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FINAL ENVIRONMENTAL IMPACT STATEMENT/ OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

NSWC PCD MISSION ACTIVITIES







DEPARTMENT OF THE NAVY
UNITED STATES OF AMERICA

September 2009

Cover Sheet

Naval Surface Warfare Center Panama City Division (NSWC PCD), Florida

Final Environmental Impact Statement and Overseas Environmental Impact Statement (EIS/OEIS)

NSWC PCD MISSION ACTIVITIES

September 2009

This EIS/OEIS is prepared for the Department of the Navy (DON). The action proponent is the NSWC PCD. This EIS/OEIS is prepared in accordance with Chief of Naval Operations (CNO) Instruction 5090.1C, pursuant to National Environmental Policy Act (NEPA) and Executive Order (EO) 12114. The National Marine Fisheries Service (NMFS) in the National Oceanic and Atmospheric Administration (NOAA) has been identified and has accepted the role as a cooperating agency for this EIS/OEIS.

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Abstract: This EIS/OEIS has been prepared by the DON to evaluate the effects associated with the littoral and expeditionary maneuver warfare activities proposed for the NSWC PCD Study Area, which includes St. Andrew Bay (SAB) and warning areas W-151, W-155, and W-470. These activities involve a variety of naval assets including vessels, aircraft, and underwater systems that support eight primary research, development, test, and evaluation (RDT&E) capabilities: air, surface, and subsurface operations, sonar, laser, electromagnetic, live ordnance, and projectile firing operations occurring within the NSWC PCD Study Area. The potentially affected resources have been studied to evaluate if changes in NSWC PCD RDT&E, particularly sonar use and ordnance detonations, would affect the marine environment, air environment, and water surface environment. The Proposed Action is to improve NSWC PCD's capabilities to conduct new and increased mission operations for DON and customers within the three military warning areas and SAB. Three Alternatives are analyzed in this EIS/OEIS. The No Action Alternative addresses historical and current mission activities (referred to cumulatively as "baseline mission activities") within the NSWC PCD Study Area. Alternative 1 addresses baseline mission activities, as well as identified (known) future (five-year) NSWC PCD RDT&E requirements. Alternative 2 addresses baseline mission activities, as well as identified future NSWC PCD RDT&E requirements at an increased tempo, in order to maximize NSWC PCD operational capability. Potential effects associated with the alternatives were identified and evaluated. The U.S. Navy concludes that there will be no significant impact to geology and sediments, air quality, water quality, biological resources, marine habitats, invertebrates, fish, essential fish habitat (EFH), birds, socioeconomics, airspace, artificial reefs, safety, cultural and historical resources, low-income and minority populations, children, or coastal

zone resources. NSWC PCD activities have the potential to expose marine mammals to sound likely to result in Level A and Level B harassment and to expose sea turtles to sound likely to result in temporary threshold shifts (TTS). NSWC PCD will implement mitigation measures and management practices to reduce the level of effects to the environment. NSWC PCD has requested from NMFS to "take" protected species under the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA), respectively.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
µg/L	Micrograms per Liter
µg/m^3	Micrograms per Cubic Meter
µPa	Micropascal
µT	Microtesla
3-D	Three-Dimensional
46 OG/OGMTP	46th Test Wing Precision Strike Division
AAC	Air Armament Center
AAV	Amphibious Assault Vehicle
ACC	Air Combat Command
ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
AF	Air Force
AFAST	Atlantic Fleet Active Sonar Training
AFB	Air Force Base
AFIERA	Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis
AGL	Above Ground Level
AHRM	Archaeological and Historic Resources Management
AL/OBEN	Air Force's Acoustic Effects Branch
Al_2O_3	Aluminum Oxide
ALMDS	Airborne Laser Mine Detection System
AMCM	Airborne Mine Countermeasures
ANSI	American National Standards Institute
ARG/MEU	Amphibious Ready Group/Marine Expeditionary Unit
ARTCC	Air Route Traffic Control Center
ARTs	Aerial Refueling Track
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
AWI	Animal Welfare Institute
BE	Biological Evaluation
BGEPA	Bald and Golden Eagle Protection Act
BO	Biological Opinion
C	Carbon Solid
C_2H_6	Ethane
C_3H_8	Propane
CATEX	Categorical Exclusion
CCD	Coastal Consistency Determination
CDC	Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_2O	Formaldehyde
CH_3OH	Methyl Alcohol
CH_4	Methane
cm	Centimeters
CNO	Chief of Naval Operations
CO	Carbon Monoxide
CO_2	Carbon Dioxide

