# TABLE OF CONTENTS

## 1 PURPOSE AND NEED

1.1 INTRODUCTION ................................................................. 1-1
1.2 THE NAVY’S ENVIRONMENTAL COMPLIANCE AND AT-SEA POLICY ....................................................... 1-3
1.3 PROPOSED ACTION .......................................................... 1-4
1.4 PURPOSE OF AND NEED FOR PROPOSED MILITARY READINESS TRAINING AND TESTING ACTIVITIES .... 1-4
  1.4.1 WHY THE NAVY TRAINS .............................................. 1-4
  1.4.2 FLEET READINESS TRAINING PLAN ......................... 1-5
    1.4.2.1 Basic Phase ...................................................... 1-5
    1.4.2.2 Integrated Phase .............................................. 1-6
    1.4.2.3 Sustainment Phase ............................................ 1-6
    1.4.2.4 Maintenance Phase ......................................... 1-6
  1.4.3 WHY THE NAVY TESTS .............................................. 1-6
1.5 OVERVIEW AND STRATEGIC IMPORTANCE OF EXISTING RANGE COMPLEX ........................................... 1-8
1.6 THE ENVIRONMENTAL PLANNING PROCESS ......................... 1-9
  1.6.1 NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS ............................................................... 1-9
  1.6.2 EXECUTIVE ORDER 12114 ........................................ 1-10
  1.6.3 OTHER ENVIRONMENTAL REQUIREMENTS CONSIDERED .............................................................. 1-10
1.7 SCOPE AND CONTENT ................................................... 1-11
1.8 ORGANIZATION OF THIS ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT .............................................................. 1-11
1.9 RELATED ENVIRONMENTAL DOCUMENTS .......................... 1-12
1.10 ONGOING ENVIRONMENTAL DOCUMENTS IN THE STUDY AREA ............................................................. 1-13

## 2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 DESCRIPTION OF THE MARIANA ISLANDS TRAINING AND TESTING STUDY AREA .................................. 2-2
  2.1.1 MARIANA ISLANDS RANGE COMPLEX ...................... 2-2
    2.1.1.1 Special Use Airspace and Air Traffic Controlled Assigned Airspace .............................................. 2-5
    2.1.1.2 Sea and Undersea Space .................................. 2-5
    2.1.1.3 Land .................................................................. 2-6
  2.1.2 OCEAN OPERATING AREAS OUTSIDE THE BOUNDS OF THE MARIANA ISLANDS RANGE COMPLEX ........ 2-7
  2.1.3 PIERSIDE LOCATIONS AND APRA HARBOR ............ 2-7
2.2 PRIMARY MISSION AREAS ............................................... 2-19
  2.2.1 ANTI-AIR WARFARE .................................................. 2-19
  2.2.2 AMPHIBIOUS WARFARE ......................................... 2-20
  2.2.3 STRIKE WARFARE ................................................... 2-20
  2.2.4 ANTI-SURFACE WARFARE ....................................... 2-20
  2.2.5 ANTI-SUBMARINE WARFARE .................................. 2-20
  2.2.6 ELECTRONIC WARFARE ......................................... 2-21
  2.2.7 MINE WARFARE ...................................................... 2-21
  2.2.8 NAVAL SPECIAL WARFARE .................................... 2-22
2.3 DESCRIPTIONS OF SONAR, ORDNANCE/MUNITIONS, TARGETS, AND OTHER SYSTEMS EMPLOYED IN MARIANA ISLANDS TRAINING AND TESTING EVENTS .......... 2-22
  2.3.1 SONAR AND OTHER ACOUSTIC SOURCES .................. 2-22
    2.3.1.1 What is Sonar? .................................................. 2-22
    2.3.1.2 Sonar Systems .................................................. 2-23
  2.3.2 ORDNANCE/MUNITIONS .......................................... 2-29
2.7.2 PROPOSED ADJUSTMENTS TO BASELINE TESTING ACTIVITIES

2.7.1 Other Training ............................................................................................................................. 2-62
2.7.1.9 Mine Warfare .............................................................................................................................. 2-61
2.7.3 PROPOSED PLATFORMS AND SYSTEMS ................................................................................................. 2-63
2.7.1.6 Electronic Warfare ...................................................................................................................... 2-61
2.7.3.6 Munitions .................................................................................................................................... 2-67
2.7.1.4 Anti-Surface Warfare .................................................................................................................. 2-61
2.7.3.3 Unmanned Vehicles and Systems ............................................................................................... 2-65
2.7.1.3 Amphibious Warfare ................................................................................................................... 2-61
2.7.3.2 Ships ............................................................................................................................................ 2-64
2.7.1.2 Strike Warfare ............................................................................................................................. 2-61
2.3.6 Military Expended Materials ........................................................................................................... 2-38
2.7.1 PROPOSED ADJUSTMENTS TO BASELINE TRAINING ACTIVITIES .................................................. 2-60
2.2 PROPOSED ACTIVITIES ................................................................................................................ 2-39
2.4.1 Proposed training activities in the Mariana Islands training and testing study area ......................... 2-39
2.4.2 Proposed testing activities .............................................................................................................. 2-46
2.4.2.1 Naval Air Systems command testing activities ........................................................................... 2-47
2.4.2.2 Naval Sea Systems command testing activities ......................................................................... 2-48
2.4.2.3 New ship construction activities ............................................................................................... 2-48
2.4.2.4 Life cycle activities .................................................................................................................... 2-48
2.4.2.5 Other naval sea systems command testing activities ............................................................... 2-49
2.4.2.6 Office of Naval research and Naval research laboratory testing activities ................................. 2-49
2.5 Alternatives development ................................................................................................................ 2-50
2.5.1 Alternatives eliminated from further consideration ........................................................................... 2-51
2.5.1.1 Alternative training and testing locations ................................................................................. 2-51
2.5.1.2 Reduced training and testing ..................................................................................................... 2-52
2.5.1.3 Mitigations including temporal or geographic constraints within the study area ...................... 2-52
2.5.1.4 Simulated training and testing .................................................................................................... 2-53
2.5.2 Alternatives carried forward ........................................................................................................ 2-55
2.6 No action alternative: current military readiness within the mariana islands training and testing study area ........................................................................................................................................ 2-55
2.7 Alternative 1 (preferred alternative): expansion of study area plus adjustments to the baseline and additional weapons, platforms, and systems ................................................................. 2-56
2.7.1 Proposed adjustments to baseline training activities ........................................................................ 2-60
2.7.1.1 Anti-Air Warfare ......................................................................................................................... 2-60
2.7.1.2 Strike Warfare ............................................................................................................................ 2-61
2.7.1.3 Amphibious Warfare .................................................................................................................. 2-61
2.7.1.4 Anti-Surface Warfare .................................................................................................................. 2-61
2.7.1.5 Anti-Submarine Warfare ............................................................................................................. 2-61
2.7.1.6 Electronic Warfare .................................................................................................................... 2-61
2.7.1.7 Mine Warfare .............................................................................................................................. 2-61
2.7.1.8 Naval Special Warfare ............................................................................................................... 2-62
2.7.1.9 Other Training .......................................................................................................................... 2-62
2.7.2 Proposed adjustments to baseline testing activities ........................................................................ 2-62
2.7.2.1 Anti-Surface/Anti-Submarine Warfare testing .......................................................................... 2-62
2.7.2.2 Electronic Warfare .................................................................................................................... 2-62
2.7.2.3 Life cycle activities .................................................................................................................... 2-62
2.7.2.4 Shipboard protection systems and Swimmer defense testing .................................................... 2-62
2.7.2.5 New ship construction ............................................................................................................... 2-63
2.7.2.6 Office of Naval research ............................................................................................................ 2-63
2.7.3 Proposed platforms and systems ..................................................................................................... 2-63
2.7.3.1 Aircraft ...................................................................................................................................... 2-63
2.7.3.2 Ships .......................................................................................................................................... 2-64
2.7.3.3 Unmanned vehicles and systems ............................................................................................... 2-65
2.7.3.4 Missiles/Rockets/Bombs ............................................................................................................ 2-66
2.7.3.5 Guns .......................................................................................................................................... 2-67
2.7.3.6 Munitions .................................................................................................................................... 2-67
2.8 **ALTERNATIVE 2: INCLUDES ALTERNATIVE 1 PLUS ADJUSTMENTS TO THE TYPE AND TEMPO OF TRAINING AND TESTING ACTIVITIES** .................................................. 2-68
2.8.1 PROPOSED ADJUSTMENTS TO ALTERNATIVE 1 TRAINING ACTIVITIES ........................................ 2-69
2.8.2 PROPOSED ADJUSTMENTS TO ALTERNATIVE 1 TESTING ACTIVITIES ........................................ 2-69

3 **AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES** ............................................ 3.0-1
3.0 **INTRODUCTION** ........................................................................................................................................ 3.0-1
3.0.1 **REGULATORY FRAMEWORK** ........................................................................................................ 3.0-2
3.0.1.1 Federal Statutes ............................................................................................................................. 3.0-2
3.0.1.2 Executive Orders .......................................................................................................................... 3.0-5
3.0.1.3 Guidance ..................................................................................................................................... 3.0-6
3.0.2 **DATA SOURCES AND BEST AVAILABLE DATA** ................................................................................ 3.0-6
3.0.2.1 Geographical Information Systems Data ..................................................................................... 3.0-7
3.0.2.2 Navy Integrated Comprehensive Monitoring Program ............................................................... 3.0-7
3.0.2.3 Marine Species Density Database ............................................................................................... 3.0-8
3.0.3 **ECOLOGICAL CHARACTERIZATION OF THE MARIANA ISLANDS TRAINING AND TESTING STUDY AREA** .......................................................... 3.0-9
3.0.4 **ACOUSTIC AND EXPLOSIVES PRIMER** ..................................................................................... 3.0-10
3.0.4.1 Terminology/Glossary .................................................................................................................. 3.0-10
3.0.5 **OVERALL APPROACH TO ANALYSIS** .......................................................................................... 3.0-21
3.0.5.1 Resources and Issues Evaluated ................................................................................................. 3.0-23
3.0.5.2 Identification of Stressors for Analysis ....................................................................................... 3.0-24
3.0.5.3 Resource-Specific Impacts Analysis for Individual Stressors ...................................................... 3.0-48
3.0.5.4 Resource-Specific Impacts Analysis for Multiple Stressors ........................................................ 3.0-48
3.0.5.5 Cumulative Impacts .................................................................................................................... 3.0-49

