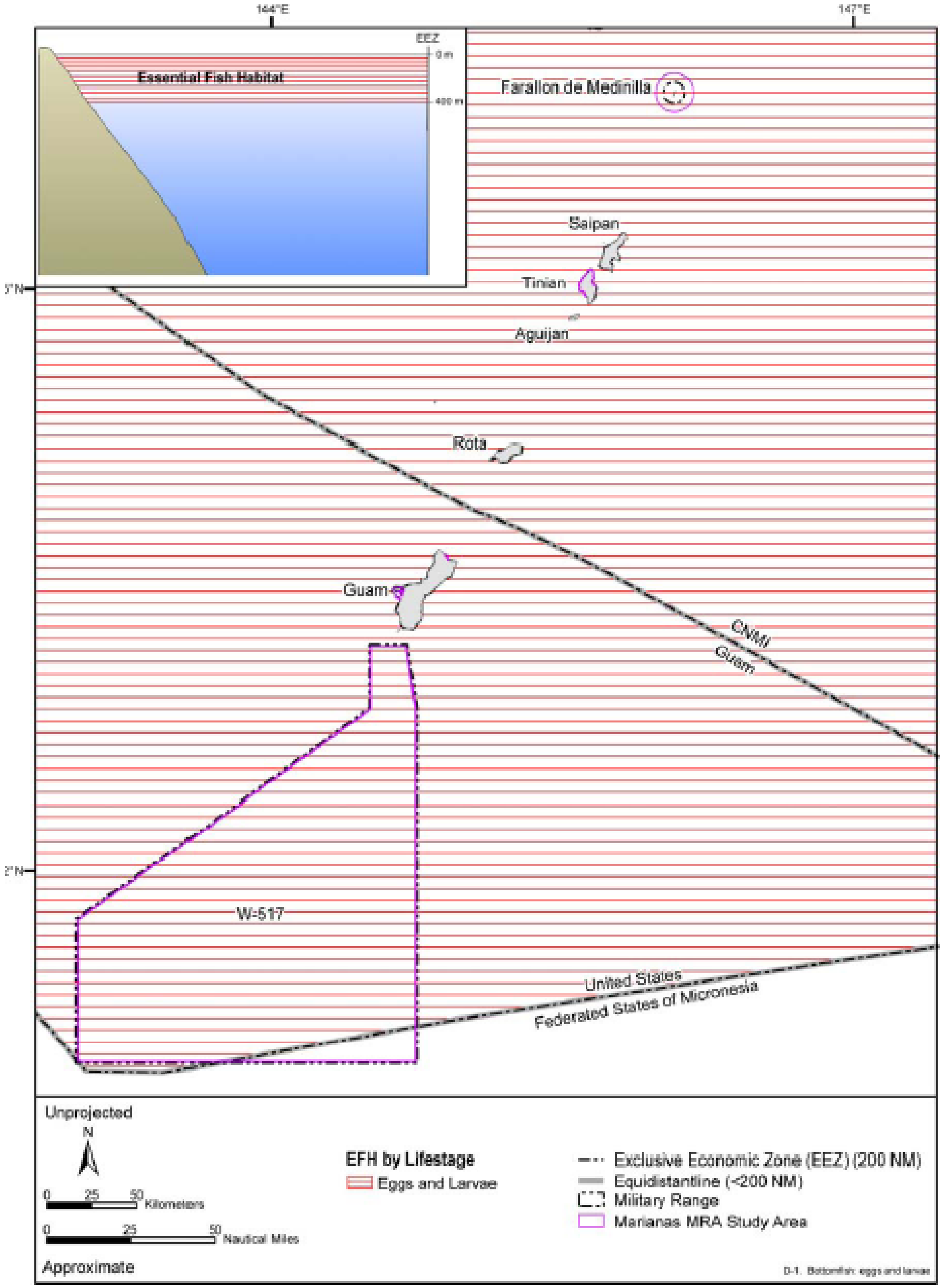


Figure B-1. Essential fish habitat (EFH) for all eggs and larval lifestages of bottomfish designated on Guam, Tinian, and Farallon de Medinilla in the MIRC study area.

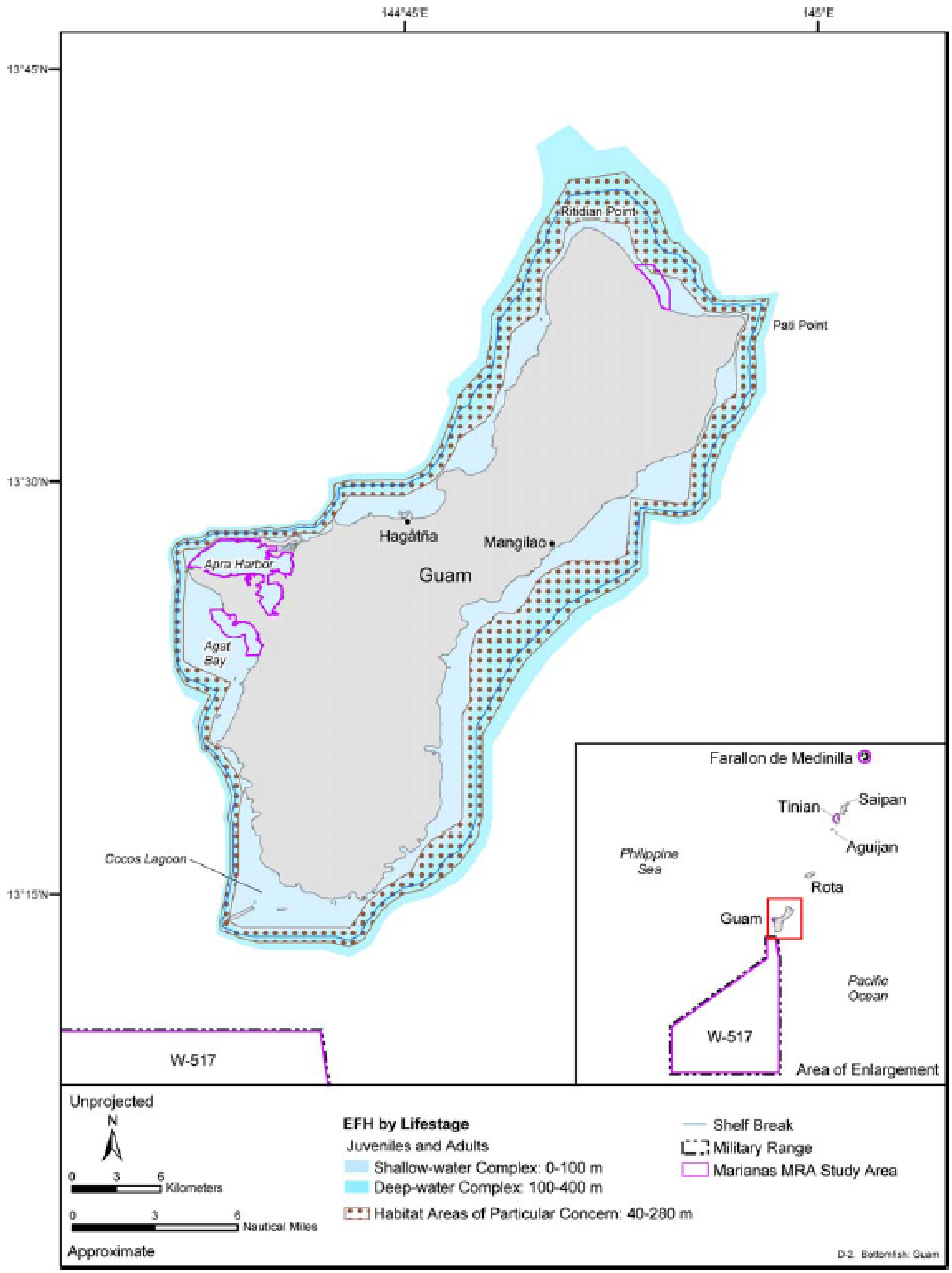


Figure B-2. EFH for all juvenile and adult lifestages of bottomfish and HAPC designated on Guam in the MIRC study area.

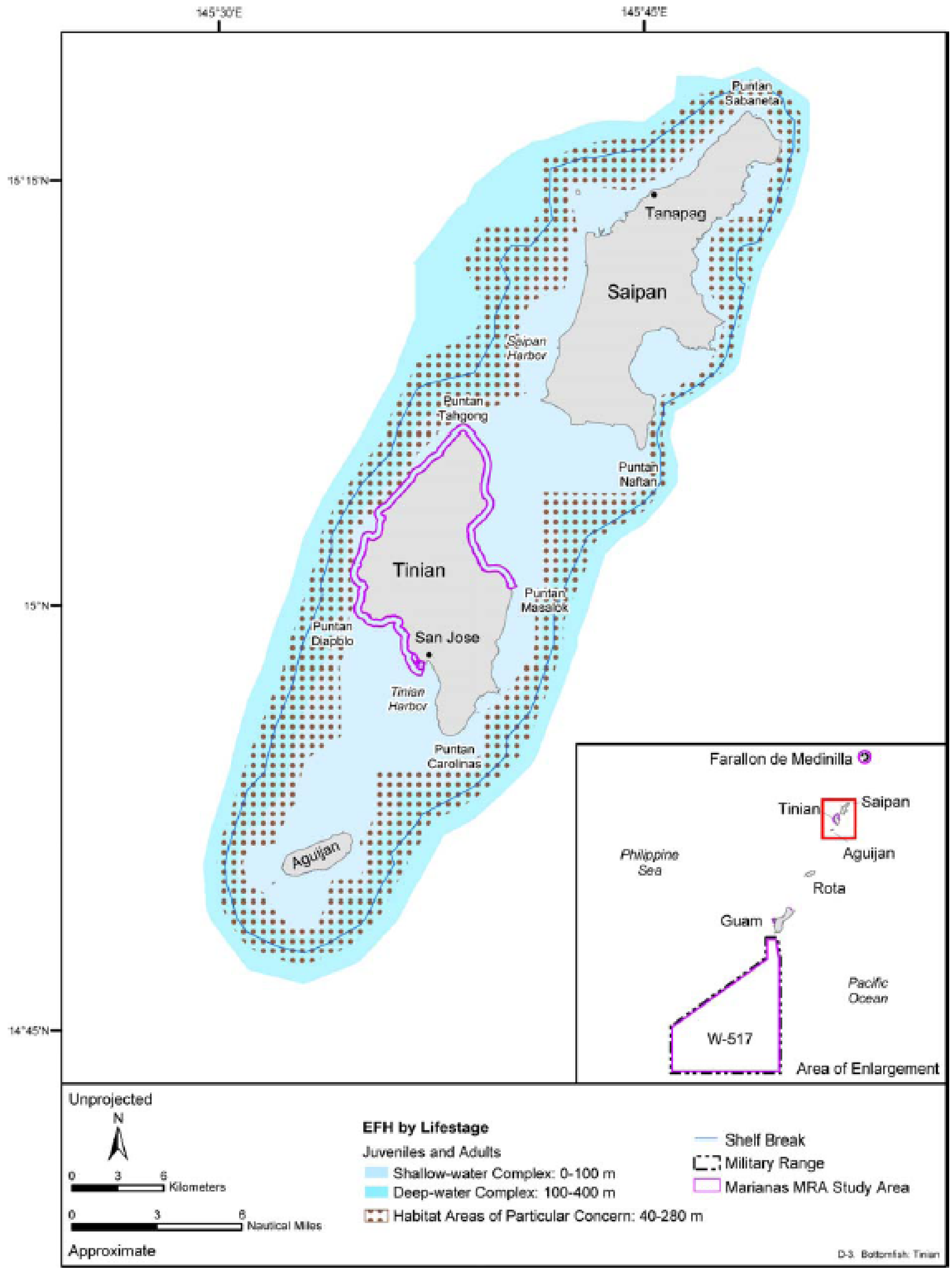


Figure B-3. EFH for all juvenile and adult lifestages of bottomfish and HAPC designated on Tinian in the MIRC study area.

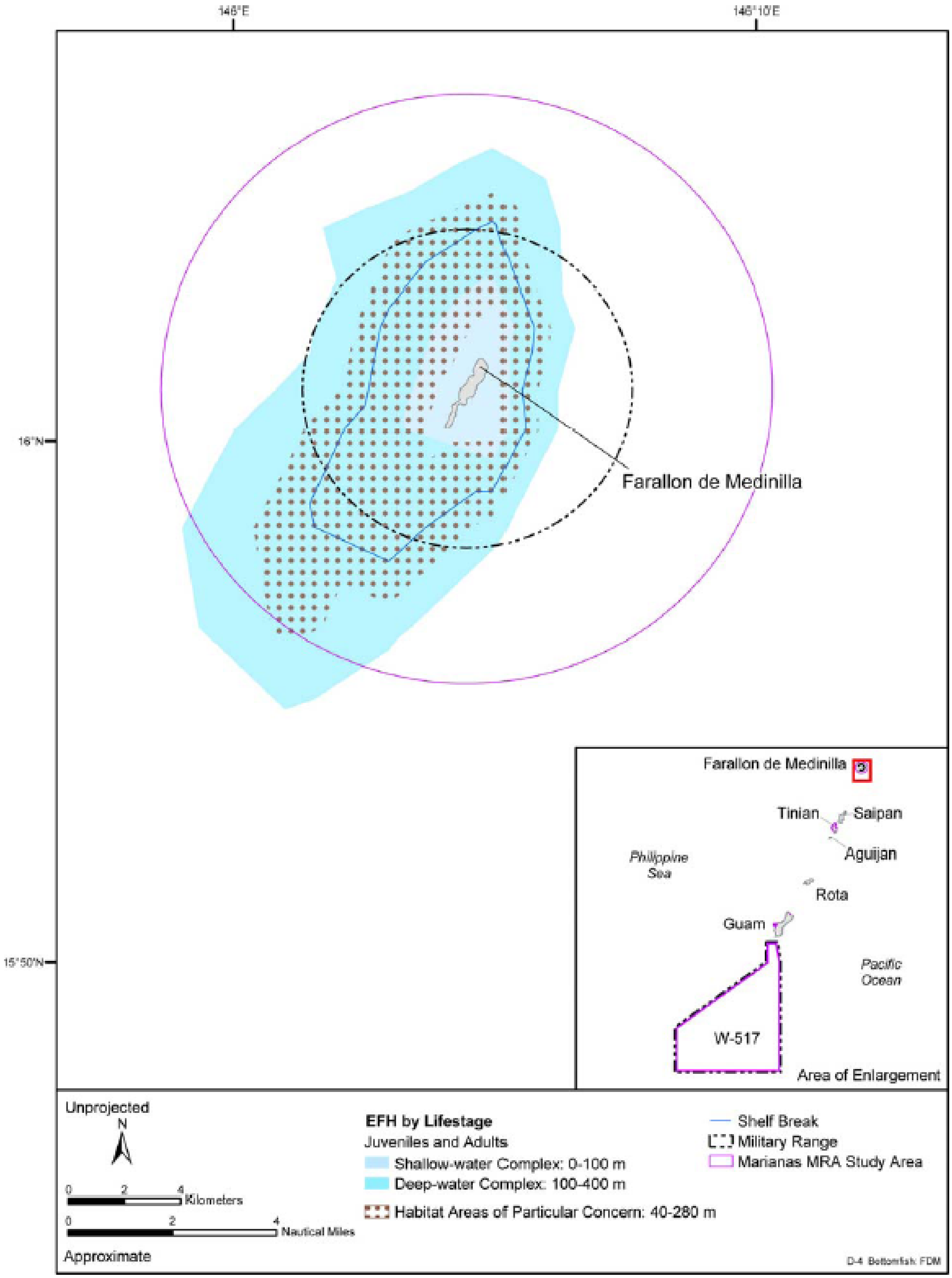


Figure B-4. EFH for all juvenile and adult lifestages of bottomfishes designated on Farallon de Medinilla (FDM) in the MIRC study area.

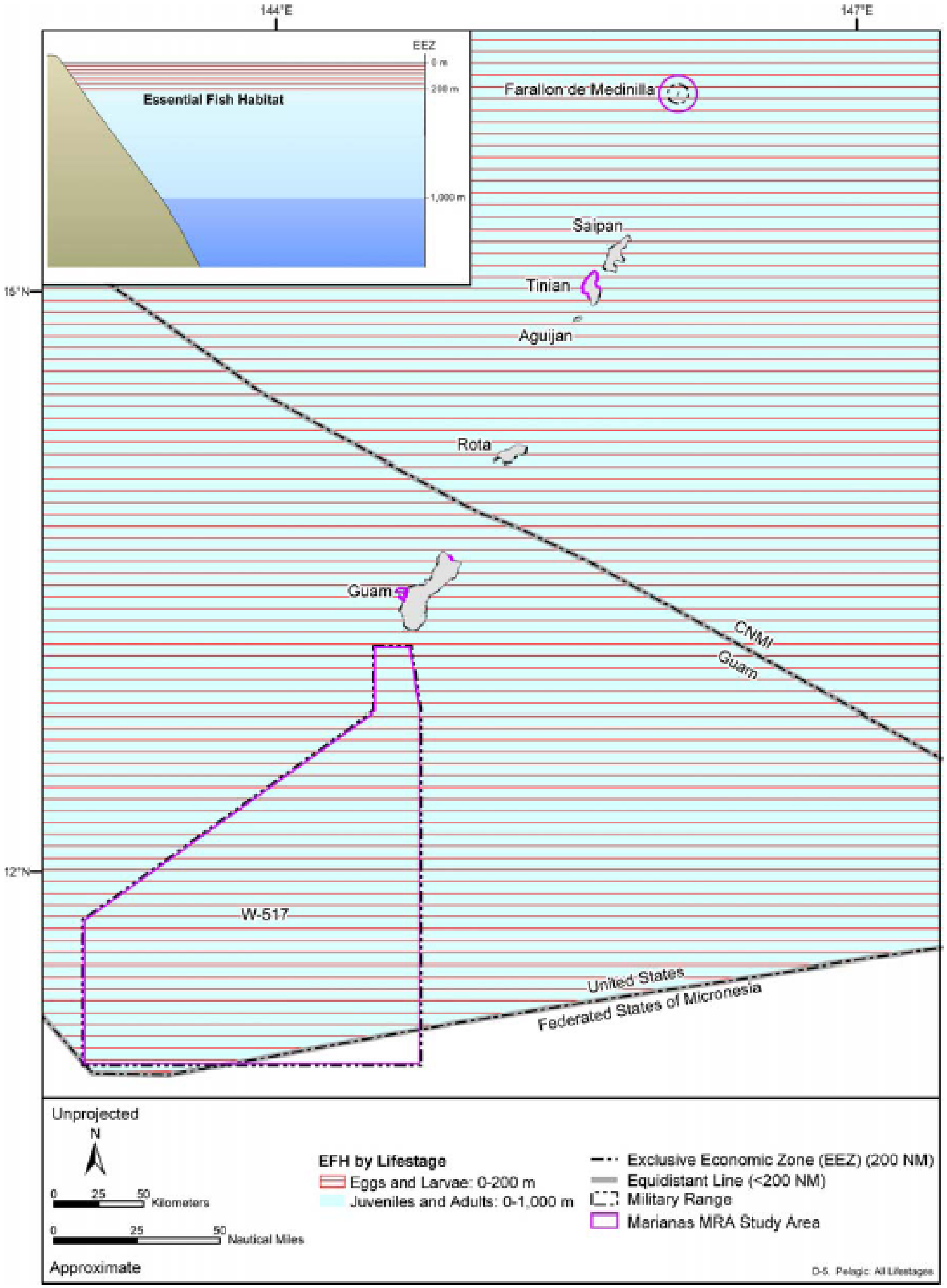


Figure B-5. EFH for all lifestages of pelagic fishes designated on Guam, Tinian, and FDM in the MIRC study area.