LIST OF ACRONYMS AND ABBREVIATIONS CONT'D

COC	Community of Comparison
COMINEWARCOM	Commander, Mine Warfare Command
COMPTUEX	Composite Training Unit Exercises
CSB	Cape San Blas
CW	Continuous Wave
CY	Calendar Year
CZMA	Coastal Zone Management Act
dB	Decibels
dB re 1 μPa	Decibels Referenced to 1 Micropascal
dB re 1 μPa^2-s	Decibels Referenced to 1 Micropascal Squared Second
dBA	A-weighted Decibels
Det	Detonation
DET	Distributed Explosive Technology
DHR	Division of Historical Resources
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DON	Department of the Navy
DOT	Department of Transportation
EA	Environmental Assessment
ECM	Electronic Countermeasures
EEZ	Exclusive Economic Zone
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EGTTR	Eglin Gulf Test and Training Range
EIS	Environmental Impact Statement
EIS/OEIS	Environmental Impact Statement/Overseas Environmental Impact Statement
EMF	Electromagnetic Field
EO	Executive Order
EOD	Explosive Ordnance Disposal
EOID	Electro-Optic Identification
ESA	Endangered Species Act
EWTA	Eglin Water Training Area
F.S.	Florida Statute
FAA	Federal Aviation Administration
FAC	Florida Administrative Code
FCMP	Florida Coastal Management Program
FDA	Food and Drug Administration
FDEP	Florida Department of Environmental Protection
FEIS	Final Environmental Impact Statement
FFA	Freefall Air
FL	Flight Level
FMP	Fisheries Management Plan
FMRI	Florida Marine Research Institute
FNAI	Florida Natural Areas Inventory
ft	Feet
ft^2	Square Feet
ft^3	Cubic Feet

LIST OF ACRONYMS AND ABBREVIATIONS CONT'D

FWC	Florida Fish and Wildlife Conservation Commission
FY	Fiscal Year
g	Grams
G	Gauss
g/L	Grams per Liter
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fisheries Management Council
GOM	Gulf of Mexico
GPS	Global Positioning System
GRAB	Gaussian Ray Bundle
H_2	Hydrogen
H_2CO_3	Carbonic Acid
H_2O	Water
HAP	Hazardous Air Pollutant
HAPC	Habitat of Particular Concern
HCl	Hydrochloric Acid
HCN	Hydrogen Cyanide
HE	High Explosive
hp	Horsepower
HPA	Hypothalamic-Pituitary-Adrenal
hr	Hour
HRC	Hawaii Range Complex
HUD	Department of Housing and Urban Development
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IFE	In-Flight Emergencies
IHA	Incidental Harassment Authorization
in	Inches
ITS	Incidental Take Statement
JASSM	Joint Air-to-Surface Stand-off Missile
JTA	Joint Test Assembly
JTFEX	Joint Task Force Exercises
kg	Kilograms
kHz	Kilohertz
km	Kilometers
km^2	Square Kilometers
Kt	Knots
L	Liters
LAARS	Florida Large Area Artificial Reef Sites
lbs	Pounds
LCAC	Landing Craft Air Cushion
LCU	Landing Craft Utility
L_{dn}	Day-Night Average Sound Level
L_{dnmr}	Onset-Rate Adjusted Monthly Day-Night Average Sound Level
L_{eq}	Equivalent Sound Level
$L_{eq(24)}$	24-hour Equivalent Noise Level
LFA	Low-Frequency Active
LIDAR	Light Imaging Detection and Ranging