3.1 **SEDIMENTS AND WATER QUALITY** ................................................................................................. 3.1-1
3.1.1 **INTRODUCTION AND METHODS** .............................................................................................. 3.1-1
3.1.1.1 Introduction ................................................................................................................................ 3.1-1
3.1.1.2 Methods ................................................................................................................................... 3.1-9
3.1.2 **AFFECTED ENVIRONMENT** ....................................................................................................... 3.1-12
3.1.2.1 Sediments .................................................................................................................................. 3.1-12
3.1.2.2 Water Quality ............................................................................................................................ 3.1-15
3.1.3 **ENVIRONMENTAL CONSEQUENCES** ..................................................................................... 3.1-18
3.1.3.1 Explosives and Explosive Byproducts ..................................................................................... 3.1-19
3.1.3.2 Metals .................................................................................................................................... 3.1-31
3.1.3.3 Chemicals Other Than Explosives ......................................................................................... 3.1-41
3.1.3.4 Other Materials ......................................................................................................................... 3.1-49
3.1.4 **SUMMARY OF POTENTIAL IMPACTS (COMBINED IMPACT OF ALL STRESSORS) ON SEDIMENTS AND WATER QUALITY** .......................................................... 3.1-55
3.1.4.1 No Action Alternative............................................................................................................... 3.1-55
3.1.4.2 Alternative 1 ............................................................................................................................. 3.1-55
3.1.4.3 Alternative 2 ........................................................................................................................... 3.1-56
3.2 AIR QUALITY .......................................................................................................................... 3.2-1
3.2.1 INTRODUCTION AND METHODS ..................................................................................... 3.2-1
3.2.1.1 Introduction .................................................................................................................... 3.2-1
3.2.1.2 Methods ......................................................................................................................... 3.2-2
3.2.1.3 Climate Change ............................................................................................................... 3.2-11
3.2.1.4 Other Compliance Considerations, Requirements and Practices .................................... 3.2-12
3.2.2 AFFECTED ENVIRONMENT ............................................................................................... 3.2-13
3.2.2.1 Region of Influence ..................................................................................................... 3.2-13
3.2.2.2 Climate of the Study Area .......................................................................................... 3.2-14
3.2.2.3 Regional Emissions ...................................................................................................... 3.2-14
3.2.2.4 Existing Air Quality ..................................................................................................... 3.2-15
3.2.2.5 Regional Emissions ...................................................................................................... 3.2-15
3.2.3 ENVIRONMENTAL CONSEQUENCES ................................................................................ 3.2-15
3.2.3.1 Criteria Pollutants ....................................................................................................... 3.2-15
3.2.3.2 Hazardous Air Pollutants ............................................................................................ 3.2-23
3.2.4 SUMMARY OF POTENTIAL IMPACTS (COMBINED IMPACTS OF ALL STRESSORS) ON AIR QUALITY ........ 3.2-24
3.2.4.1 No Action Alternative ................................................................................................. 3.2-24
3.2.4.2 Alternative 1 ............................................................................................................... 3.2-25
3.2.4.3 Alternative 2 ............................................................................................................... 3.2-25

3.3 MARINE HABITATS .................................................................................................................. 3.3-3
3.3.1 INTRODUCTION .................................................................................................................. 3.3-3
3.3.2 AFFECTED ENVIRONMENT .............................................................................................. 3.3-8
3.3.2.1 Soft Shores .................................................................................................................... 3.3-9
3.3.2.2 Rocky Shores ............................................................................................................... 3.3-10
3.3.2.3 Vegetated Shores ......................................................................................................... 3.3-10
3.3.2.4 Aquatic Beds ............................................................................................................... 3.3-11
3.3.2.5 Soft Bottoms ............................................................................................................... 3.3-11
3.3.2.6 Hard Bottoms ............................................................................................................. 3.3-12
3.3.2.7 Artificial Structures .................................................................................................... 3.3-21
3.3.3 ENVIRONMENTAL CONSEQUENCES .............................................................................. 3.3-24
3.3.3.1 Acoustic Stressors ....................................................................................................... 3.3-24
3.3.3.2 Physical Disturbance and Strike Stressors ................................................................... 3.3-28
3.3.4 SUMMARY OF POTENTIAL IMPACTS (COMBINED IMPACTS OF ALL STRESSORS) ON MARINE HABITATS .......... 3.3-41
3.3.4.1 No Action Alternative ................................................................................................. 3.3-42
3.3.4.2 Alternative 1 ............................................................................................................... 3.3-42
3.3.4.3 Alternative 2 ............................................................................................................... 3.3-42

3.4 MARINE MAMMALS ............................................................................................................... 3.4-1
3.4.1 INTRODUCTION ................................................................................................................ 3.4-2
3.4.1.1 Species Unlikely to Be Present in the Mariana Islands Training and Testing Study Area .... 3.4-5
3.4.2 AFFECTED ENVIRONMENT ............................................................................................ 3.4-8
3.4.2.1 Group Size .................................................................................................................... 3.4-8
3.4.2.2 Diving ........................................................................................................................... 3.4-8
3.4.2.3 Vocalization and Hearing of Marine Mammals ............................................................... 3.4-9
3.4.2.4 General Threats ......................................................................................................... 3.4-12
3.4.2.5 Humpback Whale (Megaptera novaeangliae) ................................................................. 3.4-14
3.4.2.6 Blue Whale (Balaenoptera musculus) ........................................................................... 3.4-16
3.4.2.7 Fin Whale (Balaenoptera physalus) ............................................................................ 3.4-17
3.4.2.8 Sei Whale (*Balaenoptera borealis*) ................................................................. 3.4-18
3.4.2.9 Bryde’s Whale (*Balaenoptera edeni*) ............................................................... 3.4-19
3.4.2.10 Minke Whale (*Balaenoptera acutorostrata*) .................................................. 3.4-21
3.4.2.11 Omura’s Whale (*Balaenoptera omurai*) ......................................................... 3.4-22
3.4.2.12 Sperm Whale (*Physeter macrocephalus*) ....................................................... 3.4-23
3.4.2.13 Pygmy Sperm Whale (*Kogia breviceps*) ....................................................... 3.4-25
3.4.2.14 Dwarf Sperm Whale (*Kogia sima*) ............................................................... 3.4-26
3.4.2.15 Killer Whale (*Orcinus orca*) ......................................................................... 3.4-27
3.4.2.16 False Killer Whale (*Pseudorca crassidens*) .................................................. 3.4-28
3.4.2.17 Pygmy Killer Whale (*Feresa attenuata*) ....................................................... 3.4-30
3.4.2.18 Short-Finned Pilot Whale (*Globicephala macrorhynchus*) ......................... 3.4-31
3.4.2.19 Melon-Headed Whale (*Peponocephala electra*) .......................................... 3.4-32
3.4.2.20 Bottlenose Dolphin (*Tursiops truncatus*) ................................................... 3.4-33
3.4.2.21 Pantropical Spotted Dolphin (*Stenella attenuata*) ....................................... 3.4-35
3.4.2.22 Striped Dolphin (*Stenella coeruleoalba*) .................................................... 3.4-37
3.4.2.23 Spinner Dolphin (*Stenella longirostris*) ....................................................... 3.4-38
3.4.2.24 Rough-Toothed Dolphin (*Steno bredanensis*) .......................................... 3.4-40
3.4.2.25 Fraser’s Dolphin (*Lagenodelphis hosei*) .................................................... 3.4-41
3.4.2.26 Risso’s Dolphin (*Grampus griseus*) ............................................................ 3.4-42
3.4.2.27 Cuvier’s Beaked Whale (*Ziphius cavirostris*) ............................................. 3.4-43
3.4.2.28 Blainville’s Beaked Whale (*Mesoplodon densirostris*) ......................... 3.4-44
3.4.2.29 Longman’s Beaked Whale (*Indopacetus pacificus*) ................................... 3.4-45
3.4.2.30 Ginkgo-Toothed Beaked Whale (*Mesoplodon ginkgodens*) ..................... 3.4-46
3.4.3 ENVIRONMENTAL CONSEQUENCES .............................................................. 3.4-47
3.4.3.1 Acoustic Stressors ......................................................................................... 3.4-48
3.4.3.2 Marine Mammal Avoidance of Sound Exposures ........................................... 3.4-94
3.4.3.3 Implementing Mitigation to Reduce Sound Exposures ................................... 3.4-95
3.4.3.4 Marine Mammal Monitoring During Training and Testing ........................ 3.4-102
3.4.3.5 Application of the Marine Mammal Protection Act to Potential Acoustic and Explosive Effects ................................................................. 3.4-102
3.4.3.6 Application of the Endangered Species Act to Marine Mammals ............... 3.4-104
3.4.4 ANALYSIS OF EFFECTS ON MARINE MAMMALS ........................................ 3.4-104
3.4.4.1 Impacts from Sonar and Other Active Acoustic Sources ............................. 3.4-104
3.4.4.2 Impacts from Explosives .............................................................................. 3.4-136
3.4.4.3 Energy Stressors .......................................................................................... 3.4-170
3.4.4.4 Physical Disturbance and Strike Stressors .................................................... 3.4-174
3.4.4.5 Entanglement Stressors ................................................................................ 3.4-183
3.4.4.6 Ingestion Stressors ....................................................................................... 3.4-192
3.4.4.7 Secondary Stressors ...................................................................................... 3.4-206
3.4.5 SUMMARY OF IMPACTS ON MARINE MAMMALS ....................................... 3.4-211
3.4.5.1 Combined Impacts of All Stressors ............................................................... 3.4-211
3.4.5.2 Summary of Observations During Previous Navy Activities .................... 3.4-212
3.4.5.3 Marine Mammal Protection Act Determinations ........................................ 3.4-223
3.4.5.4 Endangered Species Act Determinations .................................................... 3.4-223
3.5 SEA TURTLES ........................................................................................................ 3.5-1
3.5.1 INTRODUCTION ................................................................................................. 3.5-2
3.5.2 AFFECTED ENVIRONMENT ............................................................................ 3.5-3
3.6 MARINE BIRDS .......................................................................................................................... 3.6-1
3.6.1 INTRODUCTION .................................................................................................................. 3.6-1
3.6.1.1 Endangered Species Act ................................................................................................. 3.6-2
3.6.1.2 Migratory Bird Treaty Act Species and 50 Code of Federal Regulations Part 21.15
   Requirements .......................................................................................................................... 3.6-3
3.6.1.3 United States Fish and Wildlife Service Birds of Conservation Concern .................. 3.6-4
3.6.1.4 Major Bird Groups ........................................................................................................... 3.6-4
3.6.1.5 Areas Included in the Analysis ......................................................................................... 3.6-6
3.6.2 AFFECTED ENVIRONMENT ............................................................................................... 3.6-7
3.6.2.1 Group Size ....................................................................................................................... 3.6-8
3.6.2.2 Diving ............................................................................................................................. 3.6-8
3.6.2.3 Bird Hearing ....................................................................................................................... 3.6-8
3.6.2.4 General Threats .............................................................................................................. 3.6-9
3.6.2.5 At-Sea Observations of Seabirds and Shorebirds .............................................................. 3.6-9
3.6.2.6 Rookery Locations and Breeding Activities within the Mariana Islands Training and
   Testing Study Area .................................................................................................................. 3.6-10
3.6.2.7 Short-Tailed Albatross (Phoebastria albatrus) ................................................................. 3.6-22
3.6.2.8 Hawaiian Petrel (Pterodroma sandwichensis) ................................................................. 3.6-25
3.6.2.9 Newell’s Shearwater (Puffinus auricularis newelli) ......................................................... 3.6-26
3.6.2.10 Great Frigatebird (Fregata minor) .................................................................................. 3.6-27
3.6.2.11 Masked Booby (Sula dactylatra) ..................................................................................... 3.6-28
3.6.2.12 Major Marine Bird Group Descriptions ......................................................................... 3.6-29
3.6.3 ENVIRONMENTAL CONSEQUENCES ............................................................................... 3.6-36
3.6.3.1 Acoustic Stressors ............................................................................................................ 3.6-37
3.6.3.2 Energy Stressors .............................................................................................................. 3.6-66
3.6.3.3 Physical Disturbance and Strike Stressors ...................................................................... 3.6-70
3.6.3.4 Ingestion Stressors ......................................................................................................... 3.6-88
3.6.3.5 Secondary Stressors ......................................................................................................... 3.6-93
3.6.4 SUMMARY OF POTENTIAL IMPACTS ON MARINE BIRDS ........................................ 3.6-94
3.6.4.1 Combined Impacts of All Stressors .................................................................................. 3.6-94
## 3.9.2 Fishes