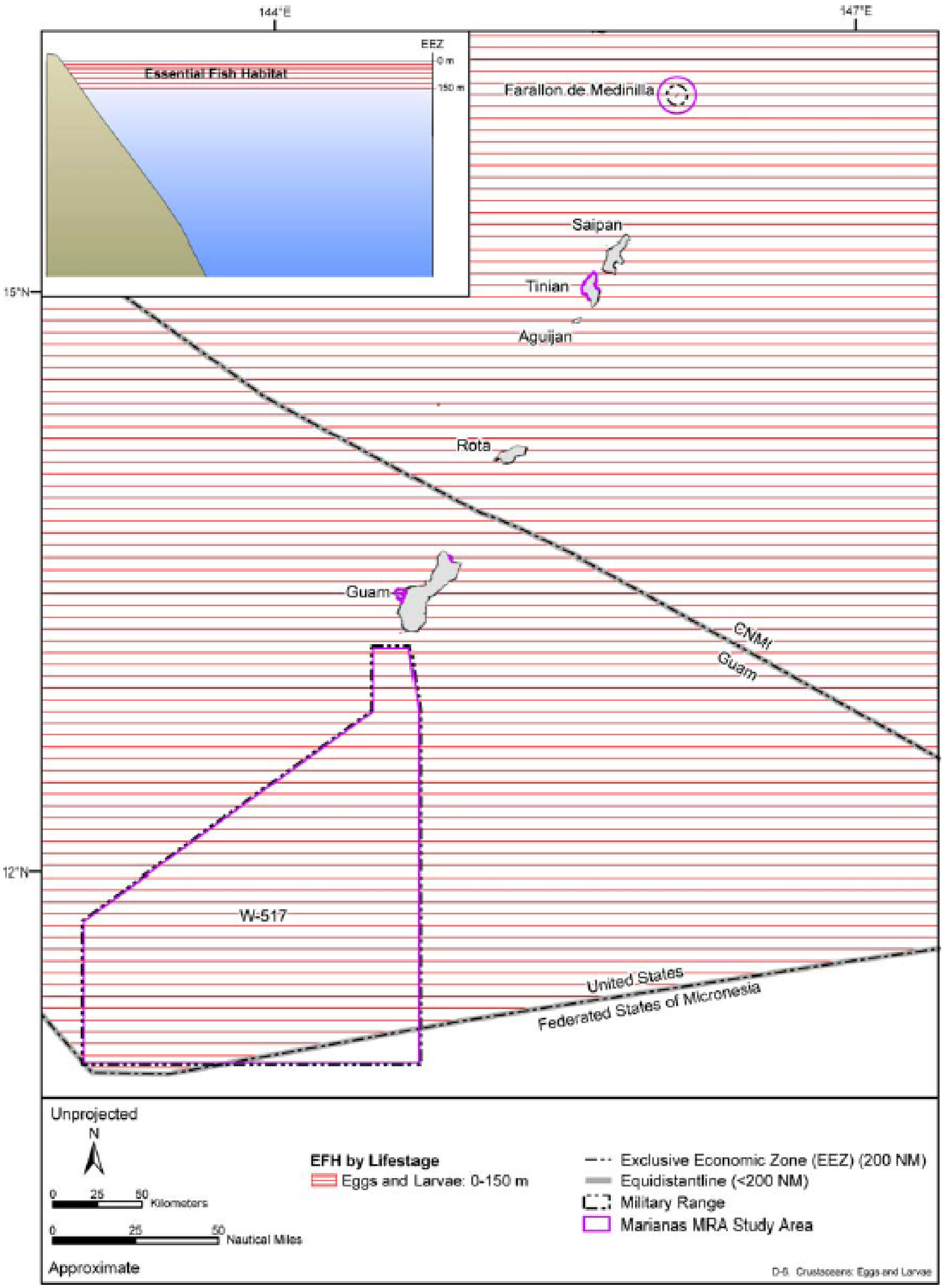


Figure B-6. EFH for all eggs and larval lifestages of crustaceans designated on Guam, Tinian, and FDM in the MIRC study area.

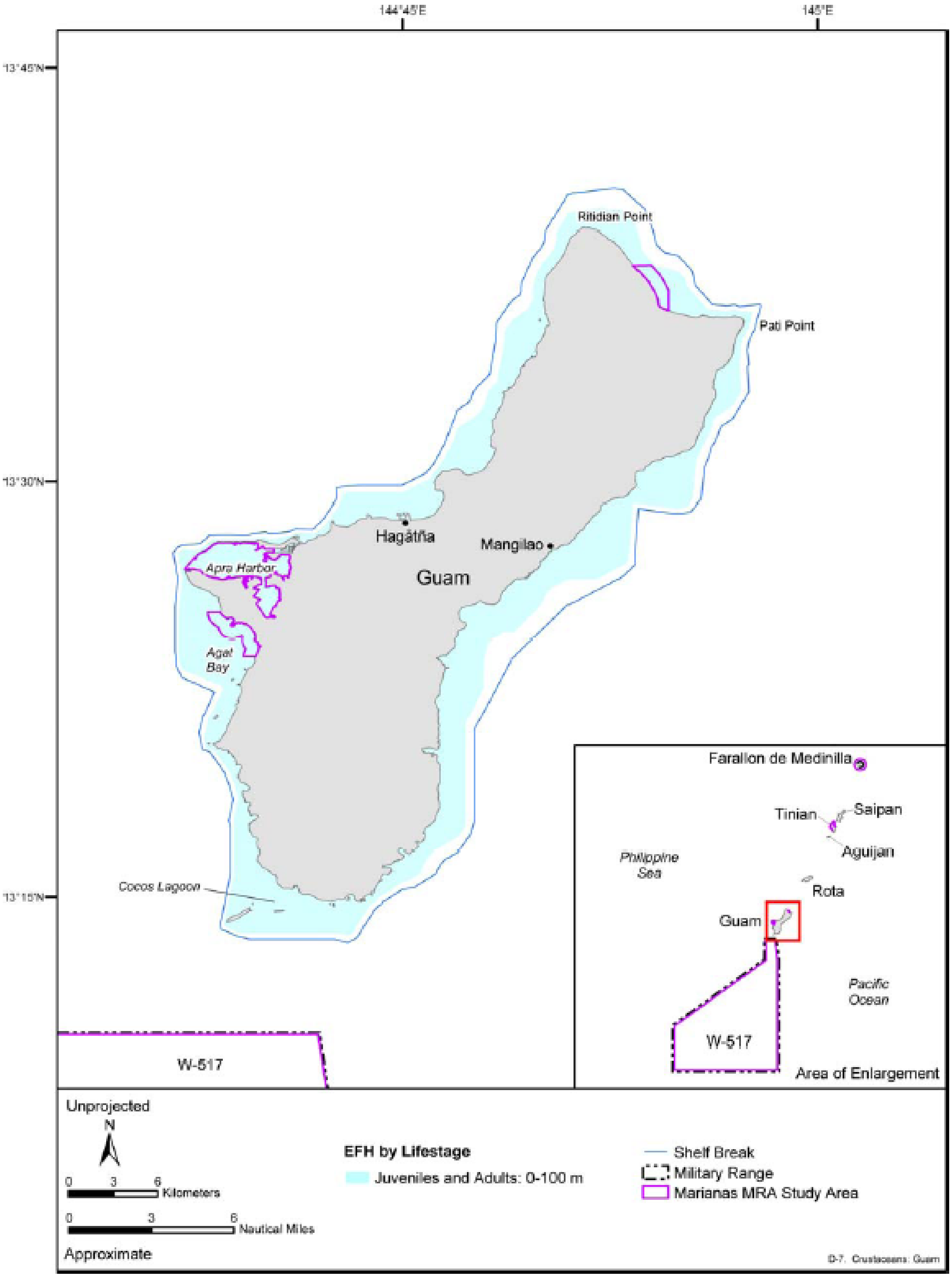


Figure B-7. EFH for all juvenile and adult lifestages of crustaceans designated on Guam in the MIRC study area.

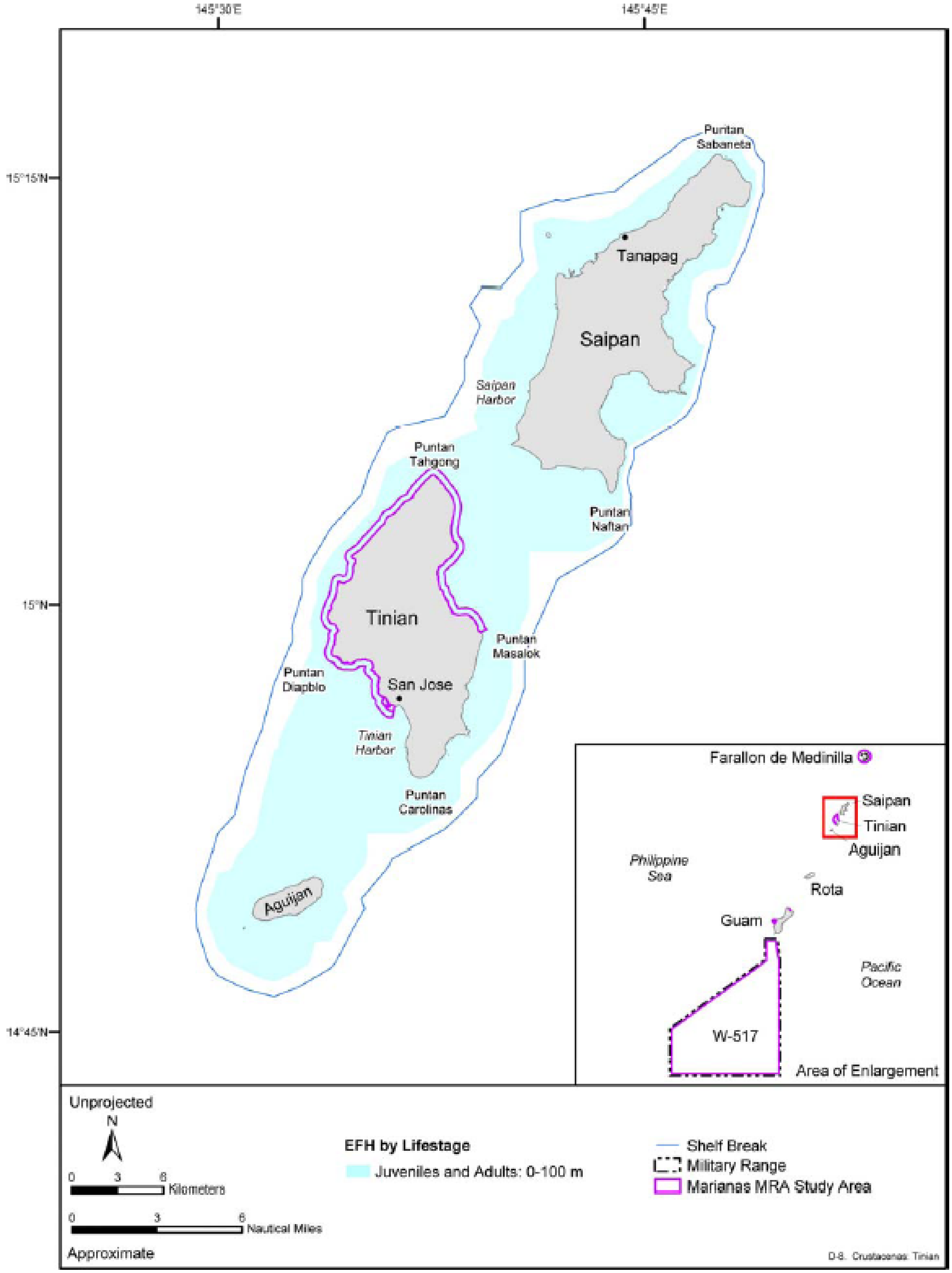


Figure B-8. EFH for all juvenile and adult lifestages of crustaceans designated on Tinian in the MIRC study area.

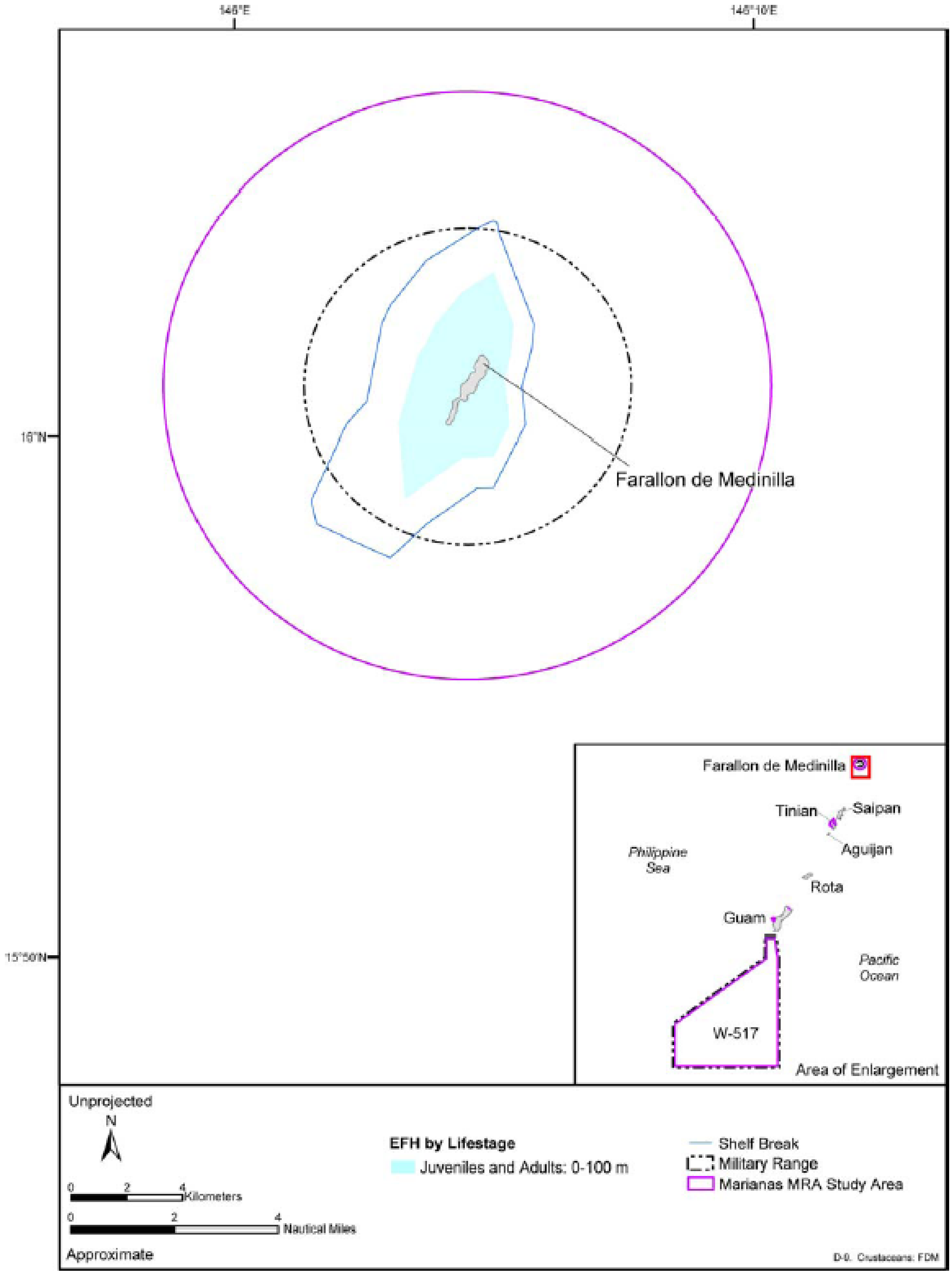


Figure B-9. EFH for all juvenile and adult lifestages of crustaceans designated on FDM in the MIRC study area.

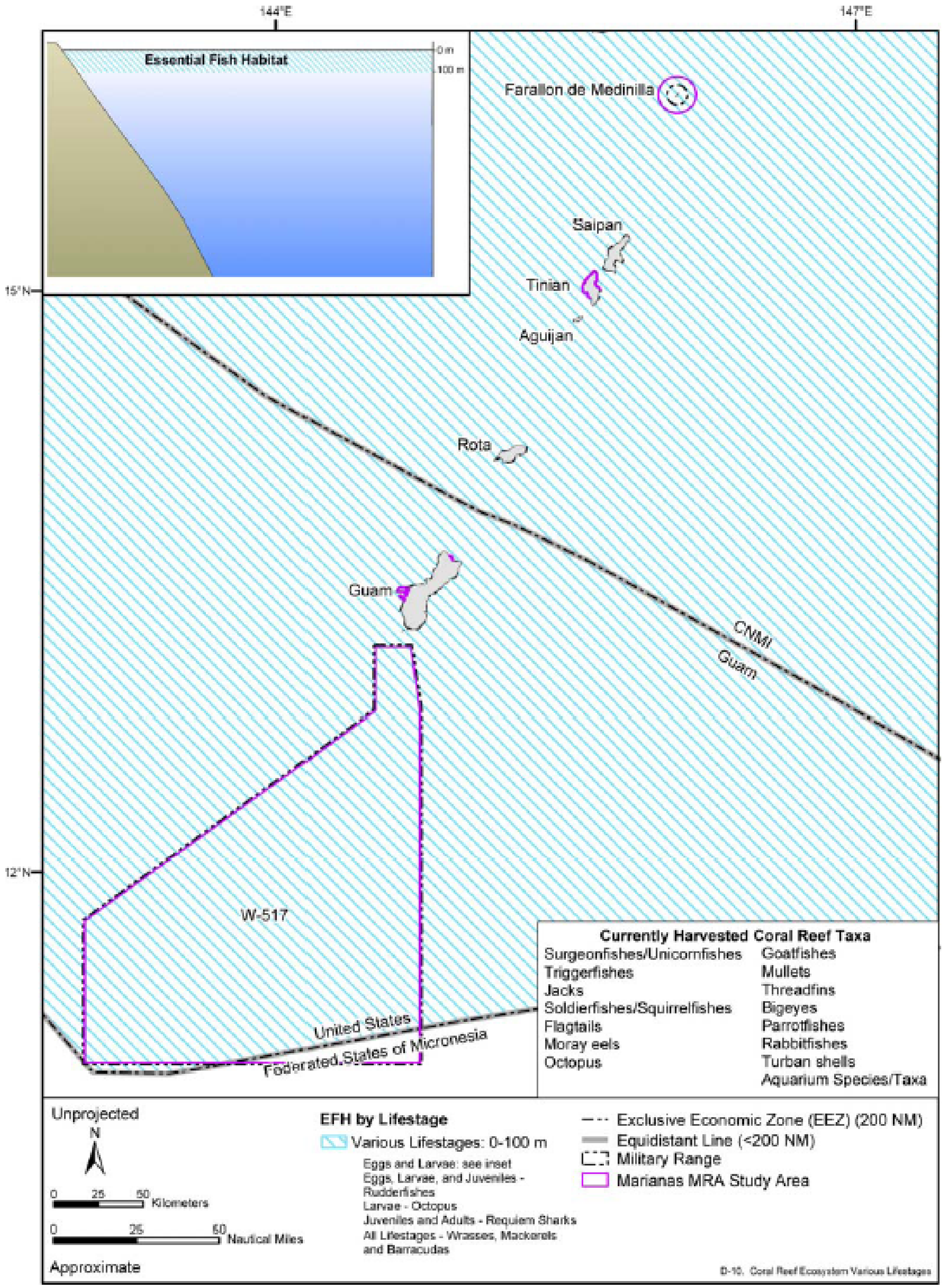


Figure B-10. EFH for various lifestages of the currently harvested coral reef taxa (CHCRT-coral reef ecosystem) and HAPC designated on Guam, Tinian, and FDM in the MIRC study area.