LIST OF ACRONYMS AND ABBREVIATIONS CONT'D

LLS	Laser Line Scan
L_{max}	Highest Sound Level Measured During a Single Noise Event
LOA	Letter of Authorization
LTO	Landing and Takeoff
LWAD	Littoral Warfare Advanced Development
m	Meters
m^2	Square Meters
m^3	Cubic Meters
MBARA	Mexico Beach Artificial Reef Association
MBTA	Migratory Bird Treaty Act
MCM	Mine Countermeasures
METOC	Meteorology and Oceanography
MFA	Mid-Frequency Active
mg	Milligrams
mg/L	Milligrams per Liter
mg/m^3	Milligrams per Cubic Meters
MHz	Megahertz
mi	Miles
mi^2	Square Miles
MIW	Mine Warfare
MLO	Mine-Like Object
mm	Millimeter
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPA	Marine Protected Area
MRA	Marine Resources Assessment
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSAT	Marine Species Awareness Training
msec	Milliseconds
MSL	Mean Sea Level
MTRs	Military Training Routes
N_2	Nitrogen
N45	CNO Environmental Protection, Safety and Occupational Health Division
NAAQS	National Ambient Air Quality Standards
NAS	Naval Air Station
NATO	North Atlantic Treaty Organization
NAVOSH	Naval Occupational Safety and Health
NAVSEA	Naval Sea Systems Command
NDAA	National Defense Authorization Act
NDE	National Defense Exemption
NEI	National Emissions Inventory
NEODS	Naval Explosive Ordnance Disposal School
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NH_3	Ammonia
NHPA	National Historic Preservation Act
NIPTS	Noise-Induced Permanent Threshold Shift
NITS	Noise-Induced Threshold Shift

LIST OF ACRONYMS AND ABBREVIATIONS CONT'D

nm	Nanometers
NM	Nautical Mile
NM^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOHD	Nominal Ocular Hazard Distance
NOI	Notice of Intent
NOSSAINST	Naval Ordnance, Safety, and Security Activity Instruction
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NRC	Nuclear Regulatory Commission
NRC	National Research Council
NRDC	National Resources Defense Council
NRHP	National Register of Historic Places
NSA	Naval Support Activity
NSA PC	Naval Support Activity Panama City
NSAPCINST	Naval Support Activity Panama City Instruction
NSWC	Naval Surface Warfare Center
NSWC PCD	Naval Surface Warfare Center Panama City Division
NSWCCSSINST	Naval Surface Warfare Center Coastal System Station Instruction
nT	Nanotesla
NTU	Nephelometric Turbidity Units (a measure of turbidity)
O_3	Ozone
OAML	Oceanographic and Atmospheric Library
OASIS	Organic Airborne and Surface Influence Sweep
OCS	Outer Continental Shelf
OEIS	Overseas Environmental Impact Statement
OMP	Operational Management Plan
ONR	Office of Naval Research
OP	Operating Procedures
OPAREA	Operating Area
OPFOR	Opposing Forces
OPNAVINST	Office of the Chief of Naval Operations Instruction
OPS	Operations
OSHA	Occupational Safety and Health Administration
Pb	Lead
PC	Panama City
PCB	Polychlorinated Biphenyl
PCD	Panama City Division
PM_{10}	Particulate Matter Less Than 10 Microns in Diameter
$PM_{2.5}$	Particulate Matter Less Than 2.5 Microns in Diameter
ppm	Parts per Million
psi-ms	Pounds per Square Inch per Millisecond
PSW	Precision Strike Weapon
PTS	Permanent Threshold Shift