<table>
<thead>
<tr>
<th>Suborder</th>
<th>Genera</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gobiodei</td>
<td>Gobies, Blennies</td>
<td>Flounders (Pleuronectiformes)</td>
</tr>
<tr>
<td>Blennioidei</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acanthuroidei</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zeiformes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Istiophoridae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suborder Scombroidei</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aulopiformes &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnotiformes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcharhiniformes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squaliformes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcharhinidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphyrnidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mustelus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galeorhinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphyrna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcharhinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnotus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnura</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dasyatis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphyrna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mustelus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galeorhinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphyrna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcharhinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnotus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnura</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dasyatis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squalus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydoselachus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notidanus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squalus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydoselachus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notidanus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.9.3 Environmental Consequences

- Entanglement Stressors
- Physical Disturbance and Strike Stressors
- Energy Stressors
- Ingestion Stressors
- Acoustic Stressors
- Secondary Stressors

### 3.9.4 Summary of Potential Impacts on Fish

- Combined Impacts of All Stressors

### 3.9.5 Endangered Species Act Determinations

### 3.10 Terrestrial Species and Habitats

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.10.1</td>
<td>Introduction</td>
</tr>
<tr>
<td>3.10.1.1</td>
<td>Endangered Species Act Requirements</td>
</tr>
<tr>
<td>3.10.1.2</td>
<td>Migratory Bird Treaty Act and 50 Code of Federal Regulations Part 21.15 Requirements</td>
</tr>
<tr>
<td>3.10.1.3</td>
<td>General Taxonomic Groups</td>
</tr>
<tr>
<td>3.10.1.4</td>
<td>General Threats to Terrestrial Species and Habitats within the Mariana Islands</td>
</tr>
<tr>
<td>3.10.2</td>
<td>Affected Environment</td>
</tr>
<tr>
<td>3.10.2.1</td>
<td>Vegetation Communities</td>
</tr>
<tr>
<td>3.10.2.2</td>
<td>Wildlife Communities</td>
</tr>
<tr>
<td>3.10.2.3</td>
<td>Endangered Species Act Listed Species</td>
</tr>
<tr>
<td>3.10.2.4</td>
<td>Species Considered as Candidates for Endangered Species Act Listing</td>
</tr>
<tr>
<td>3.10.3</td>
<td>Environmental Consequences</td>
</tr>
<tr>
<td>3.10.3.1</td>
<td>Acoustic Stressors</td>
</tr>
<tr>
<td>3.10.3.2</td>
<td>Physical Stressors</td>
</tr>
<tr>
<td>3.10.3.3</td>
<td>Secondary Stressors</td>
</tr>
<tr>
<td>3.10.4</td>
<td>Summary of Potential Impacts on Terrestrial Species and Habitats</td>
</tr>
<tr>
<td>3.10.4.1</td>
<td>Combined Impacts of All Stressors</td>
</tr>
</tbody>
</table>
3.10.4.2 Endangered Species Act Determinations ................................................................. 3.10-84
3.10.4.3 Migratory Bird Treaty Act Determinations .............................................................. 3.10-85

3.11 CULTURAL RESOURCES ............................................................................................... 3.11-1
3.11.1 INTRODUCTION ........................................................................................................ 3.11-1
3.11.1.1 Identification, Evaluation, and Treatment of Cultural Resources ............................ 3.11-2
3.11.1.2 Methods .................................................................................................................. 3.11-4
3.11.1.3 Methods of Impact Analysis .................................................................................... 3.11-7
3.11.2 AFFECTED ENVIRONMENT ........................................................................................ 3.11-7
3.11.2.1 Guam ....................................................................................................................... 3.11-8
3.11.2.2 Commonwealth of the Northern Mariana Islands ................................................. 3.11-15
3.11.2.3 Mariana Islands Training and Testing Transit Corridor ......................................... 3.11-19
3.11.2.4 Current Requirements, Practices, and Protective Measures ..................................... 3.11-19
3.11.3 ENVIRONMENTAL CONSEQUENCES .................................................................... 3.11-20
3.11.3.1 Acoustic Stressors ................................................................................................. 3.11-21
3.11.3.2 Physical Disturbance and Strike Stressors ............................................................... 3.11-25
3.11.4 SUMMARY OF POTENTIAL IMPACTS ON CULTURAL RESOURCES ..................... 3.11-31
3.11.4.1 Combined Impact of All Stressors ......................................................................... 3.11-31
3.11.4.2 Regulatory Determinations ..................................................................................... 3.11-31

3.12 SOCIOECONOMIC RESOURCES ................................................................................. 3.12-1
3.12.1 INTRODUCTION AND METHODS ............................................................................ 3.12-1
3.12.2 AFFECTED ENVIRONMENT ....................................................................................... 3.12-3
3.12.2.1 Commercial Transportation and Shipping .............................................................. 3.12-3
3.12.2.2 Commercial and Recreational Fishing ................................................................. 3.12-14
3.12.2.3 Subsistence Use ...................................................................................................... 3.12-23
3.12.2.4 Tourism ................................................................................................................ 3.12-25
3.12.3 ENVIRONMENTAL CONSEQUENCES .................................................................... 3.12-28
3.12.3.1 Accessibility (to the Ocean and Airspace) .............................................................. 3.12-29
3.12.3.2 Airborne Acoustics ............................................................................................... 3.12-39
3.12.3.3 Physical Disturbance and Strike Stressors ............................................................... 3.12-40
3.12.3.4 Secondary Impacts from Availability of Resources ............................................... 3.12-44
3.12.4 SUMMARY OF POTENTIAL IMPACTS (COMBINED IMPACTS OF ALL STRESSORS) ON SOCIOECONOMICS .... 3.12-45

3.13 PUBLIC HEALTH AND SAFETY .................................................................................. 3.13-1
3.13.1 INTRODUCTION AND METHODS ............................................................................ 3.13-1
3.13.1.1 Introduction ............................................................................................................. 3.13-1
3.13.1.2 Methods ................................................................................................................ 3.13-2
3.13.2 AFFECTED ENVIRONMENT ....................................................................................... 3.13-2
3.13.2.1 Overview ................................................................................................................ 3.13-2
3.13.2.2 Safety and Inspection Procedures .......................................................................... 3.13-5
3.13.3 ENVIRONMENTAL CONSEQUENCES .................................................................... 3.13-5
3.13.3.1 Underwater Energy ............................................................................................... 3.13-10
3.13.3.2 In-Air Energy .......................................................................................................... 3.13-15
3.13.3.3 Physical Interactions ............................................................................................. 3.13-17
3.13.3.4 Secondary Impacts ............................................................................................... 3.13-20
3.13.4 SUMMARY OF POTENTIAL IMPACTS (COMBINED IMPACTS OF ALL STRESSORS) ON PUBLIC HEALTH AND SAFETY .... 3.13-20

TABLE OF CONTENTS TOC-ix
4 CUMULATIVE IMPACTS ........................................................................................................... 4-1
4.1 INTRODUCTION .................................................................................................................. 4-1
4.2 APPROACH TO ANALYSIS ............................................................................................... 4-1
4.2.1 OVERVIEW ....................................................................................................................... 4-1
4.2.2 IDENTIFY APPROPRIATE LEVEL OF ANALYSIS FOR EACH RESOURCE ......................... 4-2
4.2.3 DEFINE THE GEOGRAPHIC BOUNDARIES AND TIMEFRAME FOR ANALYSIS .............. 4-2
4.2.4 DESCRIBE CURRENT RESOURCE CONDITIONS AND TRENDS .................................... 4-2
4.2.5 IDENTIFY POTENTIAL IMPACTS OF THE PREFERRED ALTERNATIVE THAT MIGHT CONTRIBUTE TO CUMULATIVE IMPACTS ........................................................................................................... 4-3
4.2.6 IDENTIFY OTHER ACTIONS AND OTHER ENVIRONMENTAL CONSIDERATIONS THAT AFFECT EACH RESOURCE ........................................................................................................... 4-3
4.2.7 ANALYZE POTENTIAL CUMULATIVE IMPACTS ................................................................ 4-4
4.3 OTHER ACTIONS ANALYZED IN THE CUMULATIVE IMPACTS ANALYSIS........................... 4-4
4.3.1 OVERVIEW ....................................................................................................................... 4-4
4.3.2 OIL AND NATURAL GAS EXPLORATION, EXTRACTION, AND PRODUCTION .................. 4-4
4.3.2.1 Oil Pipeline .................................................................................................................... 4-4
4.3.2.2 Seismic Surveys ............................................................................................................. 4-4
4.3.3 OTHER MILITARY ACTIONS ............................................................................................. 4-9
4.3.3.1 Army and Air Force Exchange Service on Guam ................................................................. 4-9
4.3.3.2 Guam and Commonwealth of the Northern Mariana Islands Military Relocation/Guam Commonwealth of the Northern Mariana Islands Military Relocation (2012) Roadmap Adjustments .................................................................................................................................................. 4-9
4.3.3.3 Surveillance Towed Array Sensor System Low Frequency Active Sonar ................................ 4-9
4.3.3.4 Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact Statement/Overseas Environmental Impact Statement ................................................................. 4-10
4.3.3.5 X-Ray Wharf Environmental Assessment ......................................................................... 4-10
4.3.3.6 Divert Activities and Exercises ....................................................................................... 4-10
4.3.3.7 Marine Mammal Protection Act Incidental Take Authorizations ........................................ 4-10
4.3.3.8 Other Environmental Considerations ................................................................................ 4-10
4.3.3.9 Other Military Actions .................................................................................................... 4-10
4.3.4.1 Coastal and Marine Spatial Planning ................................................................................ 4-10
4.3.4.2 Marine Mammal Protection Act Incidental Take Authorizations ........................................ 4-10
4.3.5 OTHER ENVIRONMENTAL CONSIDERATIONS ................................................................ 4-10
4.3.5.1 Commercial Fishing ........................................................................................................ 4-10
4.3.5.2 Maritime Traffic ............................................................................................................. 4-11
4.3.5.3 Development of Coastal Lands ...................................................................................... 4-11
4.3.5.4 Ocean Pollution ............................................................................................................. 4-12
4.3.5.5 Ocean Noise .................................................................................................................. 4-12
4.3.5.6 Commercial and General Aviation .................................................................................. 4-13
4.3.5.7 Transportation Improvements ....................................................................................... 4-13
4.3.5.8 Climate Change ............................................................................................................. 4-14
4.4 RESOURCE-SPECIFIC CUMULATIVE IMPACTS ................................................................. 4-14
4.4.1 SEDIMENTS AND WATER QUALITY .............................................................................. 4-15
4.4.2 AIR QUALITY .................................................................................................................... 4-15
4.4.2.1 Greenhouse Gases ........................................................................................................ 4-16
4.4.3 MARINE HABITATS ......................................................................................................... 4-19
4.4.4 MARINE MAMMALS ....................................................................................................... 4-20
4.4.4.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts .................. 4-20
4.4.4.2 Impacts of Other Actions .............................................................................................. 4-20
4.4.4.3 Cumulative Impacts on Marine Mammals .................................................................... 4-23
5.3.1.1 Specialized Training ................................................................. 5-11
5.3.1.2 Lookouts ........................................................................... 5-13
5.3.2 Mitigation Zone Procedural Measures ........................................ 5-21
5.3.2.1 Acoustic Stressors ................................................................... 5-25
5.3.2.2 Physical Disturbance and Strike .............................................. 5-48
5.3.3 Mitigation Areas ...................................................................... 5-52
5.3.3.1 Seafloor Resources .............................................................. 5-52
5.3.3.2 Mitigation Measures Considered but Eliminated ................... 5-53
5.3.3.3 Previously Considered but Eliminated ................................... 5-53
5.3.3.4 Previously Accepted but Now Eliminated ......................... 5-63
5.4 Mitigation Summary – At Sea ....................................................... 5-64
5.5 Monitoring and Reporting ............................................................ 5-70
5.5.1 Approach to Monitoring ............................................................ 5-70
5.5.1.1 Integrated Comprehensive Monitoring Program ....................... 5-70
5.5.1.2 Scientific Advisory Group Recommendations ......................... 5-72
5.5.2 Reporting ............................................................................... 5-72
5.5.2.1 Exercise, Testing, and Monitoring Reporting ......................... 5-72
5.5.2.2 Stranding Response Plan ....................................................... 5-72
5.5.2.3 Bird Strike Reporting ............................................................ 5-72
5.5.2.4 Marine Mammal Incident Reporting ....................................... 5-73
5.6 Overview of Terrestrial Standard Operating Procedures and Mitigation Measures .............................. 5-73
5.7 Standard Operating Procedures – Terrestrial ................................. 5-73
5.7.1 Amphibious Assault and Amphibious Raids ................................ 5-73
5.7.2 Fire Management Plan .............................................................. 5-74
5.7.3 Farallon de Medinilla Access Restrictions .................................. 5-74
5.8 Mitigation Measures – Terrestrial ................................................ 5-74
5.8.1 Invasive Species Control Measures .......................................... 5-74
5.8.1.1 Regional Biosecurity Plan for Micronesia and Hawaii ............. 5-74
5.8.1.2 Armed Forces Pest Management Board Technical Guide ................ 5-74
5.8.1.3 Pathway Risk Analysis ......................................................... 5-74
5.8.1.4 Brown Treesnake Control ..................................................... 5-75
5.8.2 Mitigation Measures for Training Activities ................................. 5-77
5.8.2.1 Activities on Guam ............................................................... 5-77
5.8.2.2 Activities on Rota, Tinian, and Saipan ..................................... 5-78
5.8.2.3 Activities on Farallon de Medinilla .......................................... 5-80
5.8.3 Effectiveness and Operational Assessments for Terrestrial Mitigation ........................................ 5-80
5.8.3.1 Invasive Species Control Measures ....................................... 5-80
5.8.3.2 Measures for Guam, Rota, Tinian, Saipan, and Farallon de Medinilla .................................................. 5-81
5.9 Cultural Resources ........................................................................ 5-81