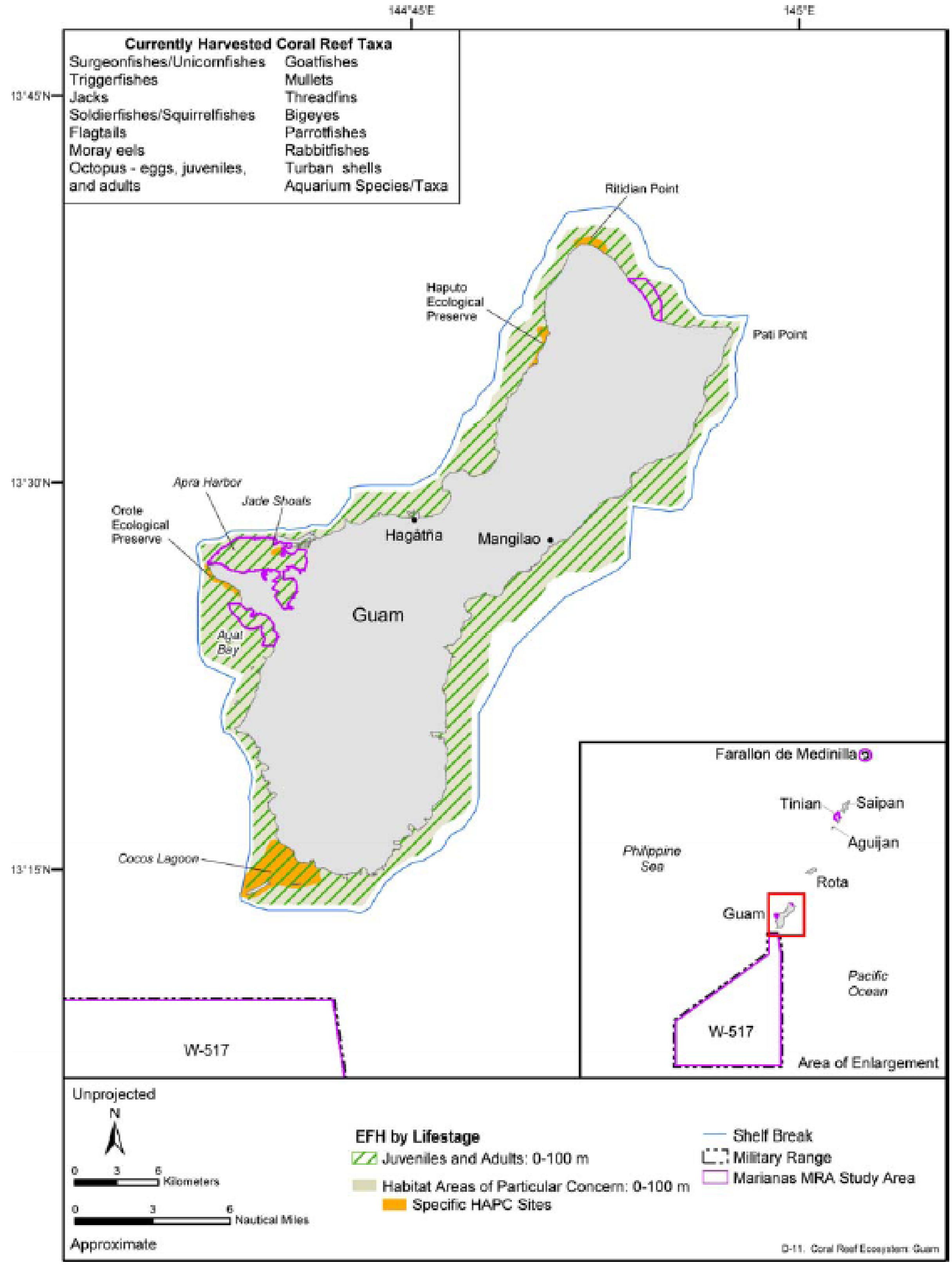


Figure B-11. EFH for all juvenile and adult lifestages of the CHCRT-coral reef ecosystem and HAPC designated on Guam in the MIRC study area.

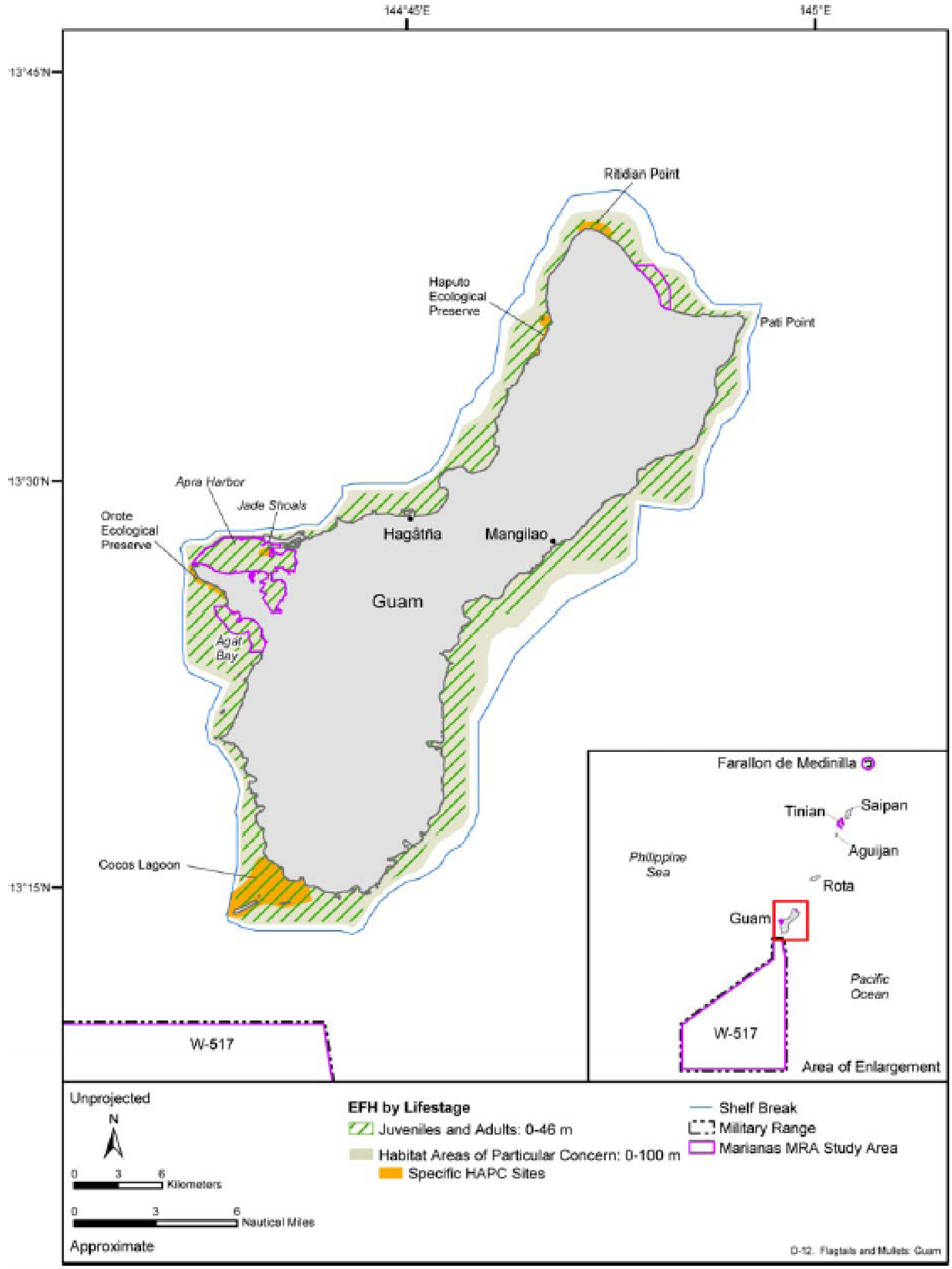


Figure B-12. EFH for all juvenile and adult lifestages of flagtails and mullets (CHCRT-coral reef ecosystem) and HAPC designated on Guam in the MIRC study area.

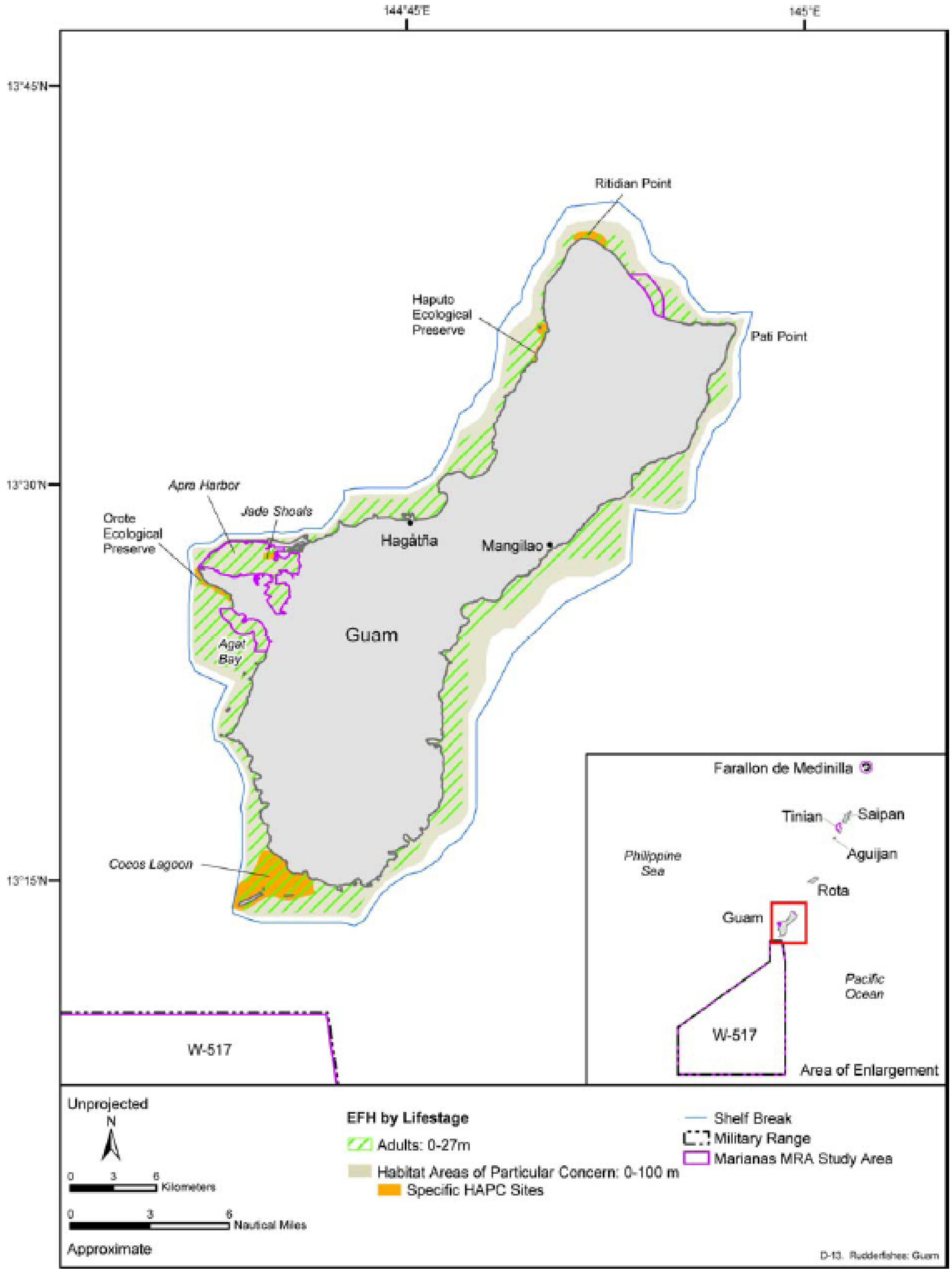


Figure B-13. EFH for all adult lifestages of rudderfishes (CHCRT-coral reef ecosystem) and HAPC designated on Guam in the MIRC study area.

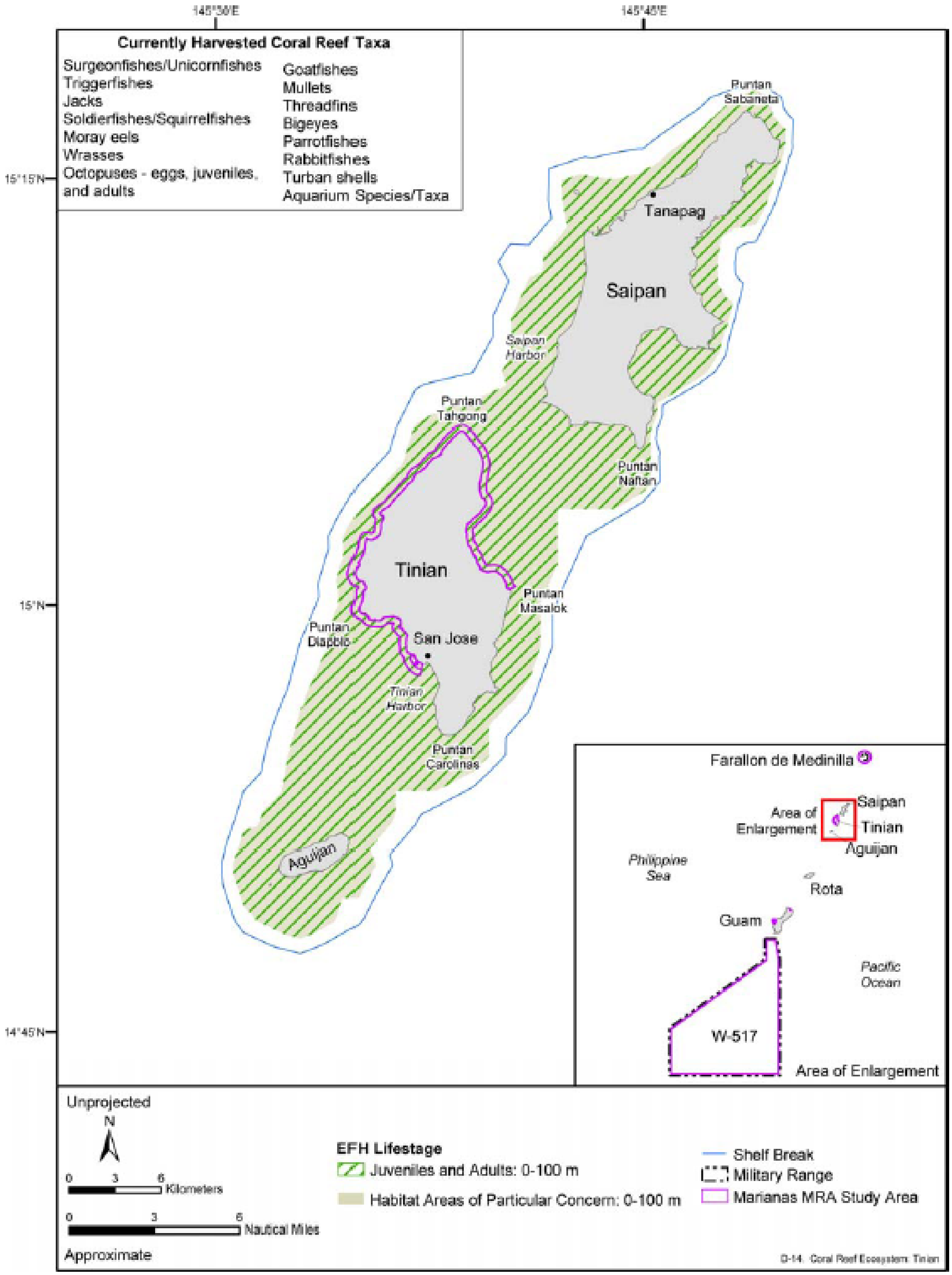


Figure B-14. EFH for all juvenile and adult lifestages of the CHCRT-coral reef ecosystem and HAPC designated on Tinian in the MIRC study area.

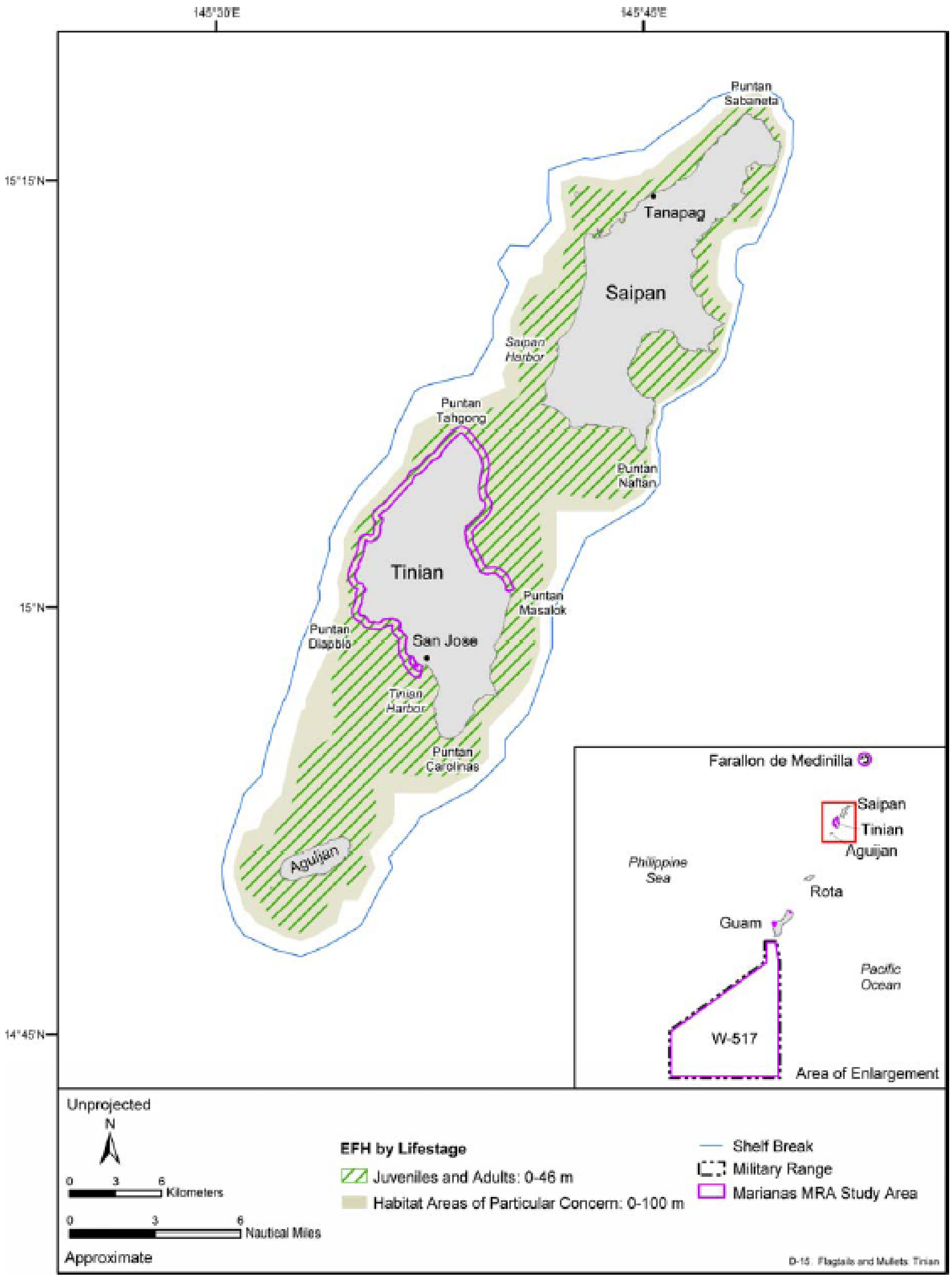


Figure B-15. EFH for all juvenile and adult lifestages of flagtails and mullets (CHCRT-coral reef ecosystem) and HAPC designated on Tinian in the MIRC study area.