LIST OF ACRONYMS AND ABBREVIATIONS CONT'D

RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test, and Evaluation
RDX	Cyclotrimethylene Trinitramine
re	Referenced to
REC	Record of Environmental Consideration
REG	Retarded Ground
RHIB	Rigid Hull Inflatable Boat
rms	Root-Mean-Squared
ROD	Record of Decision
SAB	St. Andrew Bay
SAFMC	South Atlantic Fishery Management Council
SCUBA	Self Contained Under Water Breathing Apparatus
SDB	Small-Diameter Bomb
SDV	Sea-Air-Land Delivery Vehicle
SEL	Sound Exposure Level
SHPO	State Historic Preservation Officer
SMCM	Surface Mine Countermeasure
SMP	Special Maintenance Plan
SNS	Sympathetic Nervous System
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SO_x	Sulfur Oxides
SPL	Sound Pressure Level
SRI	Santa Rosa Island
SSC	Space and Naval Warfare Systems Center
STIL	Streak Tube Imaging LIDAR
SUA	Special Use Area
SURTASS	Surveillance Towed Array Sensor System
SVP	Sound Velocity Profile
TA	Test Area
TED	Turtle Excluder Devices
THPO	Tribal Historic Preservation Officer
TL	Transmission Loss
TM	Tympanic Membrane
TNT	Trinitrotoluene
TS	Threshold Shift
TSRC	Test Safety Review Committee
TTS	Temporary Threshold Shift
U.S.	United States
UME	Unusual Mortality Event
USACOE	U.S. Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USDI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USS	United States Ship
USWTR	Undersea Warfare Training Range

LIST OF ACRONYMS AND ABBREVIATIONS CONT'D

USWEX	Undersea Warfare Exercise
UUV	Unmanned Underwater Vehicles
UXO	Unexploded Ordnance
VA	Veterans Administration
VEM	Versatile Exercise Mine
VHF	Very High Frequency
VOC	Volatile Organic Compound
WR	War Reserve
WSEP	Weapons Systems Evaluation Program
yd^2	Square Yards
Yr	Year
ZOE	Zone of Exposure

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This Naval Surface Warfare Center Panama City Division (NSWC PCD) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) analyzes the potential environmental effects associated with littoral (coastal region) and expeditionary (military operations abroad) maneuver warfare activities for the NSWC PCD Study Area, which includes W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), W-470, and St. Andrew Bay (SAB) (Figure ES-1 and Figure ES-2). The Proposed Action is to improve NSWC PCD's capabilities to conduct new and increased mission operations for the Department of the Navy (DON) and other customers. These activities involve a variety of naval assets including vessels, aircraft, and underwater systems that support eight primary research, development, test, and evaluation (RDT&E) capabilities: air, surface, and subsurface operations, sonar, laser, electromagnetic, live ordnance, and projectile firing operations. NSWC PCD's activities occur either on or over the waters present within the NSWC PCD Study Area. All shoreside support activities are managed by Naval Support Activity Panama City (NSA PC) and involve infrastructure management activities unrelated to at-sea activities. No hazardous waste is generated at sea during NSWC PCD RDT&E activities, as discussed in Section ES.7. This EIS/OEIS will address only the in-water activities related to NSWC PCD's RDT&E activities conducted within the NSWC PCD Study Area. The routine infrastructure management functions performed by NSA PC are not included in this EIS/OEIS because they are not required in order to conduct at-sea activities and the NSWC PCD Study Area is limited to water areas. Furthermore, this EIS/OEIS only encompasses NSWC PCD RDT&E activities.

This EIS/OEIS has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), which requires a detailed environmental analysis for major federal actions with the potential to significantly affect the quality of the human and natural environments on land ranges and within U.S. territorial waters (i.e., shoreline seaward to 22.2 kilometers (km) (12 nautical miles [NM]). This document was also prepared in accordance with Presidential Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This EO requires federal agencies to prepare environmental documentation for effects to resources seaward of U.S. territorial waters. Whether to apply NEPA or EO 12114 is determined by where the potential effects occur, not where the action takes place. Therefore, discussions of potential effects under the purview of NEPA are presented under a section on territorial waters, and discussions of potential effects under the purview of EO 12114 are presented under a section on non-territorial waters. In addition to NEPA and EO 12114, this document complies with a variety of other environmental regulations including the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Coastal Zone Management Act (CZMA), and the Migratory Bird Treaty Act (MBTA).