6 Additional Regulatory Considerations ............................................. 6-1
6.1 Consistency with Other Applicable Federal, State, and Local Plans, Policies, and Regulations .................. 6-1
6.1.1 Coastal Zone Management Act Compliance ............................. 6-4
6.1.1.1 Guam Coastal Management Program .................................... 6-4
6.1.1.2 Commonwealth of the Northern Mariana Islands Coastal Zone Management Program .................... 6-5
6.1.2 Marine Protected Areas ............................................................ 6-5
6.2 Relationship Between Short-Term Use of the Environment and Maintenance and Enhancement of Long-Term Productivity .................................................. 6-16
6.3 Irreversible or Irretrievable Commitment of Resources .................................................. 6-16
6.4 Energy Requirements and Conservation Potential of Alternatives and Mitigation Measures .... 6-17

7 LIST OF PREPARERS ........................................................................................................... 7-1
7.1 Government Preparers .................................................................................................. 7-1
7.2 Contractor Preparers .................................................................................................. 7-2

APPENDIX A TRAINING AND TESTING ACTIVITIES DESCRIPTIONS ........................................... A-1
A.1 Training Activities ....................................................................................................... A-1
A.1.1 Anti-Air Warfare Training ....................................................................................... A-2
  A.1.1.1 Air Combat Maneuver ..................................................................................... A-2
  A.1.1.2 Air Defense Exercise (ADEX) ......................................................................... A-3
  A.1.1.3 Air Intercept Control (AIC) ........................................................................... A-4
  A.1.1.4 Gunnery Exercise (Air-to-Air) – Medium-Caliber .......................................... A-5
  A.1.1.5 Missile Exercise (Air-to-Air) .......................................................................... A-6
  A.1.1.6 Gunnery Exercise (Surface-to-Air) – Large-Caliber ....................................... A-8
  A.1.1.7 Gunnery Exercise (Surface-to-Air) – Medium-Caliber .................................... A-9
  A.1.1.8 Missile Exercise (Surface-to-Air) .................................................................. A-10
  A.1.2 Strike Warfare Training ....................................................................................... A-11
    A.1.2.1 Bombing Exercise (Air-to-Ground) ............................................................... A-11
    A.1.2.2 Gunnery Exercise (Air-to-Ground) ............................................................... A-12
    A.1.2.3 Missile Exercise .......................................................................................... A-13
    A.1.2.4 Combat Search and Rescue ......................................................................... A-14
  A.1.3 Amphibious Warfare Training ............................................................................. A-15
    A.1.3.1 Naval Surface Fire Support Exercise – Land-Based Target ......................... A-15
    A.1.3.2 Amphibious Rehearsal, No Landing – Marine Air Ground Task Force ......... A-16
    A.1.3.3 Amphibious Assault .................................................................................... A-17
    A.1.3.4 Amphibious Raid ....................................................................................... A-18
    A.1.3.5 Urban Warfare Training .............................................................................. A-19
    A.1.3.6 Noncombatant Evacuation Operation ......................................................... A-20
    A.1.3.7 Humanitarian Assistance Operations/Disaster Relief Operations .............. A-21
    A.1.3.8 Unmanned Aerial Vehicle – Intelligence, Surveillance, and Reconnaissance .. A-22
  A.1.4 Anti-Surface Warfare Training .......................................................................... A-23
    A.1.4.1 Gunnery Exercise (Air-to-Surface) – Small-Caliber ..................................... A-24
    A.1.4.2 Gunnery Exercise (Air-to-Surface) – Medium-Caliber ................................. A-25
    A.1.4.3 Missile Exercise (Air-to-Surface) – Rocket ................................................... A-26
    A.1.4.4 Missile Exercise (Air-to-Surface) ................................................................. A-27
    A.1.4.5 Laser Targeting (At Sea) ............................................................................. A-28
    A.1.4.6 Bombing Exercise (Air-to-Surface) ............................................................. A-29
    A.1.4.7 Torpedo Exercise (Submarine-to-Surface) .................................................... A-30
    A.1.4.8 Missile Exercise (Surface-to-Surface) .......................................................... A-31
    A.1.4.9 Gunnery Exercise (Surface-to-Surface) Ship – Large-Caliber ....................... A-32
    A.1.4.10 Gunnery Exercise (Surface-to-Surface) Ship – Small-Caliber and Medium-Caliber .... A-33
    A.1.4.11 Sinking Exercise (SINKEX) ...................................................................... A-34
    A.1.4.12 Gunnery Exercise (Surface-to-Surface) Boat – Small-Caliber and Medium-Caliber .... A-36
    A.1.4.13 Maritime Security Operations (MSO) ......................................................... A-37
  A.1.5 Anti-Submarine Warfare Training ..................................................................... A-39
    A.1.5.1 Tracking Exercise – Helicopter ................................................................. A-40

TABLE OF CONTENTS TOC-xiii
A.1.5.2 Torpedo Exercise – Helicopter .......................................................... A-41
A.1.5.3 Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys........ A-42
A.1.5.4 Tracking Exercise – Maritime Patrol Aircraft ........................................... A-43
A.1.5.5 Torpedo Exercise – Maritime Patrol Aircraft .......................................... A-44
A.1.5.6 Tracking Exercise – Surface ................................................................... A-45
A.1.5.7 Torpedo Exercise – Surface ................................................................. A-46
A.1.5.8 Tracking Exercise – Submarine ............................................................ A-47
A.1.5.9 Torpedo Exercise – Submarine ................................................................ A-48
A.1.6 MAJOR TRAINING EVENTS .................................................................. A-49
A.1.6.1 Joint Expeditionary Exercise ................................................................. A-49
A.1.6.2 Joint Multi-Strike Group Exercise ........................................................ A-50
A.1.6.3 Fleet Strike Group Exercise .................................................................... A-51
A.1.6.4 Integrated Anti-Submarine Warfare Exercise ......................................... A-52
A.1.6.5 Ship Squadron Anti-Submarine Warfare Exercise .................................. A-53
A.1.6.6 Marine Air Ground Task Force Exercise (Amphibious) – Battalion .......... A-54
A.1.6.7 Special Purpose Marine Air Ground Task Force Exercise ....................... A-55
A.1.6.8 Urban Warfare Exercise ....................................................................... A-56
A.1.7 ELECTRONIC WARFARE TRAINING .................................................. A-57
A.1.7.1 Electronic Warfare Operations ............................................................. A-57
A.1.7.2 Counter Targeting Flare Exercise – Aircraft ........................................ A-58
A.1.7.3 Counter Targeting Chaff Exercise – Ship ............................................. A-59
A.1.7.4 Counter Targeting Chaff Exercise – Aircraft ........................................ A-60
A.1.8 MINE WARFARE TRAINING ............................................................... A-61
A.1.8.1 Mine Laying ....................................................................................... A-61
A.1.8.2 Mine Neutralization – Explosive Ordnance Disposal (EOD) ................. A-62
A.1.8.3 Limpet Mine Neutralization System/Shock Wave Generator ................. A-63
A.1.8.4 Submarine Mine Exercise .................................................................. A-64
A.1.8.5 Airborne Mine Countermeasure – Mine Detection ............................... A-65
A.1.8.6 Mine Countermeasure Exercise – Towed Sonar .................................. A-66
A.1.8.7 Mine Countermeasure Exercise – Surface Sonar .................................. A-67
A.1.8.8 Mine Neutralization – Remotely Operated Vehicle Sonar .................... A-68
A.1.8.9 Mine Countermeasure – Towed Mine Neutralization ............................ A-69
A.1.9 NAVAL SPECIAL WARFARE TRAINING ............................................ A-70
A.1.9.1 Personnel Insertion/Extraction ............................................................. A-70
A.1.9.2 Parachute Insertion ........................................................................... A-71
A.1.9.3 Embassy Reinforcement ..................................................................... A-72
A.1.9.4 Direct Action (Combat Close Quarters) .............................................. A-73
A.1.9.5 Direct Action (Breaching) .................................................................... A-74
A.1.9.6 Direct Action (Tactical Air Control Party) ............................................ A-75
A.1.9.7 Underwater Demolition Qualification/Certification ............................... A-76
A.1.9.8 Intelligence, Surveillance, Reconnaissance (ISR) ................................ A-77
A.1.9.9 Urban Warfare Training .................................................................... A-78
A.1.9.10 Underwater Survey .......................................................................... A-79
A.1.10 OTHER ............................................................................................... A-80
A.1.11 SURFACE SHIP SONAR MAINTENANCE ............................................ A-80
A.1.11.1 Submarine Sonar Maintenance .......................................................... A-81
A.1.11.2 Small Boat Attack ........................................................................... A-82
A.1.11.3 Submarine Navigation ....................................................................... A-83
A.2 NAVAL AIR SYSTEMS COMMAND TESTING ACTIVITIES ................................................................. A-96
A.2.1 Air-to-Surface Missile Test ........................................................................................................ A-97
A.2.2 Anti-Submarine Warfare Testing ............................................................................................... A-98
A.2.2.1 Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft (Sonobuoys) ........ A-98
A.2.2.2 Anti-Submarine Warfare Torpedo Test .................................................................................. A-99
A.2.2.3 Broad Area Maritime Surveillance Testing – MQ-4C Triton ............................................... A-100
A.2.3 Electronic Warfare .................................................................................................................... A-101
A.2.3.1 Flare Test .............................................................................................................................. A-101
A.3 NAVAL SEA SYSTEMS COMMAND TESTING ACTIVITIES ..................................................... A-102
A.3.1 Lifecycle Activities .................................................................................................................. A-102
A.3.1.1 Ship Signature Testing .......................................................................................................... A-102
A.3.2 Anti-Surface Warfare/Anti-Submarine Warfare Testing ......................................................... A-103
A.3.2.1 Kinetic Energy Weapon Testing ............................................................................................ A-103
A.3.2.2 Torpedo Testing .................................................................................................................... A-104
A.3.2.3 Countermeasure Testing ...................................................................................................... A-105
A.3.2.4 At-Sea Sonar Testing ........................................................................................................... A-106
A.3.3 Shipboard Protection Systems and Swimmer Defense Testing ............................................... A-107
A.3.3.1 Pierside Integrated Swimmer Defense ................................................................................ A-107
A.3.4 New Ship Construction ........................................................................................................... A-107
A.3.4.1 Anti-Submarine Warfare Mission Package Testing .............................................................. A-108
A.3.4.2 Mine Countermeasure Mission Package Testing ............................................................... A-109
A.3.4.3 Anti-Surface Warfare Mission Package Testing ................................................................. A-110
A.4 OFFICE OF NAVAL RESEARCH AND NAVAL RESEARCH LABORATORY TESTING ACTIVITIES A-111
A.4.1 Office of Navy Research ........................................................................................................... A-112
A.4.1.1 North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water) ................ A-112
A.5 UNITED STATES COAST GUARD TRAINING ACTIVITIES ..................................................... A-113
A.5.1 Gunnery Exercise (Surface-to-Surface) Ship – Small-Caliber and Medium-Caliber .......... A-113
A.5.2 Gunnery Exercise (Surface-to-Surface) Boat – Small-Caliber and Medium-Caliber ........ A-114
A.5.3 Maritime Security Operations (MSO) ....................................................................................... A-115
A.5.4 Civilian Port Defense ................................................................................................................ A-116
A.5.5 Search and Rescue at Sea ......................................................................................................... A-117
A.5.6 Precision Anchoring ............................................................................................................... A-118