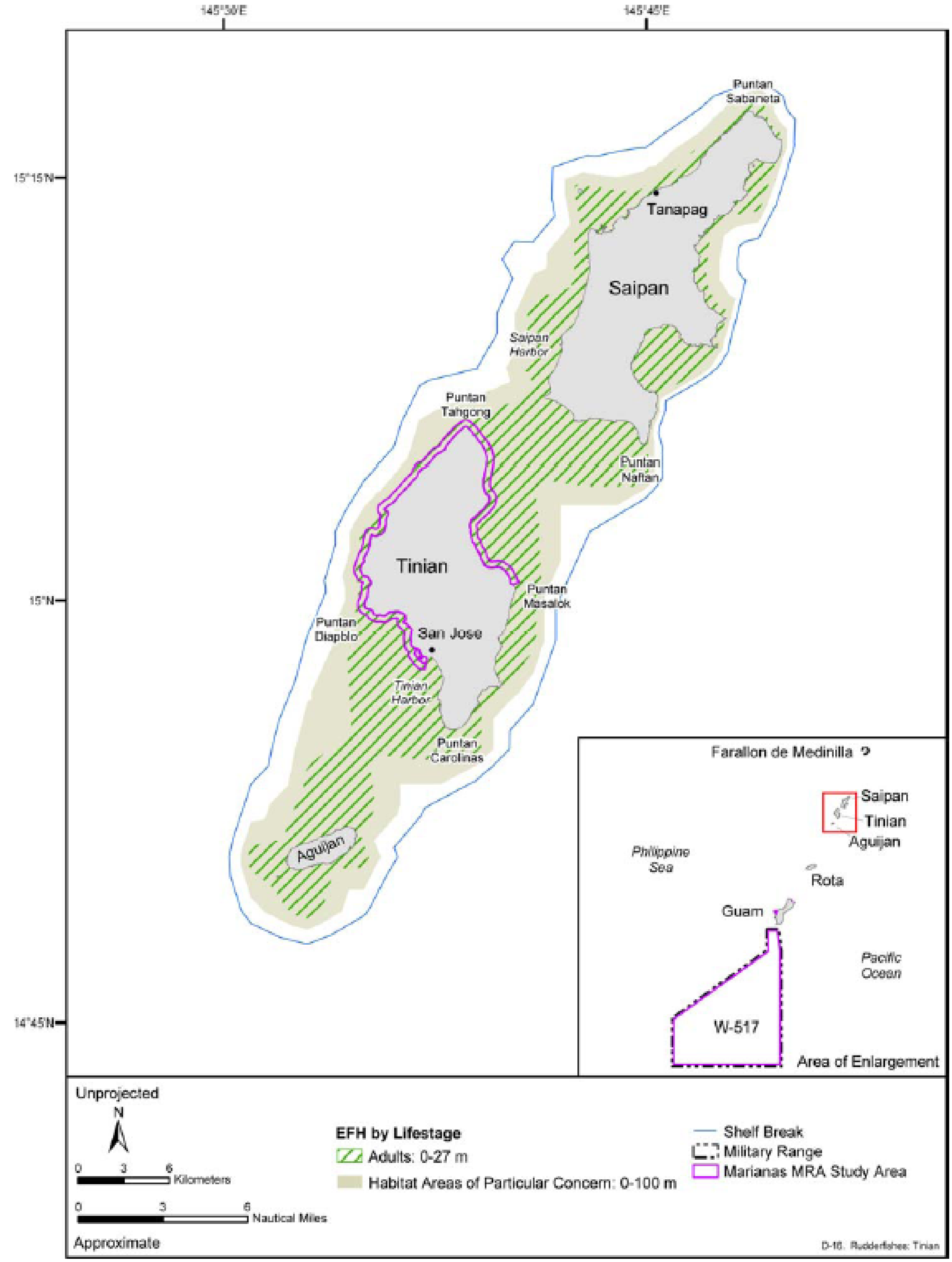


Figure B-16. EFH for all adult lifestages of rudderfishes (CHCRT-coral reef ecosystem) and HAPC designated on Tinian in the MIRC study area.

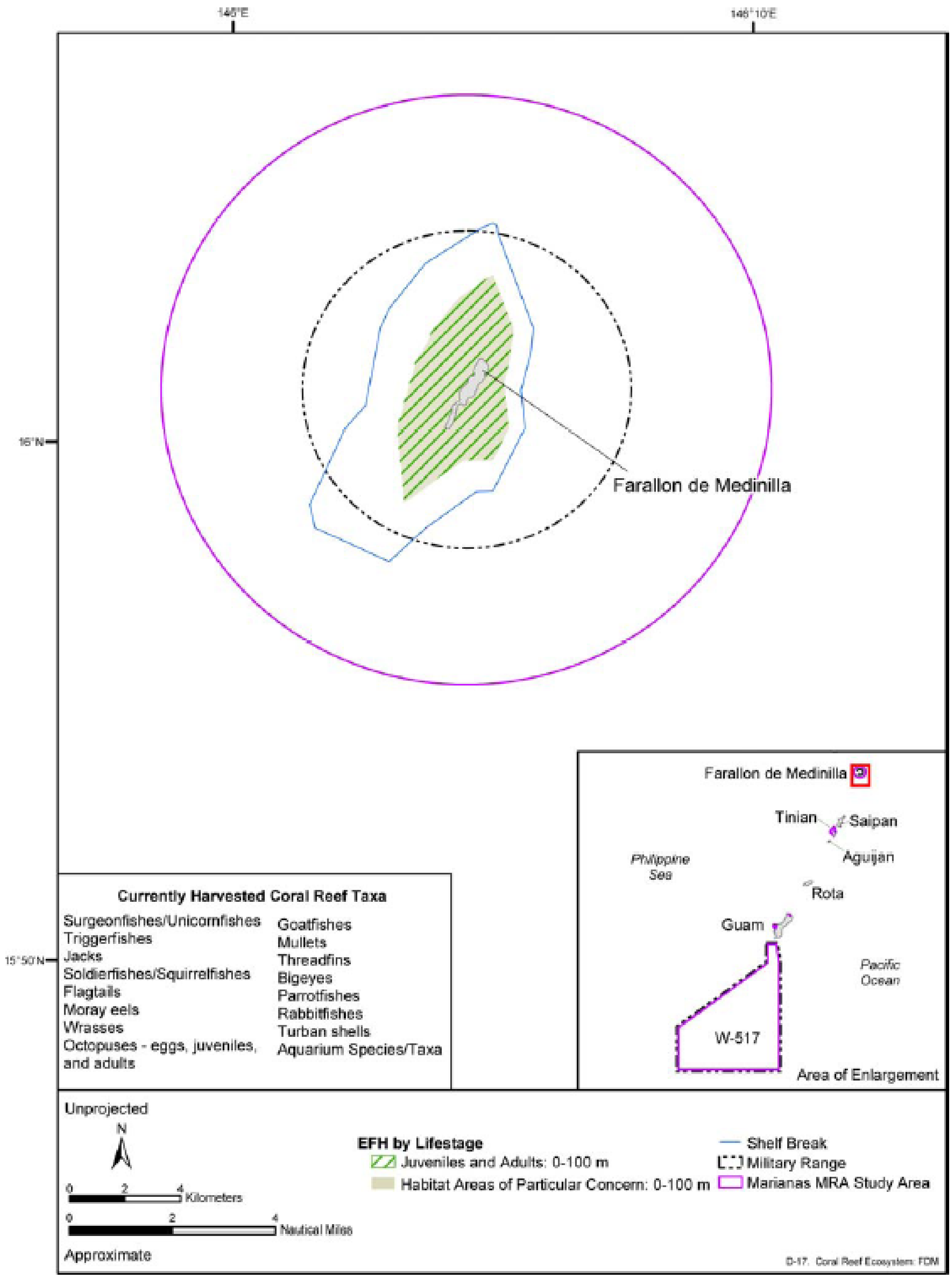


Figure B-17. EFH for all juvenile and adult lifestages of the CHCRT-coral reef ecosystem and HAPC designated on Farallon de Medinilla in the MIRC study area. Map adapted from: WPRFMC (2001).

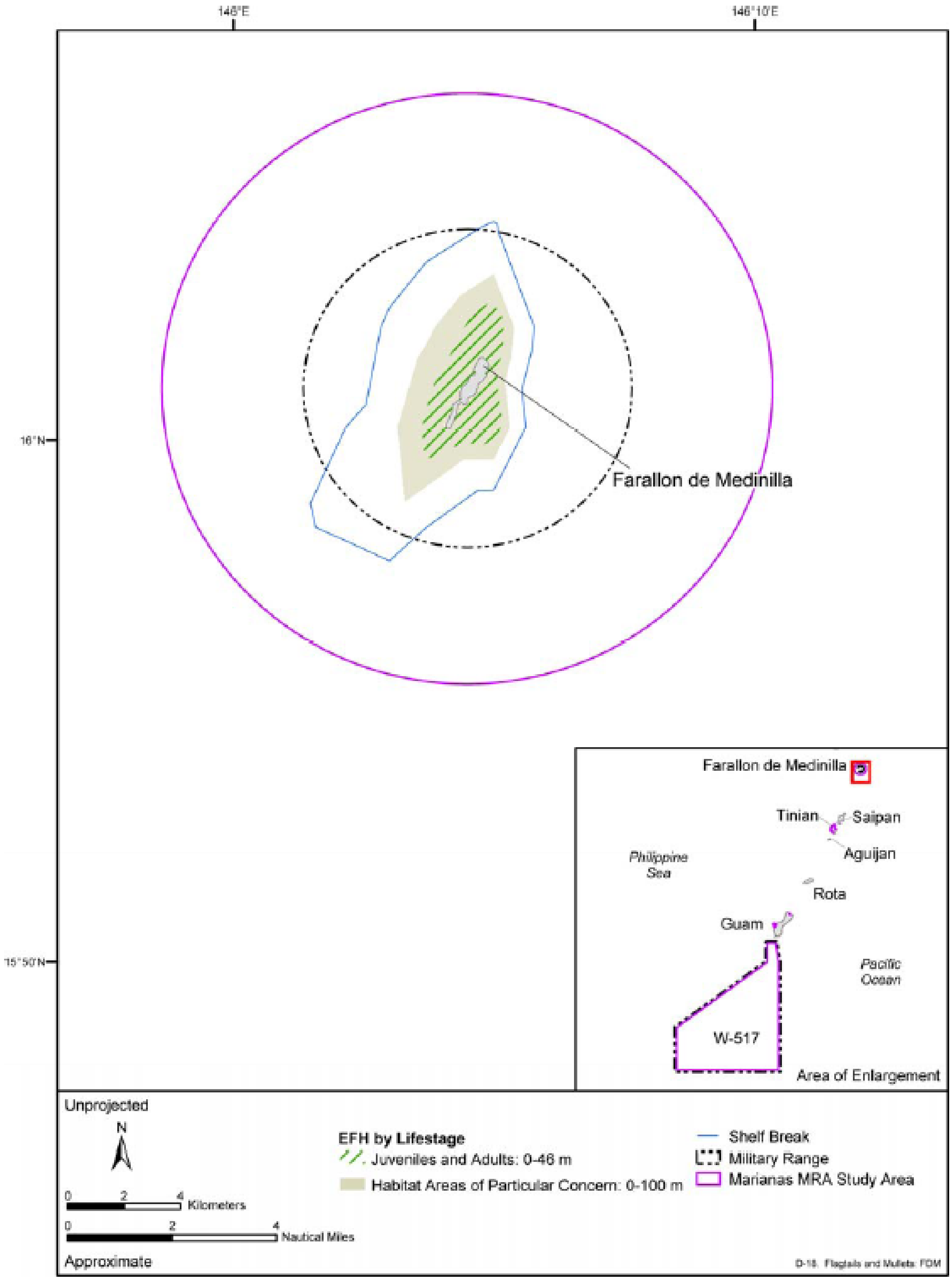


Figure B-18. EFH for all juvenile and adult lifestages of the flagtails and mullets (CHCRT-coral reef ecosystem) and HAPC designated on FDM in the MIRC study area.

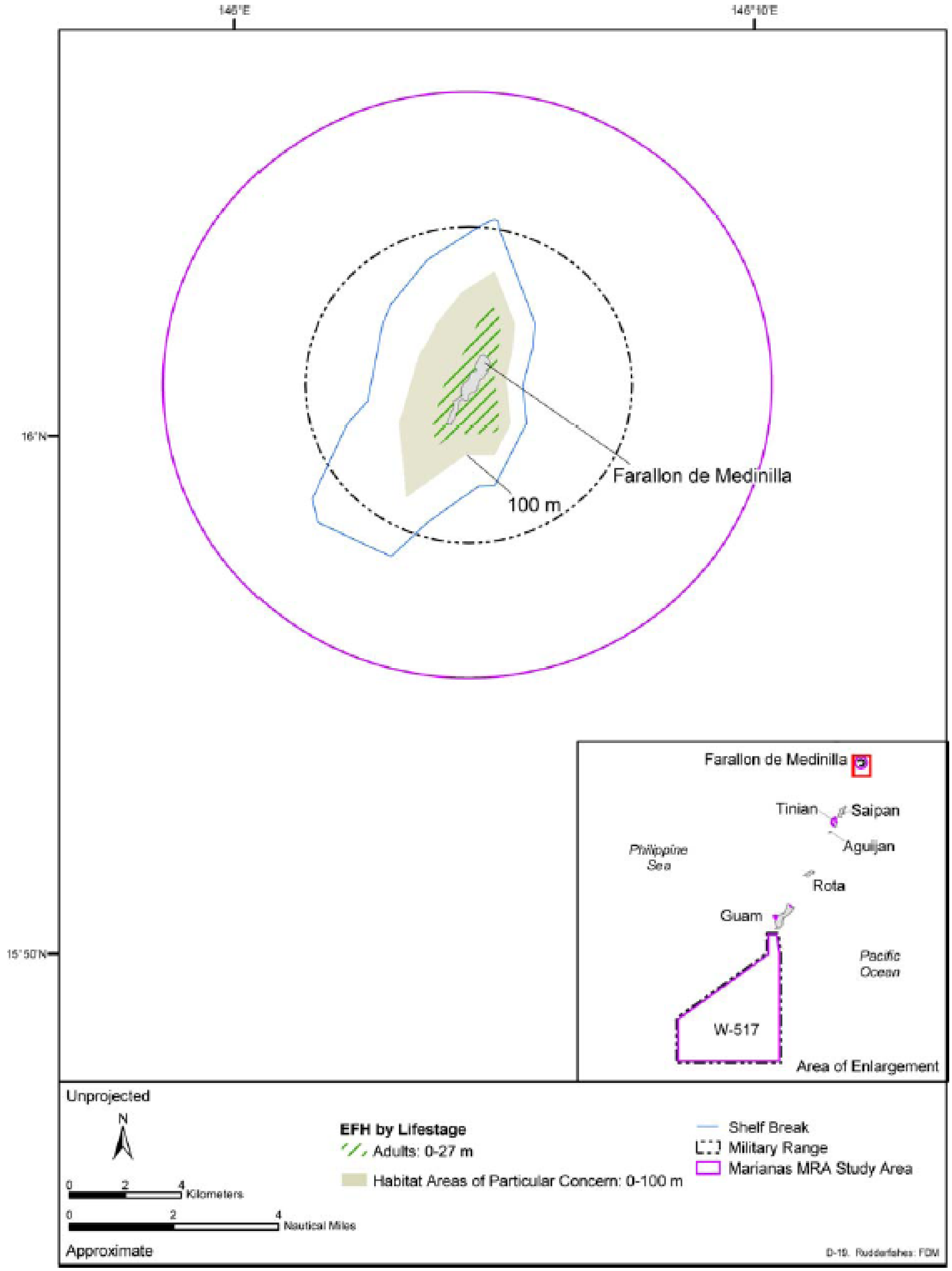


Figure B-19. EFH for all adult lifestages of rudderfishes (CHCRT-coral reef ecosystem) and HAPC designated on FDM in the MIRC study area.