APPENDIX B NOTICE OF INTENT .................................................................................................. B-1
APPENDIX C  AGENCY CORRESPONDENCE ................................................................. C-1
NOTICE OF INTENT NOTIFICATION LETTER............................................................ C-1
NOTICE OF INTENT TO AGENCIES AND OFFICIALS.................................................. C-1
COORDINATING AGENCY CORRESPONDENCE ....................................................... C-7
NAVY REQUEST FOR DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE TO SERVE AS A COOPERATING AGENCY .......... C-7
DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE RESPONSE............................... C-13
NAVY REQUEST FOR NATIONAL MARINE FISHERIES SERVICE TO SERVE AS A COOPERATING AGENCY ........................................ C-15
NATIONAL MARINE FISHERIES RESPONSE ............................................................... C-21
NAVY REQUEST FOR UNITED STATES FISH AND WILDLIFE SERVICE TO SERVE AS A COOPERATING AGENCY ............................. C-23
UNITED STATES FISH AND WILDLIFE SERVICE RESPONSE ...................................... C-29
NAVY REQUEST FOR UNITED STATES COAST GUARD SECTOR GUAM TO SERVE AS A COOPERATING AGENCY .............. C-31
UNITED STATES COAST GUARD SECTOR GUAM RESPONSE ..................................... C-37
UNITED STATES COAST GUARD HEADQUARTERS CONCURRENCE ......................... C-39
MARINE MAMMAL PROTECTION ACT, INCIDENTAL TAKE AUTHORIZATION REQUEST ............................................ C-41
NAVY TRANSMITTAL LETTER TO NATIONAL MARINE FISHERIES SERVICE OFFICE OF PROTECTED RESOURCES .............. C-41
NATIONAL MARINE FISHERIES SERVICE ENDANGERED SPECIES ACT CONSULTATION ........................................ C-43
REQUEST FOR FORMAL CONSULTATION WITH THE NATIONAL MARINE FISHERIES SERVICE, OFFICE OF PROTECTED RESOURCES ........................................................................................................... C-43
RESPONSE TO REQUEST FOR FORMAL CONSULTATION WITH THE NATIONAL MARINE FISHERIES SERVICE, OFFICE OF PROTECTED RESOURCES ........................................................................................................... C-45
NAVY NOTIFICATION OF REVISED TIMELINE FOR FORMAL CONSULTATION WITH THE NATIONAL MARINE FISHERIES SERVICE, OFFICE OF PROTECTED RESOURCES .............................................. C-47
MARINE BE ADDENDUM COVER LETTER TO MARINE FISHERIES SERVICE, OFFICE OF PROTECTED RESOURCES ................... C-49
FISH AND WILDLIFE SERVICE ENDANGERED SPECIES ACT CONSULTATION .......... C-51
REQUEST FOR CONCURRENCE ON SPECIES LIST AND CRITICAL HABITAT UNITS WITH THE PACIFIC ISLANDS FISH AND WILDLIFE SERVICE ................................................................. C-51
RESPONSE TO REQUEST FOR CONCURRENCE ON SPECIES LIST AND CRITICAL HABITAT UNITS WITH THE PACIFIC ISLANDS FISH AND WILDLIFE SERVICE ................................................................. C-55
REQUEST FOR FORMAL CONSULTATION WITH THE PACIFIC ISLANDS FISH AND WILDLIFE SERVICE ................................................................. C-57
RESPONSE TO REQUEST FOR REINITIATION OF FORMAL CONSULTATION WITH THE PACIFIC ISLANDS FISH AND WILDLIFE SERVICE ................................................................. C-61
NAVY BE ADDENDUM COVER LETTER ..................................................................... C-95
RESPONSE OF PACIFIC ISLANDS FISH AND WILDLIFE SERVICE OFFICE TO BE ADDENDUM ................................................................. C-97
NAVY REVISED BE COVER LETTER ........................................................................ C-99
COASTAL ZONE MANAGEMENT ACT ........................................................................ C-101
CONSISTENCY DETERMINATION REQUEST TO BUREAU OF STATISTICS AND PLANS, NAVY TRANSMITTAL LETTER ............ C-101
CONSISTENCY DETERMINATION CONCURRENCE LETTER FROM BUREAU OF STATISTICS AND PLANS GUAM COASTAL MANAGEMENT PROGRAM ................................................................................. C-103
CONSISTENCY DETERMINATION REQUEST TO DIVISION OF COASTAL RESOURCES MANAGEMENT, NAVY TRANSMITTAL LETTER ................................................................................. C-107
RESPONSE TO CONSISTENCY DETERMINATION REQUEST FROM DIVISION OF COASTAL RESOURCES MANAGEMENT ................ C-109
REQUEST FOR EXTENSION LETTER FROM DIVISION OF COASTAL RESOURCES MANAGEMENT ......................................................... C-111
REVISED CONSISTENCY DETERMINATION LETTER FROM NAVY ......................................................... C-113
CONSISTENCY DETERMINATION RESPONSE LETTER FROM DIVISION OF COASTAL RESOURCES MANAGEMENT .................. C-115
NAVY RESPONSE AND PROVISION OF ADDITIONAL INFORMATION ..................... C-135
APPENDIX I  ACOUSTIC AND EXPLOSIVES PRIMER ................................................................. I-1
I.1  TERMINOLOGY/GLOSSARY ................................................................................................. I-1
I.1.1  PARTICLE MOTION AND SOUND PRESSURE ................................................................. I-1
I.1.2  FREQUENCY ..................................................................................................................... I-2
I.1.3  DUTY CYCLE .................................................................................................................... I-2
I.1.4  LOUDNESS ....................................................................................................................... I-2
I.2  PREDICTING HOW SOUND TRAVELS .............................................................................. I-3
I.2.1  SOUND ATTENUATION AND TRANSMISSION LOSS .................................................... I-4
I.2.2  SPREADING LOSS ............................................................................................................. I-5
I.2.2.1  Reflection and Refraction .............................................................................................. I-5
I.2.2.2  Diffraction, Scattering, and Reverberation ................................................................... I-6
I.2.2.3  Multipath Propagation ................................................................................................... I-6
I.2.2.4  Surface and Bottom Effects ........................................................................................ I-6
I.2.2.5  Air-Water Interface ....................................................................................................... I-7
I.3  SOURCES OF SOUND ........................................................................................................ I-8
I.3.1  UNDERWATER SOUNDS ................................................................................................. I-10
I.3.2  PHYSICAL SOURCES OF UNDERWATER SOUND ........................................................... I-10
I.3.3  BIOLOGICAL SOURCES OF UNDERWATER SOUND ....................................................... I-11
I.3.4  ANTHROPOGENIC SOURCES OF UNDERWATER SOUND ............................................. I-11
I.3.5  AERIAL SOUNDS ............................................................................................................. I-11
I.3.6  NAVY SOURCES OF SOUND IN THE WATER ................................................................. I-12
I.4  SOUND METRICS .............................................................................................................. I-12
I.4.1  PRESSURE ....................................................................................................................... I-12
I.4.2  SOUND PRESSURE LEVEL ............................................................................................. I-13
I.4.3  SOUND EXPOSURE LEVEL ............................................................................................ I-13
I.4.4  AUDITORY WEIGHTING FUNCTIONS .......................................................................... I-16
LIST OF TABLES

CHAPTER 1 Purpose and Need

There are no tables in this section.

CHAPTER 2 Description of Proposed Action and Alternatives

Table 2.4-1: Typical Training Activities in the Mariana Islands Training and Testing Study Area............2-40
Table 2.4-2: Typical Naval Air Systems Command Testing Activities in the Study Area.................................2-48
Table 2.4-3: Typical Naval Sea Systems Command Testing Activities in the Study Area.........................2-49
Table 2.4-4: Typical Office of Naval Research Testing Activity in the Study Area ........................................2-50
Table 2.7-1: Nearshore Training and Testing Danger Zones...........................................................................2-59
Table 2.8-1: Baseline and Proposed Training Activities.................................................................................2-70
Table 2.8-2: Baseline and Proposed Naval Air Systems Command Testing Activities..............................2-87
Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities............................2-88
Table 2.8-4: Baseline and Proposed Office of Naval Research Testing Activities.....................................2-90

CHAPTER 3 Affected Environment and Environmental Consequences

Table 3.0-1: Sources of Non-Navy Geographic Information System Data Used to Generate Figures in Chapter 3 (Affected Environment and Environmental Consequences) .........................................................................................3.0-7
Table 3.0-2: Common In-Air and Underwater Sounds and their Approximate Source Levels ........................3.0-13
Table 3.0-3: Non-Impulse Acoustic Sources Quantitatively Analyzed ..............................................................3.0-15
Table 3.0-4: Training and Testing Explosive Source Classes ........................................................................3.0-17
Table 3.0-5: Source Classes Excluded from Quantitative Analysis ..............................................................3.0-19
Table 3.0-6: List of Stressors Analyzed ........................................................................................................3.0-21
Table 3.0-7: Stressors by Warfare and Testing Area ......................................................................................3.0-23
Table 3.0-8: Training and Testing Acoustic Sources Quantitatively Analyzed in the Mariana Islands Training and Testing Study Area ................................................................................................................3.0-25
Table 3.0-9: Explosives for Training and Testing Activities Quantitatively Analyzed in the Mariana Islands Training and Testing Study Area ..................................................................................................3.0-28
Table 3.0-10: Representative Ordnance, Net Explosive Weights, and Detonation Depths .........................3.0-29
Table 3.0-11: Representative Weapons Noise Characteristics ........................................................................3.0-30
Table 3.0-12: Representative Aircraft Sound Characteristics ........................................................................3.0-34
Table 3.0-13: Sonic Boom Underwater Sound Levels Modeled for F/A-18 Hornet Supersonic Flight ........3.0-35
Table 3.0-14: Annual Number of Events Including Aircraft Movement ......................................................3.0-37
Table 3.0-15: Representative Vessel Types, Lengths, and Speeds .................................................................3.0-37
Table 3.0-16: Representative Types, Sizes, and Speeds of In-Water Devices .............................................3.0-39
Table 3.0-17: Annual Number of Events Including Towed In-Water Devices .............................................3.0-39
Table 3.0-18: Annual Number of Non-Explosive Practice Munitions Expended At Sea in the Study Area ........................................................................................................................................3.0-40
Table 3.0-19: Annual Number of Explosive Ordnance Used in the Study Area Resulting in Expended Fragments ........................................................................................................................................3.0-40
Table 3.0-20: Annual Number of Targets Expended in the Study Area .........................................................3.0-40
Table 3.0-21: Annual Number of Events Including Seafloor Devices ..........................................................3.0-41
Table 3.0-22: Annual Number of Ordnance Used on Farallon de Medinilla by Alternative ......................3.0-42
Table 3.0-23: Annual Number of Expended Fiber Optic Cable .................................................................3.0-43
Table 3.0-24: Annual Number of Expended Guidance Wire ........................................................................3.0-44
Table 3.0-25: Annual Number of Expended Decelerators/Parachutes ..........................................................3.0-44
Table 3.0-26: Annual Number of Expended Chaff Cartridges .......................................................................3.0-47
Table 3.0-27: Annual Number of Expended Flares ................................................................. 3.0-47

Section 3.1 Sediments and Water Quality
Table 3.1-1: Concentrations of Selected Elements in Seawater ............................................. 3.1-6
Table 3.1-2: Military Materials as Components of Materials Recovered on the West Coast, United States, 2007–2008 ............................................................................. 3.1-15
Table 3.1-3: Byproducts of Underwater Detonation of Royal Demolition Explosive .......... 3.1-20
Table 3.1-4: Rates of Failure and Low-Order Detonations ...................................................... 3.1-21
Table 3.1-5: Federal Criteria for Explosives and Explosive Byproducts in Saltwater .......... 3.1-21
Table 3.1-6: Water Solubility of Common Explosives and Explosive Degradation Products .... 3.1-22
Table 3.1-7: Volume of Water Needed to Meet Marine Screening Value for Royal Demolition Explosive .................................................................................................................. 3.1-25
Table 3.1-8: Threshold Values for Exposure to Selected Metals in Saltwater ......................... 3.1-33
Table 3.1-9: Concentrations and National Oceanic and Atmospheric Administration Screening Levels for Selected Metals in Sediments, Vieques, Puerto Rico ......................................................... 3.1-35
Table 3.1-10: Constituents Remaining after Low-Order Detonations and from Unconsumed Explosives .......................................................................................................................... 3.1-43
Table 3.1-11: Summary of Components of Marine Markers and Flares .................................... 3.1-50
Table 3.1-12: Major Components of Chaff .................................................................................. 3.1-51

Section 3.2 Air Quality
Table 3.2-1: National Ambient Air Quality Standards ............................................................... 3.2-3
Table 3.2-2: De Minimis Thresholds for Conformity Determinations ......................................... 3.2-5
Table 3.2-3: Annual Criteria Pollutant Emissions from Training under the No Action Alternative 3.2-16
Table 3.2-4: Estimated Annual Criteria pollutant Emissions in MITT Study Area, No Action Alternative .......................................................................................................................... 3.2-18
Table 3.2-5: Annual Criteria Pollutant Emissions from Training under Alternative 1 .......... 3.2-18
Table 3.2-6: Annual Criteria Pollutant Emissions from Testing under Alternative 1 ............... 3.2-19
Table 3.2-7: Estimated Annual Criteria pollutant Emissions in MITT Study Area, Alternative 1 3.2-20
Table 3.2-8: Annual Criteria Pollutant Emissions from Training under Alternative 2 ............ 3.2-21
Table 3.2-9: Annual Criteria Pollutant Emissions from Testing under Alternative 2 ............. 3.2-21
Table 3.2-10: Estimated Annual Criteria Pollutant Emissions by MITT Study Area, Alternative 2 3.2-22

Section 3.3 Marine Habitats
Table 3.3-1: Habitat Types within the Open Ocean and Coastal Portions of the Mariana Islands Training and Testing Study Area ........................................................................................................ 3.3-5
Table 3.3-2: Coastal and Marine Ecological Classification Standard Crosswalk ................. 3.3-6
Table 3.3-3: Annual Training and Testing Activities that Include Seafloor Explosions .......... 3.3-25
Table 3.3-4: Bottom Detonations for Training Activities under the No Action Alternative, Alternative 1, and Alternative 2 ........................................................................................................ 3.3-26
Table 3.3-5: Bottom Detonations for Testing Activities under Alternative 1 and Alternative 2 .... 3.3-27
Table 3.3-6: Number and Impact Footprint of Military Expended Materials – No Action Alternative 3.3-34
Table 3.3-7: Number and Impact Footprint of Military Expended Materials – Alternative 1 .... 3.3-36
Table 3.3-8: Number and Impact Footprint of Military Expended Materials – Alternative 2 .... 3.3-38
Table 3.3-9: Combined Impact of Acoustic Stressor (Underwater Explosions) and Physical Disturbances (Military Expended Materials) on Marine Substrates for All Alternatives ........ 3.3-42
Section 3.4 Marine Mammals

Table 3.4-1: Marine Mammals with Possible or Confirmed Presence within the Mariana Islands Training and Testing Study Area ................................................................................................ 3.4-4

Table 3.4-2: Hearing and Vocalization Ranges for All Marine Mammal Functional Hearing Groups and Species Potentially Occurring within the Study Area ............................................. 3.4-10

Table 3.4-3: Acoustic Criteria and Thresholds for Predicting Physiological Effects on Marine Mammals from Sonar and Other Active Acoustic Sources ............................................................................. 3.4-83

Table 3.4-4: Criteria and Thresholds for Predicting Physiological Effects on Marine Mammals ............................................................. 3.4-84

Table 3.4-5: Summary of Behavioral Thresholds for Marine Mammals .............................................................................................. 3.4-87

Table 3.4-6: Airgun Thresholds Used in this Analysis to Predict Effects on Marine Mammals ............ 3.4-89

Table 3.4-7: Lower and Upper Cutoff Frequencies for Marine Mammal Functional Hearing Groups Used in this Acoustic Analysis .......................................................................................... 3.4-92

Table 3.4-8: Sightability Based on g(0) Values for Marine Mammal Species in the Study Area ......... 3.4-100

Table 3.4-9: Post-Model Acoustic Impact Analysis Process .............................................................................................................. 3.4-101

Table 3.4-10: Approximate Ranges to Permanent Threshold Shift Criteria for Each Functional Hearing Group for a Single Ping from Three of the Most Powerful Sonar Systems within Representative Ocean Acoustic Environments ...................................................................... 3.4-107

Table 3.4-11: Approximate Ranges to Onset of Temporary Threshold Shift for Four Representative Sonar Over a Representative Range of Ocean Environments .................................................. 3.4-109

Table 3.4-12: Range to Received Sound Pressure Level in 6-Decibel Increments and Percentage of Behavioral Harassments for Low-Frequency Cetaceans under the Mysticete Behavioral Response Function for Four Representative Source Bins (Nominal Values; Not Specific to the Study Area) .......................................................................................................................... 3.4-110

Table 3.4-13: Range to Received Sound Pressure Level in 6-Decibel Increments and Percentage of Behavioral Harassments for Mid-Frequency Cetaceans under the Odontocete Behavioral Response Function for Four Representative Source Bins (Nominal Values for Deep Water Offshore Areas; Not Specific to the Study Area) ....................................................................................................................... 3.4-111

Table 3.4-14: Training Activities Using Sonar and Other Active Acoustic Sources Preceded by Multiple Vessel Movements or Hovering Helicopters ............................................................................. 3.4-113

Table 3.4-15: Testing Activities Using Sonar and Other Active Acoustic Sources Preceded by Multiple Vessel Movements or Hovering Helicopters ................................................................................. 3.4-113

Table 3.4-16: Non-Impulse Activities Adjustment Factors Integrating Implementation of Mitigation into Modeling Analyses ........................................................................................................... 3.4-115

Table 3.4-17: Predicted Impacts from Annual Training Use of Sonar and Other Active Acoustic Sources ................................................................................................................................... 3.4-117

Table 3.4-18: Predicted Impacts from Annual Testing Use of Sonar and Other Active Acoustic Sources ................................................................................................................................... 3.4-118

Table 3.4-19: Average Approximate Range to Effects from a Single Explosion for Marine Mammals Across Representative Acoustic Environments (Nominal Values for Deep Water Offshore Areas; Not Specific to the Study Area) ................................................................................................................. 3.4-118

Table 3.4-20: Activities Using Impulse Sources Preceded by Multiple Vessel Movements or Hovering Helicopters for the Mariana Islands Training and Testing Study Area ............ 3.4-143

Table 3.4-21: Adjustment Factors for Activities Using Explosives Integrating Implementation of Mitigation into Modeling Analyses for the Mariana Islands Training and Testing Study Area ........................................................................................................................... 3.4-145

Table 3.4-22: Activities with Multiple Non-Concurrent Explosions ......................................................................................................................... 3.4-146

Table 3.4-23: Alternative 1 and Alternative 2 Annual Training Exposure Summary for Impulse Sound Sources i ........................................................................................................................................ 3.4-149
Table 3.4-24: Alternative 1 and Alternative 2 Annual Testing Exposure Summary for Explosive Sources

Table 3.4-25: Odontocete Marine Mammal Species that Occur in the Study Area and Are Documented to Have Ingested Marine Debris

Table 3.4-26: Navy Reporting of Monitoring and Major Exercises

Table 3.4-27: Endangered Species Act Effects Determinations for Training and Testing Activities for the Preferred Alternative (Alternative 1)