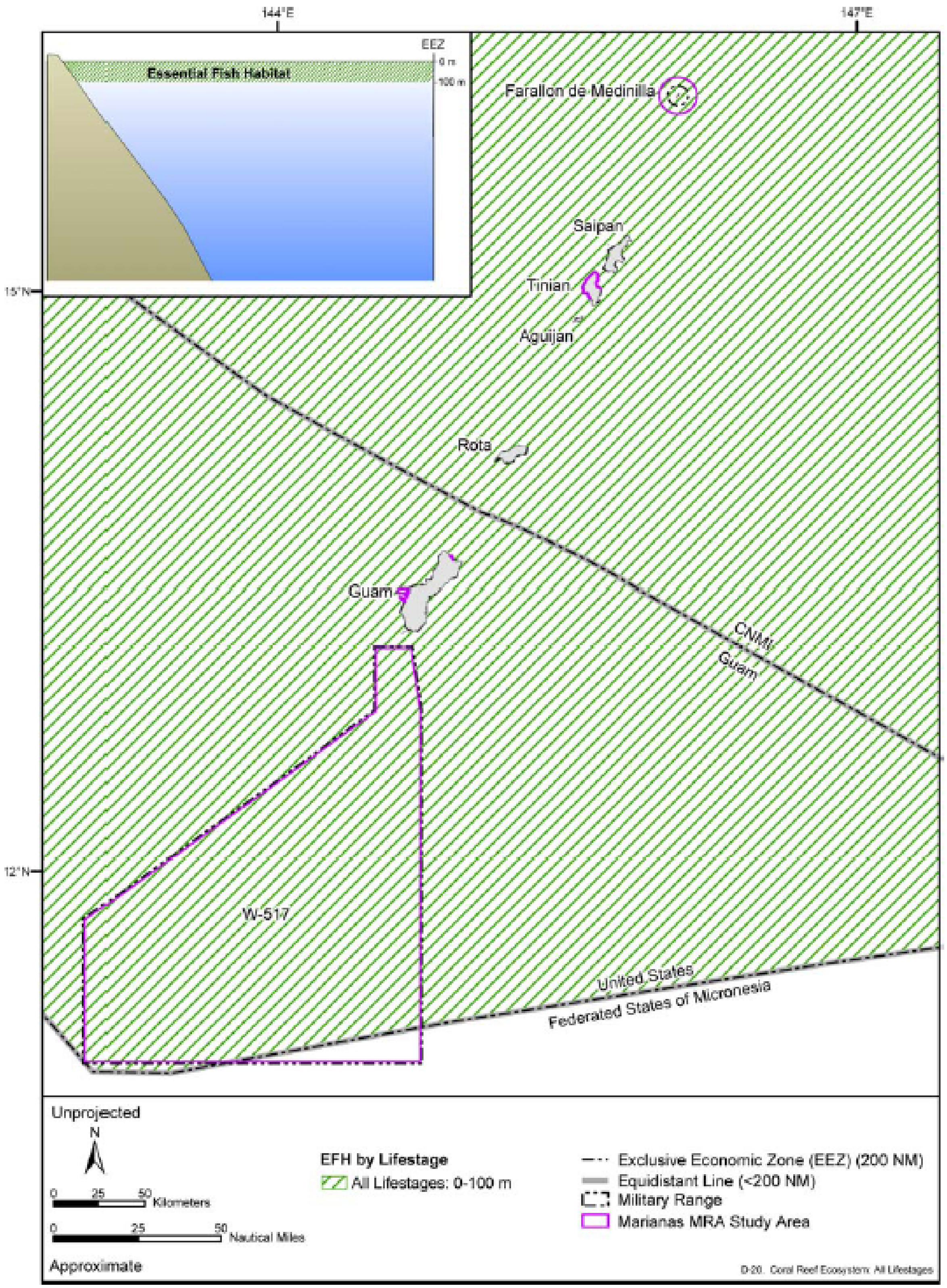


Figure B-20. EFH for all lifestages of the potentially harvested coral reef taxa (PHCRT-coral reef ecosystem) and HAPC designated on Guam, Tinian, and FDM in the MIRC study area.

APPENDIX K

GUAM SHPO, CNMI HPO, ACHP & NPS PROGRAMMATIC AGREEMENT

This page intentionally left blank.

PROGRAMMATIC AGREEMENT AMONG
THE DEPARTMENT OF DEFENSE REPRESENTATIVE
GUAM, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS,
FEDERATED STATES OF MICRONESIA AND REPUBLIC OF PALAU,
COMMANDER, JOINT REGION MARIANAS,
COMMANDER, 36TH WING, ANDERSEN AIR FORCE BASE,
THE GUAM HISTORIC PRESERVATION OFFICER, AND
THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
HISTORIC PRESERVATION OFFICER
REGARDING
MILITARY TRAINING IN THE MARIANAS

WHEREAS, the U.S. Department of Defense (DoD), through the Navy as Executive Agent manages the Mariana Islands Range Complex (MIRC); and

WHEREAS the DoD Representative Guam, Commonwealth of the Northern Marianas, Federated States of Micronesia and Republic of Palau (DoD REP), as lead federal agency, has requested that the Commander Pacific Fleet and Naval Facilities Engineering Command, Pacific, coordinate the preparation of an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) under the National Environmental Policy Act of 1969, as amended (P.L. 91-190) for the MIRC that includes all military training in the Marianas and review proposed military training exercises under Section 106 of the National Historic Preservation Act of 1966, as amended (16 United States Code [U.S.C.] 470f) hereinafter Section 106 and Section 110 of the same Act (16 U.S.C. 470h-2(f)); and

WHEREAS, "undertaking" in this document refers to all existing and proposed DoD training exercises in the Marianas as described as the Preferred Alternative in the MIRC EIS/OEIS and which will be stated in the Record of Decision and published in the Federal Register; and

WHEREAS, the MIRC includes property and land under the jurisdiction of the DoD and other entities, including 450,187 nautical miles^2 of open ocean and littorals; and

WHEREAS, the MIRC is currently operating under an existing 1999 Programmatic Agreement (PA) between the DoD REP, the Advisory Council on Historic Preservation (ACHP), and the Commonwealth of the Northern Mariana Islands (CNMI) Historic Preservation Officer (HPO) for military training on Tinian; and

WHEREAS, the MIRC is currently operating under an existing 1999 Memorandum of Agreement (MOA) between the DoD REP, 36 Air Base Wing (now known as 36th Wing), the Guam HPO, and the ACHP for military training on Guam; and

WHEREAS, the DoD REP has determined that the military training program may have an effect upon the Tinian Landing Beaches, Ushi Point Field, and North Field, Tinian Island National Historic Landmark (Tinian NHL) and other historic properties determined eligible for inclusion in the National Register of Historic Places (NRHP) on Guam and Tinian, and has consulted with the ACHP, the Guam HPO, the CNMI HPO, and the National Park Service (NPS) pursuant to 36 Code of Federal Regulations (CFR) §800.3, implementing Section 106; and

WHEREAS, the public has been notified of the proposed military training program and views were solicited through the EIS/OEIS scoping meetings and associated public hearings held on the islands of Guam, Tinian, Saipan, and Rota, and through a public comment period; and

NOW, THEREFORE, the DoD REP, Commander, Joint Region Marianas (Joint Region Marianas), Commander, 36th Wing (36th Wing), the Guam HPO, and the CNMI HPO agree that military training in the Marianas shall be administered in accordance with the following stipulations to satisfy the requirements of Section 106 responsibility for all actions undertaken as part of the proposed military training activities analyzed in the MIRC EIS/OEIS.

STIPULATIONS

The DoD will ensure that the following measures are carried out:

I. APPLICABILITY AND DEFINITIONS

A. This PA applies to all undertakings discussed within the MIRC EIS/OEIS.

B. Unless otherwise noted, this PA will utilize the definitions found at 36 CFR §800.16. All acronyms used in this PA are defined in Appendix A.

C. This PA negates and supersedes the 1999 PA and 1999 MOA pertaining to military training in the Marianas.

D. All signatories will be responsible for complying with the general provisions of this PA. In contrast, each of the following agencies shall be responsible for carrying out specific stipulations relating to historic resources under their jurisdiction.

1. On DoD leased land, Navy installations, and Air Force installations the DoD REP as Joint Region Marianas[1] is responsible.

2. The DoD REP, 36th Wing, and any other DoD units training within the MIRC are responsible for complying with Stipulation III.A regarding military training operations and the training constraint maps.

[1] Joint Region Marianas - Under the 2005 Base Realignment and Closure report, the establishment of a Joint Region was recommended for military installations in the Marianas. Thus, the Navy and the Air Force are in the process of becoming a "Joint Region." Military (training) operations will remain at their respective Commands but installation management responsibilities will now fall under the "Joint Region."

E. Any construction or modification of training areas as proposed within the MIRC EIS/OEIS on property of Naval Base Guam is subjected to the stipulations contained within the 2008 PA among the Commander, Navy Region Marianas, the Advisory Council on Historic Preservation, and the Guam Historic Preservation Officer Regarding Navy Undertakings on the Island of Guam. For all other areas, on Guam and the Northern Mariana Islands, the stipulations in this PA will be followed.

II. PROFESSIONAL STANDARDS

A. All surveys, testing, and mitigation regarding archaeological resources will be carried out by, or under the oversight or supervision of a person or persons meeting the professional qualification for Archaeologist found in "The Secretary of the Interior's (SOI) Historic Preservation Professional Qualification Standards" (SOI Qualification Standards), 62 Federal Register 33712.

B. All historic property surveys for historic buildings and structures will be carried out by, or under the oversight or supervision of, a person or persons meeting the professional qualifications for Historical Architect under Standard a or b found in SOI Qualification Standards, 62 Federal Register 33719 or Architectural Historian under Standard a or b found in SOI Qualification Standards, 62 Federal Register 33713-4 or Historic Landscape Architect under Standard a or b found in SOI Qualification Standards, 62 Federal Register 33720 or Historian under Standard a or b found in the SOI Qualification Standards, 62 Federal Register 33722.

C. Where Joint Region Marianas utilizes contracts that involve work governed by this PA that may affect historic properties, Joint Region Marianas will use appropriate contract performance requirements, and/or appropriate source selection criteria which shall include minimum qualifications for historic preservation experience and satisfactory prior performance, as appropriate to the nature of the work and the type of procurement, developed with the participation of professionals meeting the standards of Stipulation II.B, for projects involving historic buildings and structures, or II.A, for projects involving archaeological sites.

III. GENERAL STIPULATIONS:

A. TRAINING CONSTRAINT MAPS

1. For areas with training constraints due to the presence of historic properties, training constraint maps have been developed. These maps show the locations of off-limits or No Training (NT) areas and Limited Training (LT) areas.

   a. NT areas are to be avoided, and no training exercises shall occur within these areas.

b. LT areas are primarily designated as pedestrian traffic areas with vehicular access limited to designated roadways and/or with the use of rubber-tired vehicles. However, no pyrotechnics, demolition, or digging is allowed without prior consultation with the appropriate HPO.

2. Training constraint maps will be updated by the respective cultural resource managers (CRM) for each property based on consultation with the appropriate HPO on a yearly basis so that these maps remain current as new information becomes available through planned cultural resource studies or inadvertent finds. Areas defined as NT or LT can change based on the new data and consultation. Similarly, training activities may be eliminated, reduced, or expand based on the new data. However, any major changes to this PA must comply with Stipulation VIII.

3. Training constraint maps shall be disseminated and made available to military planners who coordinate and execute training exercises so that they are aware of the constraints.

B. TRAINING PROGRAM REVISIONS

The DoD REP, 36th Wing, and any other DoD units training within the MIRC will notify, coordinate, and consult with the appropriate HPO(s) and the NPS (if a NHL is involved) on a case-by-case basis for any new introduction of forces and maneuvers that do not comply with the general or area-specific stipulations of this PA.

IV. AGENCY- AREA – SPECIFIC STIPULATIONS

A. GUAM

1. Main Base / Waterfront Annex

Training will be limited per the Main Base training constraints map (see Appendix B).

2. Ordnance Annex

a. The appropriate CRM will verify that pop-up targets for the Sniper Range at Ordnance Annex are situated so that no historic properties are in the ballistic trajectory.

b. Training will be limited per the training constraints map for the Ordnance Annex in Appendix B.

3. Northwest Field

   a. As part of the Northwest Field Beddown Initiatives, the 36th Wing has conducted Historic American Building Survey/Historic American Engineering Record (commonly referred to as HABS/HAER) recordation and supplementary documentation of the Northwest Field runway complex and previously existing facilities as mitigation for any potential adverse effect of military training and support activities in the Northwest Field area.

   b. Any area of Northwest Field that has not been previously surveyed and involves construction or ground disturbing activities will be surveyed and inventoried for cultural resources. Any cultural resource within the affected area will be evaluated for inclusion on the NRHP. Any resource(s) determined eligible for the NRHP, which cannot be avoided, will be subjected to data recovery.

   c. Appendix B contains the Northwest Field training map. Training is currently constrained within these areas.

4. Tarague

   Training at Tarague will be confined to the existing Combat Arms Training and Maintenance (also known as CATM) range as shown in Appendix B.

5. Andersen South

   This area is designated as an unconstrained training area (see Appendix B).

B. TINIAN

1. Unai Chulu

   a. The Center Access Road (CAR): The back beach area of Unai Chulu is designated as a no training area except for the CAR. The entire length and width of the CAR is currently capped with a layer of crushed coral. The crushed coral cap is approximately 20 centimeters thick and 3 meters wide. The road cap covers the access road from the Dyckman Road intersection to the intersection with the existing beach access road that parallels the beach.

   b. Road Fencing: To keep vehicles on the CAR, fencing was installed running parallel to the road on both shoulders for the entire length of the road. Archaeological testing of Site TN-73 has revealed intact deposits lie below one meter of disturbed stratigraphy.

   c. Maintenance: The CRM designated by Joint Region Marianas will monitor the condition of the capped road and fence on a quarterly basis (if any training has occurred during that time period) by conducting a field visit and site check of the CAR and fencing per Stipulation V. Any deterioration of the road surface or the fence will be repaired.

d. To ensure vehicles and pedestrians remain on designated ingress and egress paths and comply with NT and LT constraints, the CRM designated by the Joint Region Marianas will, on a quarterly basis (if any training has occurred during that time period) conduct a field visit and site check of Unai Chulu (see Stipulation V).

e. Training will be limited per the Unai Chulu training constraints map (see Appendix B).

2. Unai Dankulo

a. Training will be limited per the Unai Dankulo training constraints map (see Appendix B).

b. To ensure vehicles and pedestrians remain on designated ingress and egress paths and comply with NT and LT constraints, the CRM designated by the Joint Region Marianas will, on a quarterly basis (if any training has occurred during that time period) conduct a field visit and site check of Unai Dankulo (see Stipulation V).

3. Unai Masalok

a. An area of the Unai Masalok has been designated a LT area (see Appendix B). In general, military training operations at Unai Masalok will consists of low density training (pedestrian traffic).

b. The CRM designated by the Joint Region Marianas will, on a quarterly basis (if any training has occurred during that time period) conduct a field visit and site check of Unai Masalok (see Stipulation V).

4. Tinian – DoD Leased Lands

a. The DOD leased lands on Tinian include the Exclusive Military Use Area (EMUA) and the Leased-Back Area (LBA). The Tinian NHL comprises a large portion of the EMUA (see Appendix B).

b. Training in the EMUA and LBA will be consistent with the Tinian constraints map as shown in Appendix B.

c. Historic Building and Structures

1. Bullet traps will be installed behind temporary targets within historic buildings and structures to stop the trajectory and ricochet of bullets. Previous field monitoring and visual inspections by the CRM designated by the Joint Region Marianas and CNMI HPO staff show that use of these bullet traps adequately mitigates any impacts that this type of activity may have had to historic buildings and structures.

2. After each exercise, shell casings and targets will be removed.

3. Baseline digital photo documentation of the building shall also be conducted to show the current state of the building. The CRM designated by the Joint Region Marianas shall continue to digitally photo-document the structure on a quarterly basis (if any training has occurred during that time period) as evidence that the bullet traps have successfully mitigated the potential adverse affect of this undertaking. These photos shall be submitted to the CNMI HPO and NPS via e-mail. A site visit by the CNMI HPO or NPS may be conducted in lieu of photo documentation as stated in Stipulation V.D.

d. Tinian National Historic Landmark[2]

1. The CRM designated by the Joint Region Marianas will ensure that there is ongoing documentation, survey, evaluation and assessment of the cumulative effects of training on the Tinian NHL, including its historic character and setting.

2. The CRM designated by the Joint Region Marianas will assess the cumulative effects and determine the appropriate actions associated with them, according to the Secretary of the Interior's Standards, in an annual report provided to the NPS and the CNMI HPO. The report will describe how the responsibilities are being carried out under this PA pertaining to the Tinian NHL.

3. The report will be submitted to the NPS and CNMI HPO, in addition to other interested parties who request a copy of this report.

[2] The DOD recognizes and acknowledges that 16 USC §470h-2(f) mandates that "[P]rior to approval of any Federal undertaking which may directly and adversely affect any National Historic Landmark, the head of the responsible Federal agency shall, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to such landmark." The DOD shall ensure that the military training activities included in the undertaking are carried out in a manner that is consistent with this legal mandate.

4. Upon termination of this PA under Stipulation IX or XI, the CRM designated by the DoD shall provide a report to the NPS and the CNMI HPO. This report shall summarize the following (for the time period that this PA has been in effect):

   a. The training activities that have occurred and their effects on the Tinian NHL.

   b. Steps taken to respond to those effects.

   c. List any newly identified cultural resources.

   d. NRHP eligibility evaluations completed for any newly identified cultural resources.

V. FIELD MONITORING AND REPORT SUBMISSION

A. Certain training areas will require field monitoring and report submission. See Agency-Area – Specific Stipulations (Stipulation IV).

B. Schedule: The CRM designated by the Joint Region Marianas shall conduct quarterly site checks (if any training has occurred within that time period) and shall submit a report to the appropriate HPO and NPS if applicable.

C. Field Report Contents: These reports will, at a minimum, include the following information:

   1. Digital photographs of a selection of historic properties within the affected area after completion of training exercises to show the general status of the historic properties in the area.

   2. If applicable, a description of any adverse effects that the training activities may have had on an historic property.

D. Review by the appropriate HPO: The HPO will review each report and provide the appropriate CRM with comments, if any. The HPO or the appropriate CRM may request a site visit by the appropriate HPO in lieu of photo documentation and a report.

E. See Stipulation IV.B.4.c regarding a special NHL assessment report to be submitted by the CRM designated by Joint Region Marianas to the NPS and the CNMI HPO upon the termination of this PA.

VI. DISCOVERIES AND EMERGENCIES

A. If during the performance of an undertaking, previously unknown cultural resources are discovered, the appropriate CRM shall be notified.

1. Reasonable measures to avoid or minimize impacts to the cultural resource will be undertaken.

2. Once notified, the appropriate CRM shall inspect the discovery and determine whether it is eligible for listing on the NRHP.

   a. If the discovery is not eligible for the NRHP, then the relevant agency will proceed.

   b. If it is determined that the cultural resource is eligible for the NRHP, the appropriate CRM will notify the applicable HPO via telephone, fax or e-mail, request concurrence for the determination, and document this discovery. The CRM will begin consultation with the HPO on how to mitigate the impacts or document the newly discovered historic property. If the Tinian NHL is involved, the NPS will also be notified and consulted.

B. If human burials are discovered during the performance of an undertaking, the appropriate CRM shall follow the applicable Standard Operating Procedure (commonly referred to as SOPs) specified in Appendix C. Different areas have different SOPs depending on the land managing agency and local regulations of each area.

C. In the event that natural disasters (such as typhoons or tsunamis), fires, sudden disruptions of utilities service, spill events or other emergency events occur, the particular DoD agency affected may take immediate actions to preserve life and property without having to undergo Section 106 review. However, emergency response work will take into consideration that historic properties may be affected by recovery or emergency efforts. When possible, such emergency actions will be undertaken in a manner that does not foreclose future preservation or restoration of historic properties. The appropriate CRM will notify the particular HPO by telephone of the emergency (if possible) and will follow up with written documentation if any historic properties were discovered or disturbed during the emergency events. Consultation with the appropriate HPO will be conducted as soon as practical based on the emergency circumstances.

VII. RESOLVING OBJECTIONS

A. Should any signatory to this PA object in writing regarding any actions carried out or proposed with respect to the implementation of this PA, the appropriate agency shall consult with the objecting party. All other signatories should be notified in writing that one of signatories is objecting to a specific action in this PA. The objecting party shall do the notifications.

B. If after initiating such consultation, the agency conducting the action determines that the objection cannot be resolved through consultation, it shall forward all documentation relevant to the objection to the ACHP, including the agency's proposed response to the objection.

C. Within 30 calendar days after receipt of all pertinent documentation, the ACHP shall exercise one of the following options:

1. Concur with the agency's proposed response;

2. Provide the agency with recommendations on the proposed response. The agency shall take into account such recommendations before making a final decision on the matter and proceeding accordingly;

3. Notify the agency that the objection will be referred to the ACHP membership for formal comment per 36 CFR §800.7(c). The resulting formal comment shall be taken into account by the agency in accordance with 36 CFR §800.7(c). If the ACHP has not responded within the allotted time, the agency may make a final decision on the objection and proceed accordingly.

VIII. AMENDMENT

A. Regulatory agencies (such as the Guam HPO and CNMI HPO) may propose to amend any stipulation of this PA within their area of jurisdiction. Each landowning/managing agency will have the ability to amend their portions of the PA specifically relating to any stipulation regarding the management of historic properties on their installation(s).

B. The amendment process starts when a signatory notifies the other signatories of this PA that it wishes to amend this agreement. A written notice must be sent to all signatories by the agency that wishes to amend the PA (or a particular portion of the PA). The requests should include the proposed amendments and the reasons for proposing them. The parties affected by these proposed amendments shall consult to consider the proposed changes to this PA.

C. No amendment shall take effect until it has been agreed upon and executed by all signatories affected by the amendment.

IX. TERMINATION

A. Regulatory agencies (such as the Guam HPO and CNMI HPO) may propose to terminate any stipulation of this PA within their area of jurisdiction only after complying with Stipulation VII. Each landowning/managing agency will have the ability to terminate their portions of the PA specifically relating to any stipulation regarding the management of cultural resources on their property only after complying with Stipulation VII.

B. The termination process starts when an agency provides in writing to other signatories of this PA, that it wishes to terminate this agreement, or a portion of the agreement applicable to them. A written notice must be sent to all signatories by the agency that wishes to terminate the PA (or their portion of the PA). The written notice must explain in detail the reasons for the proposed termination. The signatories will consult during a 30-calendar-day consultation period to seek agreement on amendments or other actions that would avoid termination. The 30-day consultation period starts when all parties have received written notification that an agency is requesting termination. If the signatory proposing the termination does not withdraw the proposal by the end of the 30-day consultation period and a longer period of arbitration is not agreed to by all signatories, then the PA or portion of the PA will be terminated.

C. In the event of full termination of this PA, all agencies will comply with 36 CFR §800 with regard to all individual undertakings. In the event that only a portion of the PA is terminated, then the remainder of the PA and the applicable stipulations will remain in effect and the PA will be amended to reflect this change per Stipulation VIII.

X. ANTI-DEFICIENCY ACT

A. The Anti-Deficiency Act, 31 U.S.C. §1341, prohibits federal agencies from incurring an obligation of funds in advance of or in excess of available appropriations. Accordingly, the parties agree that any requirement for obligation of funds arising from the terms of this agreement shall be subject to the availability of appropriated funds for that purpose, and that this agreement shall not be interpreted to require the obligation or expenditure of funds in violation of the Anti-Deficiency Act.

B. If compliance with the Anti-Deficiency Act alters or impairs a specific DoD agency's ability to implement the stipulations of this PA, the DoD Agency shall consult with the signatories. If an amendment is necessary, then Stipulation VIII shall be followed.

XI. DURATION

This PA shall become effective upon execution by all signatories and shall remain in effect for a period of 10 years unless terminated prior to that in accordance with Stipulation IX.

EXECUTION AND IMPLEMENTATION of this PA evidences that DOD REP, Joint Region Marianas, and the 36th Wing have afforded the Guam HPO, CNMI HPO, ACHP, and the NPS an opportunity to comment on the undertaking and its effects on historic properties in the Marianas, and have taken into account the effects of military training in the Marianas.

Each of the undersigned certifies that they have full authority to bind the party that they represent for purposes of entering into this agreement.

SIGNATORIES

THE DEPARTMENT OF DEFENSE REPRESENTATIVE
JOINT REGION MARIANAS

By: D Biesel Date: 8/22/09

D. T. BIESEL
Rear Admiral, U.S. Navy
Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau;
Commander, Joint Region Marianas

COMMANDER, 36TH WING

By: ______________________ Date: 17 JUN 09

PHILIP M. RUHLMAN
Brigadier General, USAF
Commander, 36th Wing

SIGNATORIES (continued)

GUAM HISTORIC PRESERVATION OFFICER

By: ______________________ Date: 10-2-09

JOSEPH W. DUENAS
Director
Department of Parks, Recreation & Historic Preservation

THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
HISTORIC PRESERVATION OFFICER

By: ______________________ Date: 10/30/09

PEDRO (ROY) SABLAN
Director
Commonwealth of the Northern Mariana Islands Historic Preservation Office

INVITED SIGNATORIES

NATIONAL PARK SERVICE

By: Rory D. Westberg Date: 12-11-09

RORY D. WESTBERG
Acting Regional Director
Pacific West Region, National Park Service

APPENDIX A

ACRONYMS & ABBREVIATIONS

ACRONYMS & ABBREVIATIONS

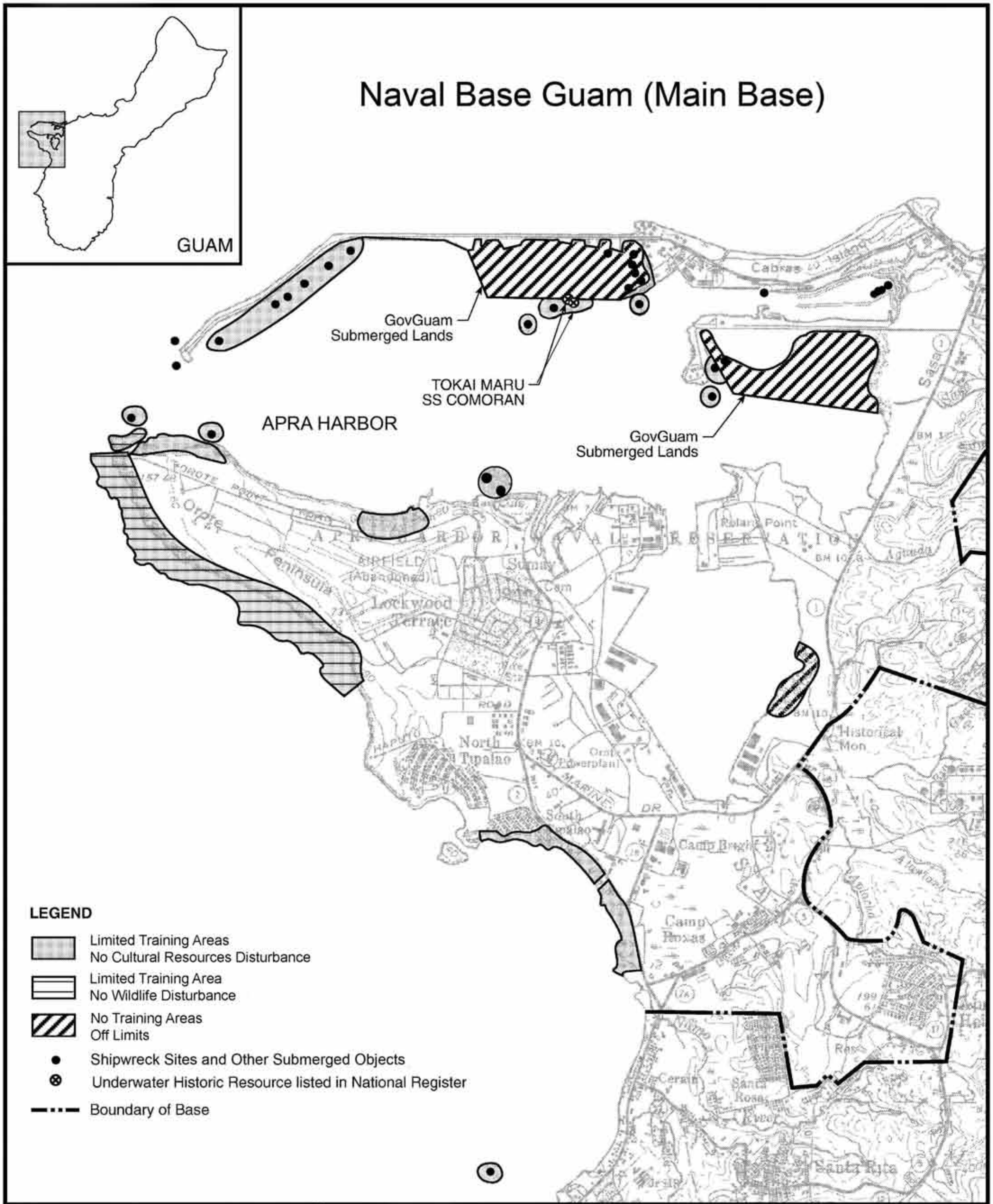
36th Wing	Commander, 36th Wing
ACHP	Advisory Council on Historic Preservation
CAR	Center Access Road
CATM	Combat Arms Training and Maintenance
CFR	Code of Federal Regulations
CNMI	Commonwealth of the Northern Mariana Islands
CNRM	Commander, Navy Region Marianas
CRM	Cultural Resource Manager
DoD	Department of Defense
DoD REP	DoD Representative Guam, Commonwealth of the Northern Marianas, Federated States of Micronesia and Republic of Palau
EIS	Environmental Impact Statement
EMUA	Exclusive Military Use Area
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HPO	Historic Preservation Officer
LT	Limited Training
MIRC	Mariana Islands Range Complex
MLA	Military Leaseback Area
MOA	Memorandum of Agreement
NHL	National Historic Landmark
NT	No Training
OEIS	Overseas Environmental Impact Statement
PA	Programmatic Agreement
SOI	Secretary of the Interior
SOP	Standard Operating Procedures
Tinian NHL	Tinian Landing Beaches, Ushi Point Field, and North Field, Tinian Island National Historic Landmark
U.S.C.	United States Code

APPENDIX B

TRAINING AND
TRAINING CONSTRAINT
MAPS

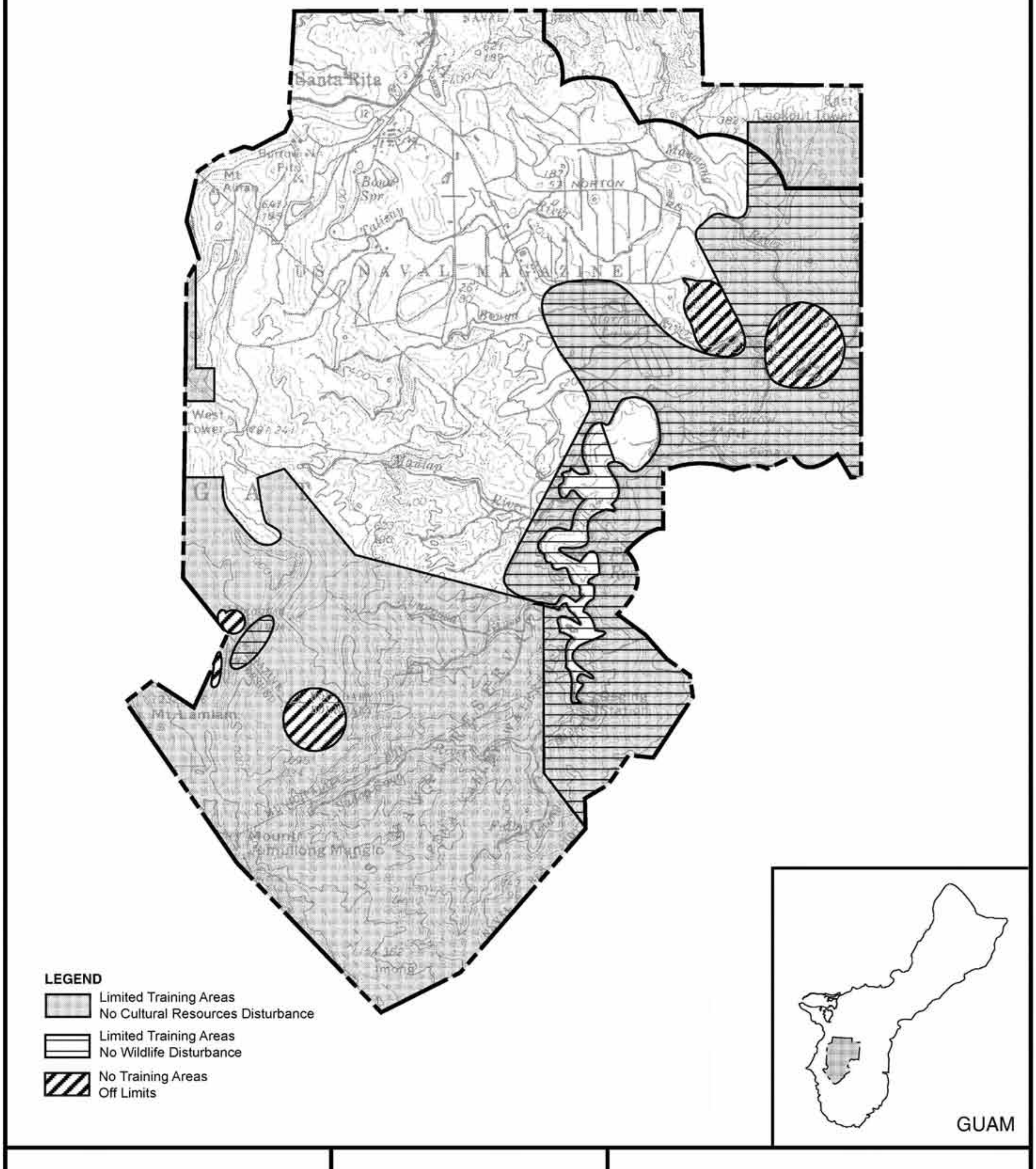
ISLAND OF GUAM

Naval Base Guam (Main Base)



Main Base
Training Constraints Map

Naval Ordnance Annex

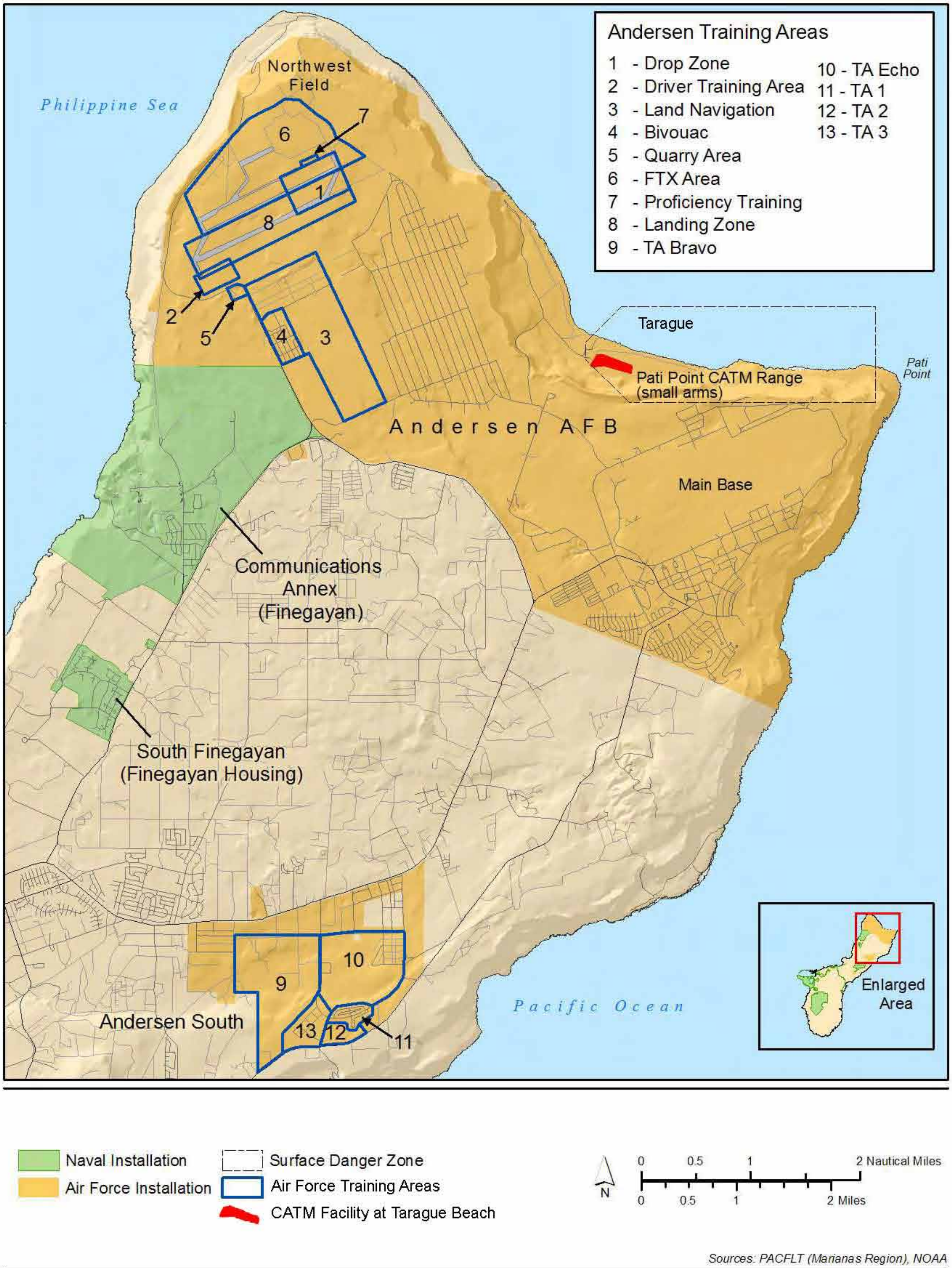


0 500 1000 (Meters)

0 2000 4000 (Feet)