Section 3.5 Sea Turtles
Table 3.5-1: Endangered Species Act Status and Presence of Endangered Species Act Listed Sea Turtles in the Mariana Islands Training and Testing Study Area
Table 3.5-2: Sea Turtle Impact Threshold Criteria for Non-Impulse Sources
Table 3.5-3: Sea Turtle Impact Threshold Criteria for Impulse Sources
Table 3.5-4: Species-Specific Masses for Determining Onset of Extensive and Slight Lung Injury Thresholds
Table 3.5-5: Annual Total Model-Predicted Impacts on Sea Turtles for Training Activities Using Sonar and Other Active Non-Impulse Acoustic Sources
Table 3.5-6: Annual Total Model-Predicted Impacts on Sea Turtles for Testing Activities Using Sonar and Other Active Non-Impulse Acoustic Sources
Table 3.5-7: Distance Impacts of In-Water Explosives on Sea Turtles from Representative Sources
Table 3.5-8: Annual Model-Predicted Impacts on Sea Turtles from Explosives for Training Activities under the No Action Alternative
Table 3.5-9: Annual Model-Predicted Impacts on Sea Turtles from Explosives for Training Activities under Alternative 1 and Alternative 2
Table 3.5-10: Annual Model-Predicted Impacts on Sea Turtles from Explosives for Testing Activities under the No Action Alternative, Alternative 1, and Alternative 2
Table 3.5-11: Estimated Sea Turtle Exposures from Direct Strike of Military Expended Materials by Area and Alternative
Table 3.5-12: Summary of Effects and Impact Determinations for Sea Turtles

Section 3.6 Marine Birds
Table 3.6-1: Endangered Species Act Listed Seabird Species Found in the Study Area
Table 3.6-2: United States Fish and Wildlife Service Birds of Conservation Concern and Breeding Seabirds within the Study Area
Table 3.6-3: Descriptions and Examples of Major Taxonomic Groups within the Study Area
Table 3.6-4: Pelagic Marine Bird Observations within the Study Area
Table 3.6-5: Known Rookery/Nesting Locations on Department of Defense Owned or Leased Lands within the Mariana Islands Training and Testing Study Area
Table 3.6-6: Range to No Injury from Detonations in Air for Birds
Table 3.6-7: Summary of Endangered Species Act Effects Determinations for Seabirds for the Preferred Alternative

Section 3.7 Marine Vegetation
Table 3.7-1: Major Groups of Marine Vegetation in the Mariana Islands Training and Testing Study Area
Table 3.7-2: Annual Training and Testing Activities that Include Seafloor Explosions
Section 3.8 Marine Invertebrates
Table 3.8-1: Endangered Species Act Listing Determinations for Species Potentially within the Mariana Islands Training and Testing Study Area ......................................................... 3.8-3
Table 3.8-2: Major Taxonomic Groups of Marine Invertebrates in the Mariana Islands Training and Testing Study Area .................................................................................................................. 3.8-8
Table 3.8-3: Summary of Proximate Threats to Coral Species .................................................................................. 3.8-12
Table 3.8-4: Summary of Endangered Species Act Determinations for Marine Invertebrates for the Preferred Alternative (Alternative 1) .................................................................................. 3.8-106

Section 3.9 Fish
Table 3.9-1: Endangered Species Act Listed and Special Status Fish Species in the Mariana Islands Training and Testing Study Area ................................................................................................ 3.9-3
Table 3.9-2: Major Taxonomic Groups of Marine Fishes within the Mariana Islands Training and Testing Study Area ..................................................................................................................... 3.9-4
Table 3.9-3: Federally Managed Fish Species within the Mariana Islands Training and Testing Study Area, Listed under Each Fishery Management Unit .................................................................................. 3.9-6
Table 3.9-4: Estimated Explosive Effects Ranges for Fish with Swim Bladders .................................................................................. 3.9-39
Table 3.9-5: Summary of Ingestion Stressors on Fish Based on Location .................................................................................. 3.9-75
Table 3.9-6: Summary of Endangered Species Act Determinations for Training and Testing Activities for the Preferred Alternative .................................................................................. 3.9-90

Section 3.10 Terrestrial Species and Habitats
Table 3.10-1: Endangered Species Act-Listed Terrestrial Species in the Mariana Islands Training and Testing Study Area ............................................................................................................ 3.10-4
Table 3.10-2: Species Considered as Candidates for Endangered Species Act Listing .................................................................................. 3.10-7
Table 3.10-3: United States Fish and Wildlife Service Birds of Conservation Concern and Breeding Terrestrial Birds within the Study Area .................................................................................. 3.10-10
Table 3.10-4: Major Vertebrate Taxonomic Groups .................................................................................................................. 3.10-11
Table 3.10-5: Acoustic Substressors in Land Training Areas and Terrestrial Resources Potentially Impacted .................................................................................................................. 3.10-51
Table 3.10-6: Physical Disturbance and Strike Substressors in Land Training Areas and Terrestrial Resources Potentially Impacted .................................................................................................................. 3.10-65
Table 3.10-7: Description of Potential Invasive Species Pathways and Interdiction Measures .................................................................................. 3.10-79
Table 3.10-8: Summary of Endangered Species Act Effects Determinations for Endangered Species Act-Listed Terrestrial Species .................................................................................. 3.10-86

Section 3.11 Cultural Resources
Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam .................................................................................. 3.11-9
Table 3.11-2: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Tinian .................................................................................. 3.11-17
Table 3.11-3: Summary of Effects of Training and Testing Activities on Cultural Resources .................................................................................. 3.11-32

Section 3.12 Socioeconomic Resources
Table 3.12-1: Warning Areas, Restricted Airspace, and Air Traffic Control Assigned Airspace in the Mariana Islands Training and Testing Study Area .................................................................................. 3.12-10
Table 3.12-2: Guam Commercial Fishery Landings .................................................................................................................. 3.12-17
Table 3.12-3: Commonwealth of the Northern Mariana Islands Commercial Fishery Landings........3.12-22
Table 3.12-4: Notices to Mariners Issued for Military Activities Occurring at Farallon de Medinilla and Warning Area 517 from 2010 through 2012 ..........................................................3.12-32

Section 3.13 Public Health and Safety
There are no tables in this section.

CHAPTER 4 Cumulative Impacts
Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis............................................................................................................................4-6
Table 4.4-1: Greenhouse Gas Emissions from Ship and Aircraft Training and Testing Activities in the Mariana Islands Training and Testing Study Area........................................................................4-19
Table 4.4-2: Comparison of Ship and Aircraft Greenhouse Gas Emissions to United States 2009 Greenhouse Gas Emissions.........................................................................................................4-19

CHAPTER 5 Standard Operating Procedures, Mitigation, and Monitoring
Table 5.3-1: Detection Probability g(0) Values for Marine Mammal Species in the Mariana Islands Training and Testing Study Area........................................................................................................5-18
Table 5.3-2: Predicted Range to Effects and Recommended Mitigation Zones ..................................5-23
Table 5.3-3: Predicted Range to Effects and Mitigation Zone Radius for Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices........................................5-24
Table 5.4-1: Summary of Recommended Mitigation Measures..............................................................5-66

CHAPTER 6 Additional Regulatory Considerations
Table 6.1-1: Summary of Environmental Compliance for the Proposed Action........................................6-2
Table 6.1-2: Marine Protected Areas within the Mariana Islands Training and Testing Study Area........6-11

CHAPTER 7 List of Preparers
There are no tables in this section.

Appendix A Training and Testing Activities Descriptions
There are no tables in this section.

Appendix B Notice of Intent
There are no tables in this section.

Appendix C Agency Correspondence
There are no tables in this section.

Appendix D Air Quality Example Calculations and Record of Non-Applicability
Table D.1-1: Emission Factors for Two Stroke Engines........................................................................... D-1
Table D.2-1: Emission Factors for Military Aircraft ................................................................................ D-3
Table D.5-1: Surface Ship Emission Factors .......................................................................................... D-9
Table D.5-2: Aircraft Emission Factors .................................................................................................. D-10
Table D.5-3: Ordnance Emission Factors ............................................................................................... D-11
Table D.5-4: Emission Factors for Other Items .................................................................................... D-16
Table D.5-5: Emissions from Surface Ships During Training, No Action Alternative ......................... D-17
Table D.5-6: Emissions from Surface Ships During Testing, No Action Alternative ......................... D-24
LIST OF FIGURES

CHAPTER 1 Purpose and Need
Figure 1.1-1: Mariana Islands Training and Testing Study Area ......................................................... 1-2
Figure 1.4-1: Fleet Readiness Training Plan .......................................................................................... 1-5
Figure 1.6-1: National Environmental Policy Act Process ................................................................. 1-10

CHAPTER 2 Description of Proposed Action and Alternatives
Figure 2.1-1: Mariana Islands Training and Testing Study Area .......................................................... 2-3
Figure 2.1-2: Mariana Islands Range Complex Airspace ...................................................................... 2-8
Figure 2.1-3: Warning Area 517 .......................................................................................................... 2-9
Figure 2.1-4: Farallon de Medinilla Restricted Area 7201, 7201A, and Danger Zone ....................... 2-10
Figure 2.1-5: Apra Harbor Naval Complex (Main Base) and Main Base/Polaris Point .................... 2-11
Figure 2.1-6: Naval Base Guam Munitions Site ................................................................................... 2-12
Figure 2.1-7: Naval Base Guam Telecommunications Site (Finegayan) .............................................. 2-13
Figure 2.1-8: Naval Base Guam Barrigada ......................................................................................... 2-14
Figure 2.1-9: Andersen Air Force Base .............................................................................................. 2-15
Figure 2.1-10: Farallon de Medinilla .................................................................................................. 2-16
Figure 2.1-11: Tinian and Saipan ....................................................................................................... 2-17
Figure 2.1-12: Rota ............................................................................................................................. 2-18
Figure 2.3-1: Guided Missile Destroyer with AN/SQS-53 Sonar ....................................................... 2-24
Figure 2.3-2: Submarine with AN/BQQ-10 Sonar Array ..................................................................... 2-24
Figure 2.3-3: Sonobuoys (e.g., AN/SSQ-62) .......................................................................................... 2-25
Figure 2.3-4: Helicopter Deploys Dipping Sonar ............................................................................. 2-25
Figure 2.3-5: Navy Torpedoes .......................................................................................................... 2-26
Figure 2.3-6: Acoustic Countermeasures ............................................................................................. 2-26
Figure 2.3-7: Anti-Submarine Warfare Training Targets .................................................................... 2-27
Figure 2.3-8: Mine Warfare Systems ................................................................................................ 2-28
Figure 2.3-9: Shipboard Small Arms Training ..................................................................................... 2-29
Figure 2.3-10: Shipboard Medium-Caliber Gun Systems ................................................................. 2-30
Figure 2.3-11: Large-Caliber Projectile Use (5-Inch) ......................................................................... 2-30
Figure 2.3-12: Rolling Airframe Missile (left) and Air-to-Air Missile (right) ....................................... 2-31
Figure 2.3-13: Anti-Surface Missile Fired from MH-60 Helicopter ..................................................... 2-31
Figure 2.3-14: F/A-18 Bomb Release (left) and Loading General Purpose Bombs (right) ............... 2-32
Figure 2.3-15: Subscale Bombs for Training ..................................................................................... 2-32
Figure 2.3-16: Anti-Air Warfare Targets ............................................................................................ 2-33
Figure 2.3-17: Deploying a “Killer Tomato™” Floating Target ......................................................... 2-34
Figure 2.3-18: Ship Deployable Surface Target (left) and High-Speed Maneuverable Seaborne Target (right) .............................................................................................................. 2-34
Figure 2.3-19: Towed Mine Detection System ................................................................................... 2-36
Figure 2.3-20: Airborne Laser Mine Detection System in Operation .............................................. 2-36
Figure 2.3-21: Organic and Surface Influence Sweep .......................................................................... 2-37
Figure 2.3-22: Airborne Mine Neutralization System ........................................................................ 2-38
Figure 2.7-1: Nearshore Training and Testing Danger Zones, Surface Danger Zones, and Exclusion Zones ........................................................................................................................................ 2-58
CHAPTER 3 Affected Environment and Environmental Consequences

Section 3.0 Introduction
There are no figures in this section.