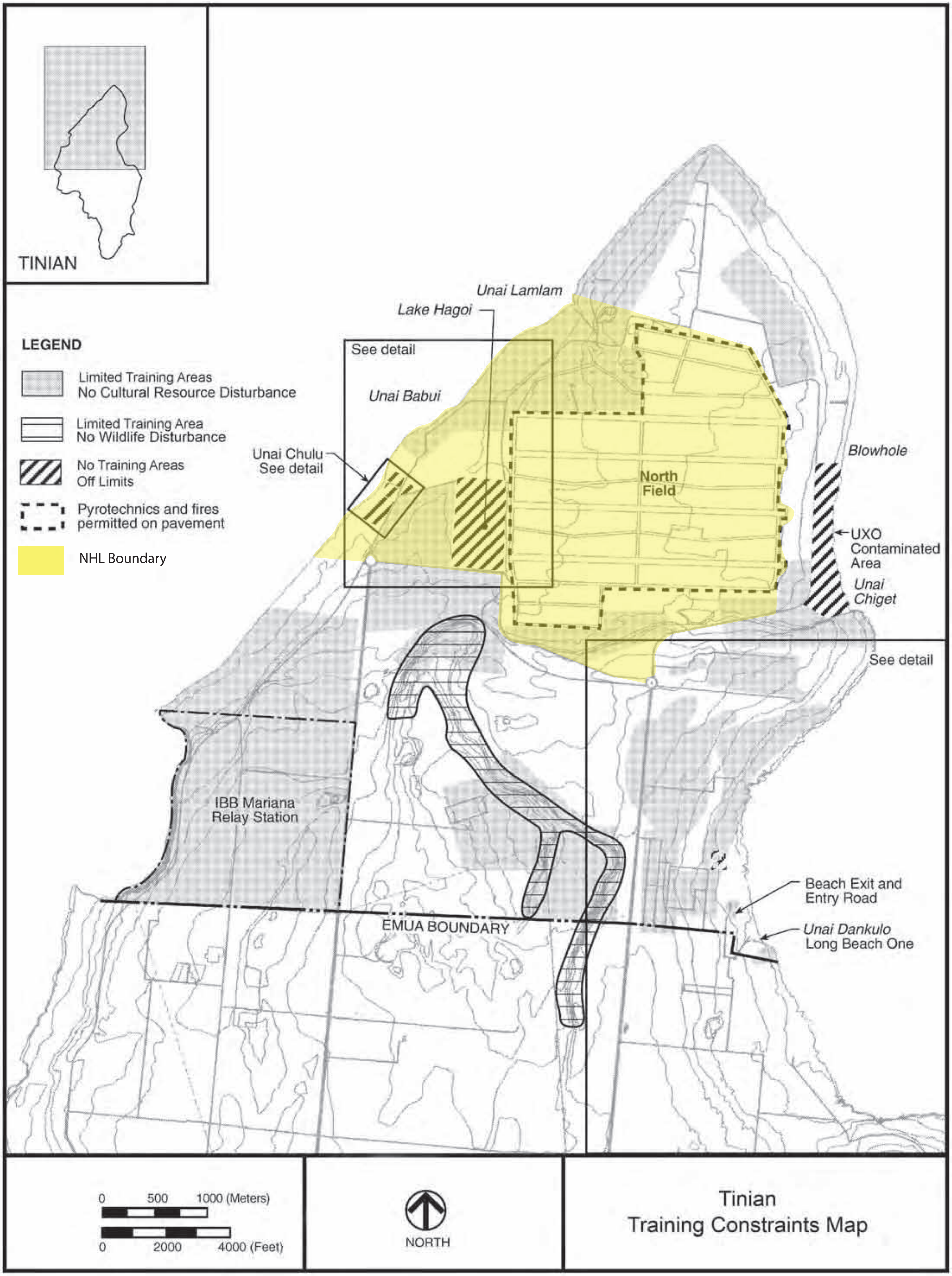
NORTH

Naval Ordnance Annex
Training Constraints Map

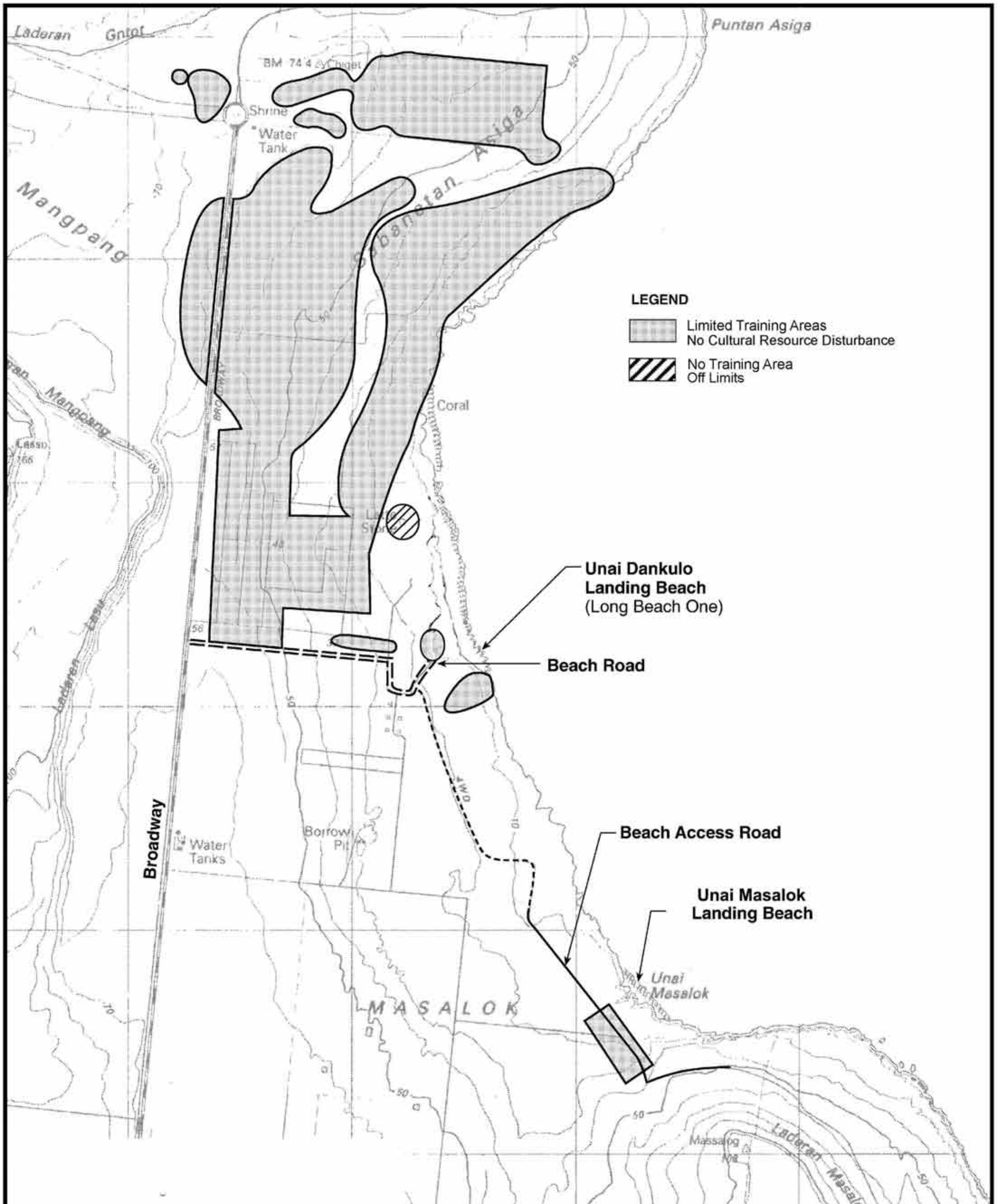


Air Force Training Areas (Northwest Field, Tarague, Andersen South).

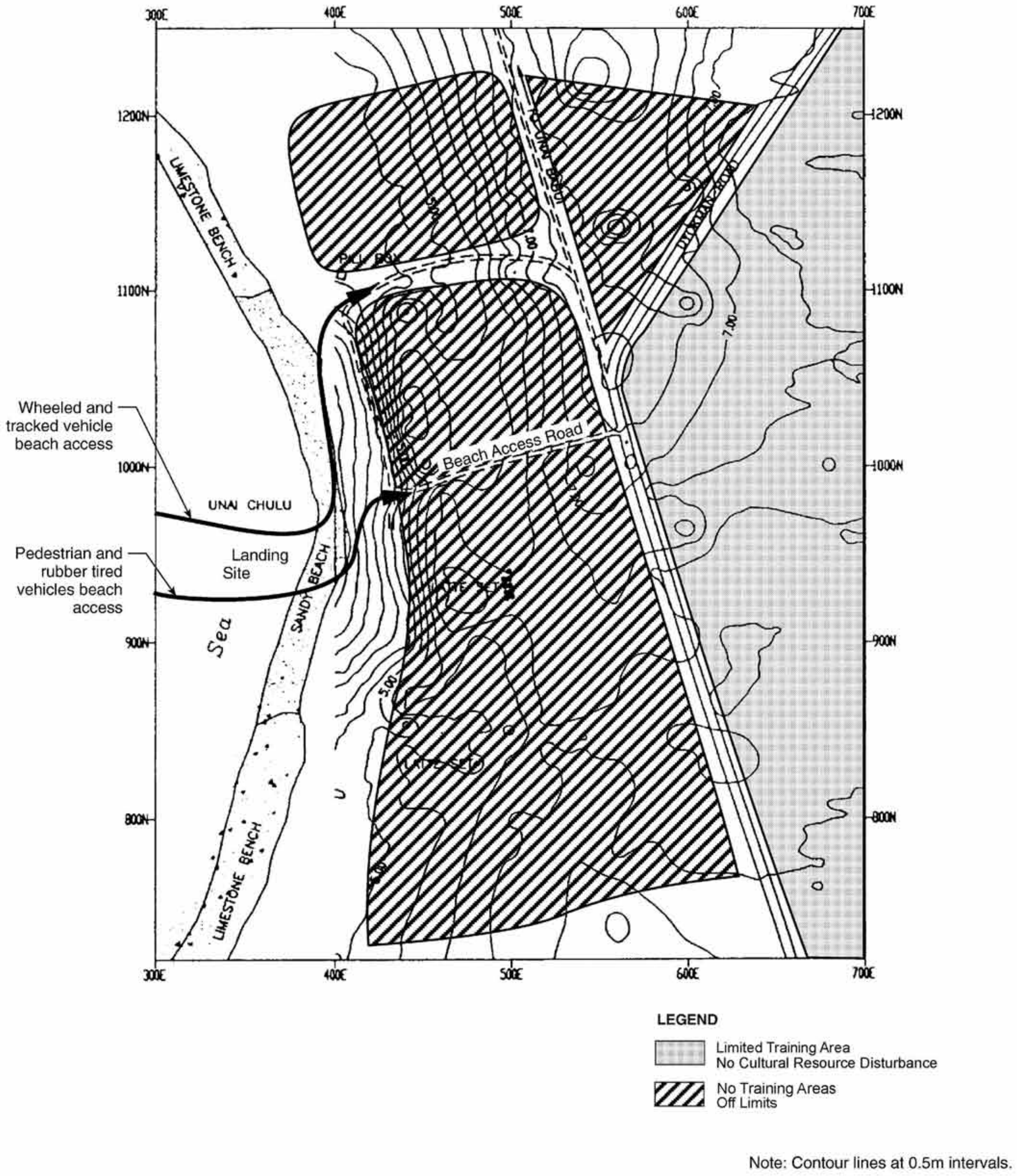
ISLAND OF TINIAN



Tinian
Training Constraints Map



Unai Dankulo and Unai Masalok
Training Constraints Map

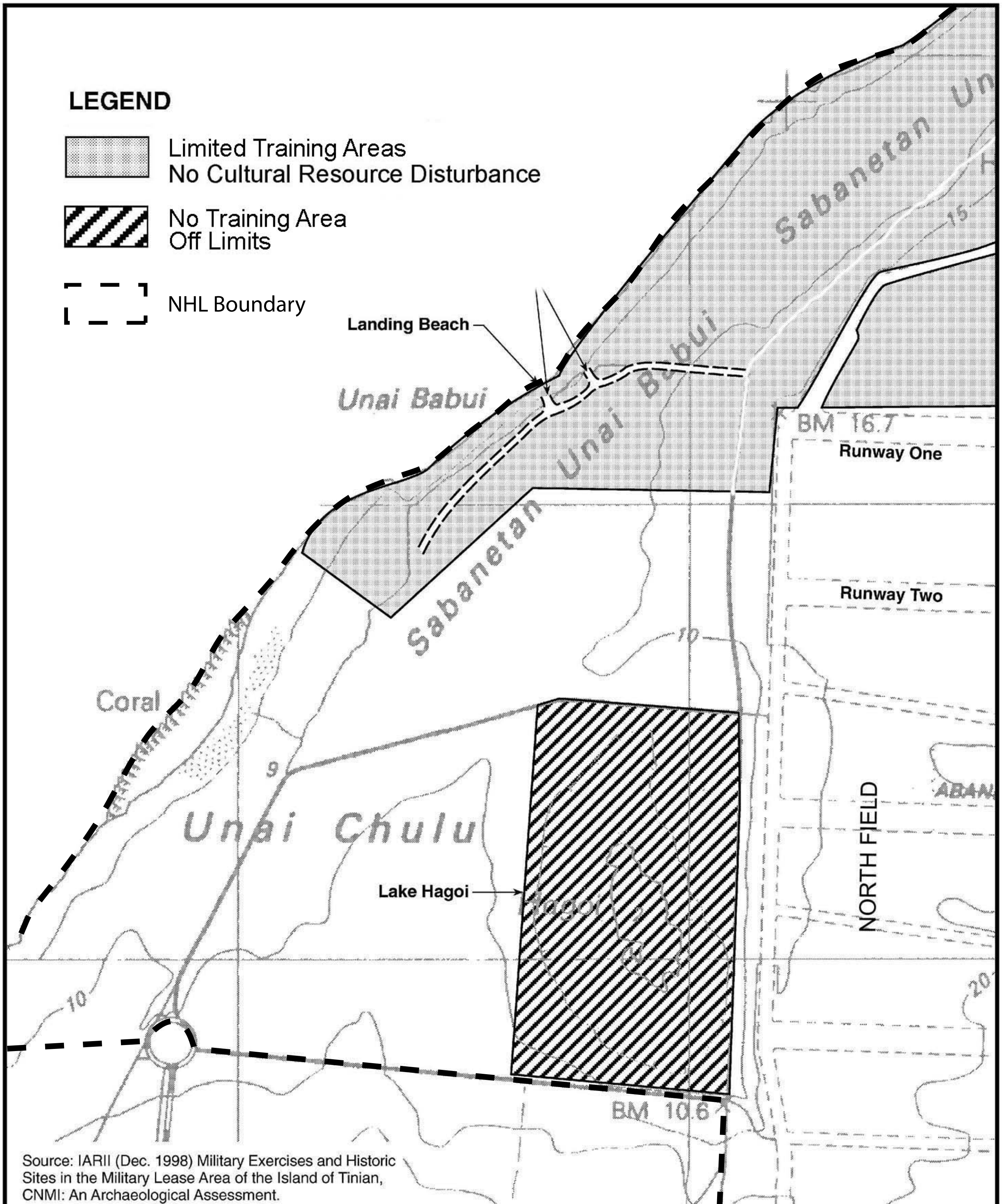


0 25 50 75 100 (Meters)

0 100 200 300 (Feet)

NORTH

Unai Chulu
Training Constraints Map



Source: IARII (Dec. 1998) Military Exercises and Historic Sites in the Military Lease Area of the Island of Tinian, CNMI: An Archaeological Assessment.

Unai Babui & Lake Hagoi Training Constraints Map

APPENDIX C

STANDARD OPERATING PROCEDURES
FOR THE INADVERTENT DISCOVERY OF HUMAN BURIALS

ISLAND OF GUAM

NAVY STANDARD OPERATING PROCEDURE
REGARDING THE INADVERTENT DISCOVERY OF HUMAN REMAINS ON GUAM

PURPOSE: This SOP provides uniform guidelines in the event that human remains are inadvertently discovered or disturbed during the course of any action, undertaking, or activity (including those caused by natural occurrences such as erosion) on Navy-retained lands on Guam. Inadvertent discovery refers to the unintentional excavation or discovery of human remains.

ETHICS: Any human remains regardless of ethnicity or time of deposition shall be treated with respect and dignity.

REFERENCE: National Historic Preservation Act, 36 CFR Part 800; Archaeological Resources Protection Act; Certain aspects of the Native American Graves Protection and Repatriation Act and the Guam Department of Parks and Recreation General Guidelines for Archaeological Burials were also incorporated into this SOP.

RESPONSIBILITY: Primary responsibility for carrying out this SOP lies with the Navy's cultural resource manager under Commander, Navy Region Marianas (CNRM). These procedures should be briefed to all on-site managers and supervisors who are carrying out work that could result in inadvertent discovery of remains on Navy property or during Navy sponsored projects.

STANDARD OPERATING PROCEDURES
REGARDING THE INADVERTENT DISCOVERY OF
HUMAN REMAINS ON GUAM

<u>STEP I</u> – INITIAL DISCOVERY

If human skeletal remains (or remains thought to be human) are found during a Navy project or on Navy retained lands on Guam, the following procedures shall be followed:

1. The remains shall be protected from the elements and the area around the discovery shall be secured. CNRM security personnel and cultural resource manager should be notified immediately.
2. If human remains were uncovered during a Navy construction project, then the contracting officer associated with the specific project shall be notified per the contract clause referencing these procedures. A stop work order for the area within the immediate vicinity of the find shall be issued by the contracting officer, if appropriate. The contracting officer shall be notified of all subsequent consultations regarding the remains

<u>STEP II</u> PRELIMINARY IDENTIFICATION

CNRM cultural resource manager shall determine if the skeletal remains are animal or human. This shall be done through a professional trained in the identification of human remains (such as an archaeologist, physical anthropologist, forensic specialist) and such professional shall examine the remains and make a determination as to whether they are human. If the skeletal remains are identified as human, then proceed to Step III.

<u>STEP III</u> IDENTIFICATION - AGE OF DEPOSITION (TIME PERIOD) & ETHNICITY

If possible, the age of deposition (time period) and ethnicity of the remains shall be determined based on skeletal morphology, context, and associated artifacts by (or under the supervision of) an archaeologist meeting federal qualifications set forth in 36 CFR 61, Appendix A. This determination shall be made as soon as possible, taking into account specific circumstances regarding the discovery of the remains. The following steps shall be undertaken during the identification phase:

<u>Modern Remains</u>

If the skeletal remains are found to be human and are modern, then CNRM security personnel and Naval Criminal Investigative Services (NCIS) will take over the investigation.

World War II Remains

If the skeletal remains are found to be human and are from World War II (WWII), then the following procedures shall be followed:

1. If there is reason to believe that the remains are from WWII and are of the indigenous origin (Charmorro) or of any other civilian present on Guam at the time, then the Community/Public Affairs office shall be notified and involved in the consultation process.
2. If there is reason to believe that the remains are of U.S. military personnel, then the Joint POW/MIA Accounting Command (JPAC) shall be notified and will take over the case.
3. If there is reason to believe that the remains are Japanese from World War II, the Consulate General of Japan (CGJ), Agana, Guam, shall be notified and consulted with as to the disposition of the remains.
4. A courtesy call will be made to the Guam [State] Historic Preservation Office (SHPO) to inform them that human skeletal remains from WWII time period were uncovered. However, human remains from this time period are usually not considered as archaeological in nature and other agencies such as JPAC or CGJ have jurisdiction over those matters.

Depending on the preliminary determination by the agencies as to whether the remains are of recent, historic, or pre-contact deposition, the following steps shall be taken:

Remains Older than WWII (Historic and Prehistoric)

If the skeletal remains are found to be human and older than 50 years (and are not associated with WWII), then following procedures shall be followed:

1. The cultural resource manager shall notify the SHPO within three working days of the identification that the skeletal remains are human and are historic or prehistoric in nature.
2. If requested, the CNRM cultural resource manager shall arrange for a site visit by a SHPO representative.
3. The cultural resource manager shall consult with the SHPO and follow Section II and III of the Policy Guidance in the Guam Department of Parks and Recreation General Guidelines for Archaeological Burials.
4. If any other organization or agency comes forward and expresses an interest in participating in the consultation process, they must submit a written request expressing their desire to participate in the consultation process and explain how they are culturally affiliated with the human remains. Their comments will be considered in the overall decision making process.
5. If the remains are encountered during project construction, CNRM shall determine the feasibility of project alternatives that will avoid disturbance of the remains or whether disinterment is necessary. If a mass burial is indicated, preservation in place shall be the preferred alternative. The results of the consultation shall be placed on file at CNRM environmental office and JPAC shall be notified.

Undetermined Remains

If a determination as to the age of deposition of the remains or the ethnicity of the remains cannot be determined, the procedures below shall be followed:

1. The SHPO will be notified and consulted with. Based on the consultation, a decision will be made to either preserve the remains *in situ* or to remove them for further analysis in hopes that the age of deposition and ethnicity can eventually be determined so that the appropriate protocols can be followed.

2. If it is determined that the skeletal remains and any associated artifacts will be exhumed, then the remains should be documented by (or under the supervision of) a qualified archaeologist.

3. Tests involving damage to the skeletal material are highly discouraged and will not be performed by the Navy. However, should it be necessary, performance of radiocarbon dating on any associated charcoal, midden, or artifacts may be conducted at the discretion of the Navy in consultation with the SHPO in order to determine age of deposition. The results of these tests, if any, shall be presented in the report by the recording professional. This report shall be submitted to the CNRM cultural resource manager and the SHPO as a record of the study.

4. If additional tests were conducted, another attempt to determine age of deposition and determine the ethnicity of the skeletal remains will be made based on the results. If a determination can be made on the age of deposition or ethnicity, then the disposition of the human remains will be conducted according to appropriate protocols outlined previously.

5. If a professional(s) not associated with the Navy, meeting the qualifications set forth in 36 CFR 61 Appendix A, seeks to analyze the skeletal remains they shall submit a written request to the CNRM cultural resource manager. The CNRM cultural resource manager shall notify the SHPO of the request and will follow the procedures outlined in the Research Guidelines section of the Guam Department of Parks and Recreation General Guidelines for Archaeological Burials. The applicant shall be notified within 30 days of submission of the Research Design whether it has been accepted or rejected. The cost of the tests and report preparation shall be borne by the applicant. A copy of the results and findings shall be provided to the Navy and the SHPO within six months after the tests are conducted. The remains shall be curated at the laboratory of the researcher until plans for reburial have been made.

6. If the age of deposition or ethnicity of the human remains cannot be determined, then the CNRM cultural resource manager, in consultation with the SHPO, shall curate the remains and any associated artifacts in the event that further information may come to light or rebury the remains. A record of the consultation process shall be placed on file at CNRM environmental office and at the SHPO.

STEP IV DISPOSITION

CNRM shall follow Sections II and III of the Policy Guidance in the Guam Department of Parks and Recreation General Guidelines for Archaeological Burials when dealing with the disposition of human remains older than WWII. Reiterated below are procedures tailored specifically to burials found on Navy property on Guam using the Department of Parks and Recreation General Guidelines for Archaeological Burials as a general guideline.

1. If the remains are found eroding out of the soil, the Navy, in consultation with the SHPO, shall decide whether the remains can be preserved in place or whether the remains would be severely damaged by leaving them *in situ.* The results of the decision-making process shall be placed on file at the CNRM environmental office.

2. If the remains are exposed during a project, and the project can be redesigned to avoid the remains, or the remains can be left in place then the following steps shall be taken: The remains and any associated artifacts shall be recorded *in situ* by an individual meeting the qualifications set forth in 36 CFR 61.9 using standard archeological procedures set forth in 48 CFR 44720. Every effort shall be made to determine the number of individuals and the age, sex, and ethnicity of the remains. The documentation and a record of the location of the remains shall be kept on file at CNRM environmental office. A copy shall be provided to the SHPO.

3. If the project cannot be redesigned to avoid disturbing the remains the following steps shall be followed:

    (a) The remains and any associated artifacts shall be removed by an archeologist meeting the professional qualifications set forth in 36 CFR 61.9**,** using standard archeological procedures set forth in 48 CFR 44720.

    (b) A report of the excavation techniques and findings, along with a photographic record shall be submitted to CNRM within 30 days of disinterment. The documentation shall be kept on file at CNRM and a copy provided to the HPO; any associated artifacts shall be temporarily curated at the contractor's laboratory until the final disposition of the remains is determined.

4. If remains have to be moved, then through consultation with the SHPO it will be determined by CNRM that the human remains may be reburied elsewhere. COMAVMARIANAS will follow Section IV(A)(1 and 4) or Section IV(B) of the Guam Department of Parks and Recreation General Guidelines for Archaeological Burials if determined appropriate and funds are available. The documentation and a record of the location of the remains shall be kept on file at the CNRM environmental office. A copy shall be provided to the SHPO.

AIR FORCE (36TH WING) STANDARD OPERATING PROCEDURE FOR THE INADVERTENT DISCOVERY OF HUMAN REMAINS

PURPOSE: This SOP provides uniform guidelines in the event that human remains are inadvertently disturbed during the course of any action, undertaking, or activity at Andersen AFB (including those caused by natural occurrences such as erosion). Inadvertent discovery refers to the unintentional discovery of human remains during the course of any operations.

REFERENCE: National Historic Preservation Act, 36 CFR Part 800; Archaeological Resources Protection Act; DoD Directive 4710.1; DoD Instruction 4715.3

RESPONSIBILITY: Primary responsibility for carrying out this SOP lies with on-site managers of the undertaking and the Andersen AFB Cultural Resource Manager (CRM). A copy of this SOP should be provided to all on-site managers and supervisors who are carrying out work that could result in inadvertent discovery of remains. A copy should also be provided to Law Enforcement, 36 SFS.

PROCEDURES.

1. Upon discovery of unanticipated archaeological remains, the individual making the discovery should notify the on-site manager or person in charge of the action, undertaking, or activity. The on-site manager should immediately halt the action, undertaking, or activity in the vicinity of the discovery.

2. The on-site manager should ensure that a reasonable effort is made to secure the area and protect the archaeological resource from damage (including vandalism). This might include cordoning the area and covering exposed items with a tarp or similar material.

3. The on-site manager should notify Andersen AFB law enforcement personnel immediately. Security personnel should inspect the remains to ensure that they are not of recent origin.

4. If the remains are not of recent origin, the on-site manager should contact the Andersen AFB CRM to report the nature, location, and circumstances of the inadvertent discovery.

5. The CRM should carry out the following actions, if necessary:

   A. arrange for an evaluation by a professional archaeologist to determine if the remains are human or non-human, and if human, to evaluate the origin, nature, and ethnicity (if possible) of the human remains. A determination of whether the inadvertent discovery constitutes a "historic property" under the NHPA should also be made; if so, then Section 106 proceedings are also called into play.

   B. if the remains are human, notify the Guam HPO immediately.

C. in consultation with the Guam HPO, the CRM should ensure that the remains are properly treated until appropriate disposition of the remains has taken place. The Guam HPO should also be consulted as to appropriate disposition protocols.

6. The CRM will make a tracking report of the inadvertent discovery for inclusion in the annual report of historic preservation activities on the installation.

7. Prior to resuming the action, undertaking, or activity, the Andersen AFB CRM should ensure that associated cultural resources discovered by this process are protected and/or adverse effects are mitigated. If associated cultural resources are protected, the CRM should ensure that they will not be further impacted by continuing the activity.

ISLAND OF TINIAN

STANDARD OPERATING PROCEDURE
FOR THE INADVERTENT DISCOVERY OF HUMAN REMAINS
WITHIN THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

PURPOSE: This Standard Operating Procedure (SOP) provides uniform guidelines in the event that human remains are inadvertently discovered during the course of any Navy action, undertaking, or activity (including those caused by natural occurrences such as erosion) or on Navy property or Department of Defense (DoD) leased lands within the Commonwealth of the Northern Mariana Islands (CNMI).

ETHICS: Any human remains regardless of ethnicity or time of deposition shall be treated with respect and dignity.

REFERENCES: National Historic Preservation Act, 36 CFR Part 800; Archaeological Resources Protection Act; Native American Graves Protection and Repatriation Act and the CNMI Historic Preservation Office's (HPO) Procedures for the Treatment of Human Remains in the Commonwealth of the Northern Mariana Islands (May 2000) were also incorporated into this SOP.

RESPONSIBILITY: Primary responsibility for carrying out this SOP lies with the Navy's cultural resource manager under Commander, Navy Region Marianas (CNRM). These procedures should be briefed to all on-site managers and supervisors who are carrying out work that could result in inadvertent discovery of remains on Navy property or DoD leased property.

DEFINITIONS: In this SOP, human remains are defined as whole or partial human skeletal remains including dentition. Human skeletal remains that have been transformed or utilitzed as artifacts (tools, implements, decoration, jewelry, etc.) are excluded from this definition. These items shall be treated as artifacts. The term "inadvertent discovery" refers to the unintentional excavation or discovery of human remains.

STANDARD OPERATING PROCEDURES
FOR THE INADVERTENT DISCOVERY OF HUMAN REMAINS
WITHIN THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

STEP I – INITIAL DISCOVERY

If human skeletal remains (or remains thought to be human) are found during a Navy project or on Navy-retained or DoD leased lands within CNMI, the procedures below shall be followed:

1. The remains shall be protected from the elements and the area around the discovery shall be secured. Security personnel and the Navy's cultural resource manager (CRM) should be notified immediately.
2. If the remains are found during a Navy sponsored construction project or on Navy retained-lands or DoD leased land, then work in the immediate vicinity shall be halted until the situation is properly evaluated. If this project is tied to a construction project, then the contracting officer associated with the specific project shall be notified per the contract clause referencing these procedures. A stop work order for the area within the immediate vicinity of the find shall be issued by the contracting officer, if appropriate. The contracting officer shall be notified of all subsequent consultations regarding the remains.

STEP II PRELIMINARY IDENTIFICATION

The CRM shall determine if the skeletal remains are animal or human. If the CRM does not have a background or training in osteology, the identification should be done through a professional trained in the identification of human remains (such as an archaeologist, physical anthropologist, forensic specialist, medical examiner, or M.D.) and such professional shall examine the remains and make a determination as to whether they are human. If the skeletal remains are identified as human, then proceed to Step III.

STEP III IDENTIFICATION - AGE OF DEPOSITION (TIME PERIOD) & ETHNICITY

If possible, the age of deposition (time period) and ethnicity of the remains shall be determined based on skeletal morphology, burial context, and associated artifacts. This identification should be conducted by (or under the supervision of) an archaeologist that meets the federal qualifications set forth by the Secretary of the Interior in 36 CFR 61, Appendix A. This determination shall be made as soon as possible, taking into account specific circumstances regarding the discovery of the remains.

The following steps shall be undertaken during the identification phase:

Modern Remains

If the skeletal remains are found to be human and are modern, then Navy security personnel and the Naval Criminal Investigative Service will take over the investigation.

World War II Remains

If the skeletal remains are found to be human and are from World War II (WWII), then the following procedures shall be followed:

1. In all cases of WWII period human remains, the Navy's Community/Public Affairs office shall be notified.
2. If there is reason to believe that the human remains are of Chamorro descent and from WWII, then the CNMI HPO will be notified since the CNMI Department of Culture and Community Affairs has designated the CNMI HPO as the agency that handles civilian remains from WWII discovered within CNMI. The CNMI HPO will be consulted with as to how the remains will be repatriated.
3. If there is reason to believe that the remains are from WWII and are civilians of Carolinian descent, then the Carolinian Affairs (CA) office will be notified and will be consulted with as to how the remains will be repatriated.
4. If there is reason to believe that the remains are of U.S. military personnel from WWII, then the Joint POW/MIA Accounting Command (JPAC) shall be notified and will take over the investigation.
5. If there is reason to believe that the remains are Japanese civilians from WWII, the Saipan Consular Office of Japan (COJ) shall be notified and will be consulted with as to how the remains will be repatriated.
6. If there is reason to believe that the remains are Korean civilians from WWII, the Republic of Korea Consulate General (ROKCG) in Guam shall be notified and will be consulted with as to how the remains will be repatriated.
7. The CNMI HPO will be notified (in the form of a phone call) to inform them that human skeletal remains were discovered and are believed to be from the WWII time period. The CNMI HPO is the keeper of records regarding all human remains disinterred in CNMI from WWII. However, since human remains from this time period are under the jurisdiction of other agencies such as CA office, JPAC, COJ, ROKCG , the Navy will put these agencies in touch with the CNMI HPO. If the agencies mentioned above decide to that they want the human remains exhumed, a record of the context, associated objects, and photograph and sketch the remains will be submitted to the HPO SHPO after the remains are disinterred.

Depending on the preliminary determination as to whether the remains are of recent, historic, or pre-contact deposition, the following steps shall be taken:

Remains Older than WWII (Historic and Prehistoric)

If the skeletal remains are found to be human and older than 50 years (and are not associated with WWII), then following procedures shall be followed:

1. CRM shall notify the CNMI HPO within five working days of the identification that the skeletal remains are human and are historic or prehistoric in nature.
2. If requested, the CRM shall arrange for a site visit by a CNMI HPO representative.
3. If possible, the CRM should identify the ethnic affiliation (Chamorro or Carolinian) of the human remains in consultation with the CNMI HPO.[1]
4. If any other organization or agency comes forward and expresses an interest in participating in the consultation process, they must submit a written request expressing their desire to participate in the consultation process and explain how they are culturally affiliated with the human remains. The CRM will assess this request along with the CNMI HPO. Their comments will be considered in the overall decision making process.
5. If the remains are encountered during project construction, CRM shall determine the feasibility of project alternatives that will avoid disturbance of the remains or whether disinterment is necessary. If a mass burial is indicated, preservation is the preferred alternative. The results of the consultation shall be placed on file at CNRM environmental office

Undetermined Remains

If a determination as to the age of deposition of the remains or the ethnicity of the remains cannot be determined, the following procedures shall be followed:

1. The CNMI HPO will be notified and consulted with. Based on the consultation, a decision will be made to either preserve the remains *in situ* or to remove them for further analysis in hopes that the age of deposition and ethnicity can eventually be determined so that the appropriate protocols can be followed.
2. If it is determined that the skeletal remains and any associated artifacts will be excavated, then they should be documented by (or under the supervision of) a qualified archaeologist.
3. Tests involving damage to the skeletal material are highly discouraged and will not be performed by the Navy. However, should it be necessary, performance of radiocarbon dating on any associated charcoal, midden, or artifacts may be conducted at the discretion of the Navy in consultation with the CNMI HPO in order to determine age of deposition. The results of these tests, if any, shall be presented in the report by the recording professional. This report shall be submitted to the CNRM environmental office and the CNMI HPO as a record of the study.
4. If additional studies are conducted, another attempt to determine age of deposition and determine ethnicity of the skeletal remains will be made based on the results. If a determination can be made on the age of deposition or ethnicity, then the disposition of the human remains will be conducted according to appropriate protocols outlined previously.

---

[1] Although not likely, but if Native American, Native Alaskan, or Native Hawaiian remains are encountered, then CNRM shall follow the procedures outlined in the Native American Graves Protection and Repatriation Act.

5. If a professional(s) not associated with the Navy, meeting the qualifications set forth in 36 CFR 61 Appendix A, seeks to analyze the skeletal remains they shall submit a written request to the CRM. The CRM shall notify the CNMI HPO of the request. A research design acceptable to both the CRM and the CNMI HPO will be required in order to conduct analyses on human remains recovered from Navy managed lands. In addition, the applicant shall fill out and submit to the CNMI HPO, a curation agreement form. The applicant shall be notified within 30 days of submission of the Research Design whether it has been accepted or rejected. The cost of the tests and report preparation shall be borne by the applicant. A copy of the results and findings shall be provided to the CRM and CNMI HPO within six months after the tests are conducted. The remains shall be curated at the laboratory of the researcher until plans for reburial have been made.
6. If the age of deposition or ethnicity of the remains cannot be determined and exhumation is necessary, then the Navy in consultation with the HPO shall curate the remains and any associated artifacts in the event that further information may come to light or rebury the remains. A record of the consultation process shall be placed on file at CNRM environmental office and at the CNMI HPO.

STEP IV DISPOSITION

Reiterated below are procedures tailored specifically to disposition of human remains found on Navy property or DoD leased land within CNMI using the Section V (Class I and II) of the CNMI HPO's Procedures for the Treatment of Human Remains in the Commonwealth of the Northern Mariana Islands (May 2000) as a general guideline. These procedures apply to prehistoric and historic human remains. The disposition of human remains from WWII or modern origin will be primarily handled by other entities and agencies as mentioned in STEP III.

Disposition of pre-historic and historic human remains:

1. If human remains are discovered eroding out of sediments, then the Navy, in consultation with the CNMI HPO, shall decide whether the remains can be preserved in place or whether the remains should be removed. The results of the decision-making process shall be placed on file at CNRM environmental office. The CRM shall carry out the procedures agreed upon during the consultation process.
2. If the remains are exposed during a project, and the project can be redesigned to avoid the remains, or the remains can be left *in situ* without impacts to the project, then the following steps shall be taken:
   a. The location and description of the remains and any associated artifacts shall be recorded *in situ* by an individual meeting the qualifications set forth in 36 CFR 61.9 using standard archeological procedures set forth in 48 CFR 44720.
   b. Every effort shall be made to determine the number of individuals and the age, sex, and ethnicity of the remains. The documentation and a record of the location of the remains shall be kept on file at CNRM environmental office. A copy shall be provided to the CNMI HPO.
3. If the project cannot be redesigned to avoid disturbing the remains the following steps shall be followed:

a. The remains and any associated artifacts shall be removed by an archeologist meeting the professional qualifications set forth in 36 CFR 61.9**,** Appendix A, using standard archeological procedures set forth in 48 CFR 44720. If the Navy or contractor seeks to curate the artifacts for a short time before turning over the artifacts to the CNMI HPO, then an artifact loan agreement form needs to filled out and submitted to the CNMI HPO.

b. A report of the excavation techniques and findings, along with a photographic record and sketches shall be submitted to CRM within 180 days of disinterment. The documentation shall be kept on file at CNRM environmental office and a copy will be provided to the HPO; any associated artifacts shall be temporarily curated at the contractor's laboratory until the final disposition of the remains is determined.

4. If remains have to be moved, then through consultation with the CNMI HPO it will be determined by CRM that the human remains may be reburied elsewhere. The CRM will consult with the CNMI HPO as to the appropriate location. The documentation and a record of the location of the remains shall be kept on file at CNRM environmental office a copy shall be provided to the CNMI HPO.

STEP V. CULTURAL ACCESS

Any requests for access to the burial sites should be submitted to CRM in writing. The agency or organization must show how their organization is culturally associated with the remains in order for their request to be considered a legitimate cultural access request. If the Navy determines that the agency or organization has a legitimate cultural access request, then they Navy will arrange a date and time for them to access the site taking into account current Navy security and training schedules. Site visit protocols require the visitors be escorted by a Navy representative at all times, that the visitors conduct themselves in a respectable manner, and follow all Navy rules and regulations while on the installation. Any behavior otherwise, and the individual(s) will be escorted off the installation or even restricted from entering again. Persons may be denied access if they do not pass the Navy’s security clearance procedures. However, every effort will be made to accommodate legitimate cultural access requests. Access requests shall be placed on file at CNRM environmental office will be reported to the CNMI HPO on a yearly basis.