Section 3.1 Sediments and Water Quality
Figure 3.1-1: Location of Approximate Dive Survey Tracks off of Farallon de Medinilla (View from the South) .......................................................... 3.1-26

Section 3.2 Air Quality
There are no figures in this section.

Section 3.3 Marine Habitats
Figure 3.3-1: Nearshore Marine Habitats around Guam ................................................................. 3.3-14
Figure 3.3-2: Marine Habitats of Apra Harbor, Guam ................................................................. 3.3-15
Figure 3.3-3: Nearshore Marine Habitats around Saipan .............................................................. 3.3-16
Figure 3.3-4: Nearshore Marine Habitats around Tinian ............................................................... 3.3-17
Figure 3.3-5: Nearshore Marine Habitats around Farallon de Medinilla ........................................ 3.3-18
Figure 3.3-6: Deep Sea Habitat ..................................................................................................... 3.3-20
Figure 3.3-7: Fish Aggregating Devices near Guam ................................................................. 3.3-22
Figure 3.3-8: Fish Aggregating Devices near Tinian and Saipan .................................................... 3.3-23

Section 3.4 Marine Mammals
Figure 3.4-1: Two Hypothetical Threshold Shifts, Temporary and Permanent .............................. 3.4-53
Figure 3.4-2: Type I Auditory Weighting Functions Modified from the Southall et al. (2007) M-Weighting Functions ........................................................................................................................................ 3.4-80
Figure 3.4-3: Type II Weighting Functions for Low-, Mid-, and High-Frequency Cetaceans .......... 3.4-81
Figure 3.4-4: Behavioral Response Function Applied to Mysticetes .............................................. 3.4-86
Figure 3.4-5: Behavioral Response Function Applied to Odontocetes .......................................... 3.4-86
Figure 3.4-6: Hypothetical Range to Specified Effects for a Non-Impulse Source ......................... 3.4-106
Figure 3.4-7: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 0.5-Pound Net Explosive Weight Charge (Bin E2) Detonated at 1-Meter Depth ........................................................................................................ 3.4-139
Figure 3.4-8: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 10-Pound Net Explosive Weight Charge (Bin E5) Detonated at 1-Meter Depth ........................................................................................................ 3.4-140
Figure 3.4-9: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 250-Pound Net Explosive Weight Charge (Bin E9) Detonated at 1-Meter Depth ........................................................................................................ 3.4-141
Figure 3.4-10: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses for a 1,000-Pound Net Explosive Weight Charge (Bin E12) Detonated at 1-Meter Depth ........................................................................................................ 3.4-142

Section 3.5 Sea Turtles
Figure 3.5-1: Auditory Weighting Function for Sea Turtles (T-Weighting) ................................. 3.5-29
Section 3.6 Marine Birds
Figure 3.6-1: West Pacific Flyway ................................................................. 3.6-8
Figure 3.6-2: Breeding Locations of Seabirds within the Mariana Islands .............................................. 3.6-11
Figure 3.6-3: Known Breeding Locations for Seabirds on Military Lands on Guam .................................. 3.6-16
Figure 3.6-4: Known Breeding Locations for Seabirds on Military-Leased Areas on Tinian ..................... 3.6-17
Figure 3.6-5: Seabird Rookery Locations on Farallon de Medinilla ......................................................... 3.6-19
Figure 3.6-6: Masked Booby Trend in Counts at FDM ............................................................................. 3.6-20
Figure 3.6-7: Red-footed Booby Trend in Counts at FDM ........................................................................ 3.6-21
Figure 3.6-8: Brown Booby Trend in Counts at FDM ............................................................................... 3.6-22
Figure 3.6-9: Pelagic Ranges and Breeding Locations for the Short-Tailed Albatross, Newell’s Shearwater, and Hawaiian Petrel .......................................................... 3.6-24

Section 3.7 Marine Vegetation
Figure 3.7-1: Marine Vegetation Surrounding Guam .................................................................................. 3.7-7
Figure 3.7-2: Marine Vegetation in the Vicinity of Apra Harbor ................................................................. 3.7-8
Figure 3.7-3: Marine Vegetation Surrounding Tinian .................................................................................. 3.7-9
Figure 3.7-4: Marine Vegetation Surrounding Saipan .............................................................................. 3.7-10
Figure 3.7-5: Marine Vegetation Surrounding Farallon de Medinilla ......................................................... 3.7-11

Section 3.8 Marine Invertebrates
Figure 3.8-1: Diversity of Phylogenetic Groups in the Mariana Islands ...................................................... 3.8-9
Figure 3.8-2: Distribution and Percent Cover of Corals Surrounding Guam ..................................................... 3.8-46
Figure 3.8-3: Distribution and Percent Cover of Corals Within Apra Harbor .................................................. 3.8-47
Figure 3.8-4: Distribution and Percent Cover of Corals Surrounding Tinian ..................................................... 3.8-48
Figure 3.8-5: Distribution and Percent Cover of Corals Surrounding Saipan ..................................................... 3.8-49
Figure 3.8-6: Distribution and Percent Cover of Corals Surrounding FDM ..................................................... 3.8-50
Figure 3.8-7: Prediction of Distance to 90 Percent Survivability of Marine Invertebrates Exposed to an Underwater Explosion ................................................................. 3.8-61

Section 3.9 Fish
There are no figures in this section.

Section 3.10 Terrestrial Species and Habitats
Figure 3.10-1: Critical Habitat Designations on Guam .............................................................................. 3.10-5
Figure 3.10-2: Training Locations, Critical Habitat, and Local Conservation Areas on Rota ...................... 3.10-6
Figure 3.10-3: Representative Vegetation Community Types on Guam ...................................................... 3.10-15
Figure 3.10-4: Reduction of Forest Communities on Farallon de Medinilla by Military Bombardment and Typhoons ......................................................................................... 3.10-25
Figure 3.10-5: Naval Base Guam Munitions Site and Mariana Swiftlet Cave Locations ............................ 3.10-35
Figure 3.10-6: Mariana Swiftlet Population Data from Mahlac Cave, Naval Munitions Site, 1986–2012 .................................................................................................................. 3.10-36
Figure 3.10-7: General Location of Mariana Swiftlet Caves on Saipan ........................................................ 3.10-37
Figure 3.10-8: Tinian Military Lease Area and Mariana Common Moorhen Nest Locations ...................... 3.10-41
Figure 3.10-9: Detailed View of Impact Areas and Special Use Areas on FDM ............................................. 3.10-55
Figure 3.10-10: Conceptual Model of Potential Invasive Species Pathways Associated with Military Training Activities ........................................................................................................ 3.10-78
Figure 3.10-11: Potential Introduction Pathways of Invasive Species Associated with Military Training in the Marianas ........................................................................................................ 3.10-81

Section 3.11 Cultural Resources
Figure 3.11-1: Known Wrecks, Obstructions, or Occurrences within the United States Territorial Waters ........................................................................................................ 3.11-16

Section 3.12 Socioeconomic Resources
Figure 3.12-1: Shipping Lanes within the Mariana Islands Training and Testing Study Area ....3.12-5
Figure 3.12-2: Mariana Islands Training and Testing Study Area Airspace ....3.12-9
Figure 3.12-3: Commercial Airways within the Mariana Islands Training and Testing Study Area ....3.12-12
Figure 3.12-4: Farallon de Medinilla Restricted Area and Pending 12 nm Danger Zone ....3.12-13
Figure 3.12-5: Guam Public Boat Launch Locations and Fish Aggregating Devices ....3.12-16
Figure 3.12-6: Galvez Bank and Santa Rosa Reef Adjacent to W-517 ....3.12-19
Figure 3.12-7: Marine Preserves on Guam ....3.12-21
Figure 3.12-8: Popular Dive Sites Within the Mariana Islands Training and Testing Study Area ....3.12-26

Section 3.13 Public Health and Safety
Figure 3.13-1: Simultaneous Activities within the Mariana Islands Training and Testing Study Area ....3.13-3

CHAPTER 4 Cumulative Impacts
There are no figures in this chapter.

CHAPTER 5 Standard Operating Procedures, Mitigation, and Monitoring
Figure 5.2-1: Flowchart of Process for Determining Recommended Mitigation Measures ....5-8

CHAPTER 6 Additional Regulatory Considerations
Figure 6.1-1: Marine Protected Areas in Guam ....6-8
Figure 6.1-2: Marine Protected Areas in Saipan ....6-9
Figure 6.1-3: Mariana Trench Marine National Monument ....6-10

CHAPTER 7 List of Preparers
There are no figures in this chapter.

Appendix A Training and Testing Activities Descriptions
Figure A-1: BQM-74 (Aerial Target) ....A-7
Figure A-2: LUU-2B/B Illuminating Flare (Aerial Target) ....A-7
Figure A-3: Tactical Air-Launched Decoy (Aerial Target) ....A-7
Figure A-4: “Killer Tomato” Stationary Floating Target ....A-38
Figure A-5: QST-35 Seaborne Powered Target ....A-38
Figure A-6: High Speed Maneuvering Surface Target ....A-38

Appendix B Notice of Intent
There are no figures in this section.

Appendix C Agency Correspondence
There are no figures in this section.
Appendix D Air Quality Example Calculations and Record of Non-Applicability
Figure D.6-1: Record of Non-Applicability Memorandum .......................................................... D-4
Figure D.6-2: Record of Non-Applicability Form ........................................................................ D-5
Figure D.6-3: Conformity Analysis ................................................................................................. D-6

Appendix E Public Participation
There are no figures in this section.

Appendix F Training and Testing Activities Matrices
There are no figures in this section.

Appendix G Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures
There are no figures in this section.

Appendix H Biological Resource Methods
Figure H.2-1: Flow Chart of the Evaluation Process of Sound-Producing Activities .................. H-3
Figure H.2-2: Two Hypothetical Threshold Shifts ......................................................................... H-7

Appendix I Acoustic and Explosives Primer
Figure I-1: Graphical Representation of the Inverse-Square Relationship in Spherical Spreading ........ I-4
Figure I-2: Characteristics of Sound Transmission through the Air-Water Interface ....................... I-8
Figure I-3: Oceanic Ambient Noise Levels from 1 Hertz to 100,000 Hertz, Including Frequency Ranges for Prevalent Noise Sources ......................................................................................... I-9
Figure I-4: Examples of Impulse and Non-impulse Sound Sources .................................................. I-12
Figure I-5: Various Sound Pressure Metrics for a Hypothetical (a) Pure Tone (Non-Impulse) and (b) Impulse Sound ........................................................................................................................................ I-13
Figure I-6: Summation of Acoustic Energy (Cumulative Exposure Level, or Sound Exposure Level) from a Hypothetical, Intermittently Pinging, Stationary Sound Source (EL = Exposure Level) .......... I-15
Figure I-7: Cumulative Sound Exposure Level under Realistic Conditions with a Moving, Intermittently Pinging Sound Source (Cumulative Exposure Level = Sound Exposure Level) ...... I-16