ES.2 PURPOSE AND NEED

The purpose of the Proposed Action is to enhance NSWC PCD's capability and capacity to meet littoral and expeditionary maneuver warfare requirements by providing an increase in current as well as new RDT&E, and in-service engineering for expeditionary maneuver warfare, operations in extreme environments, mine warfare, maritime operations, and coastal operations.

The need for the Proposed Action is for the Navy to successfully meet current and future national and global defense challenges by developing a robust capability to research, develop, test, and evaluate systems within the NSWC PCD Study Area. This allows the Navy to meet its statutory mission to deploy worldwide naval forces equipped and trained to meet existing and emergent threats and to enhance its ability to operate jointly with other components of the armed forces.

ES.3 PUBLIC INVOLVEMENT

The Navy initiated a mutual exchange of information through early and open communications with interested stakeholders during the development of this EIS/OEIS. The notice of intent (NOI), which provides an overview of the proposed project and the scope of the EIS/OEIS, was published in the *Federal Register* on August 19, 2004 (DON, 2004). The Navy held two scoping meetings during which naval staff and subject matter experts presented information using display boards and fact sheets in an open house format, as well as answered questions from attendees. The scoping meetings were held in Panama City, Florida on October 5, 2004 and in Port St. Joe, Florida, on October 6, 2004.

Scoping of the Proposed Action and alternatives has taken place with dialogue and input from both internal and external stakeholders. Internally, the NSWC PCD EIS/OEIS Project Team, which includes representatives from Naval Sea Systems Command (NAVSEA), has met regularly to discuss aspects of the EIS/OEIS. Briefings and coordination with other Navy offices have taken place to ensure a wide range of input on the Proposed Action, alternatives, and issues. Scoping with external stakeholders has taken place since 2004, including discussions with federal and state agency officials and non-governmental organizations. In addition to comments received during NSWC PCD public involvement, this EIS/OEIS also considers relevant information from comments made through public involvement activities during other ongoing Navy EIS/OEIS projects.

ES.4 DESCRIPTION OF THE PROPOSED ACTION

The Proposed Action is to improve NSWC PCD's capabilities to conduct new and increased mission operations for the Department of Defense (DoD) and other customers within the NSWC PCD Study Area. NSWC PCD is the U.S. Navy's premier research and development organization focused on littoral warfare and expeditionary maneuver warfare. NSWC PCD provides in-water RDT&E in support of expeditionary maneuver warfare, operations in extreme environments, mine warfare, maritime operations, and coastal operations. A brief overview of the eight RDT&E operations is provided in the following paragraphs.

Air Operations

Aircraft are often an essential part of the RDT&E activities conducted by NSWC PCD. The majority of the aircraft utilized to support the RDT&E activities are helicopters (MH-53, MH-60, UH-1, and variants). In the case where multiple aircraft are required to support a test, one aircraft is usually designated as the test and the other aircraft are used for surveying and monitoring to determine that a particular test site is clear of other aircraft or surface vessels. Five types of RDT&E activities are conducted from aircraft platforms within the NSWC PCD Study Area:

1. Support activities for clearance and monitoring
2. Towing of an object that contains active or passive sensors towed in the water column
3. Captive carriage to test the handling of aircraft during transport, separation, and release of objects
4. Aerial delivery and separation of inert objects, rockets, and/or mines and the aircraft's flight effects on deployment of such items, and
5. Live aerial expendables activities, which include only gun firing at predetermined targets from a helicopter.

Surface Operations

A significant portion of NSWC PCD RDT&E relies on surface operations. Four subcategories make up the surface operations category:

1. Support activities include surface vessels that carry the test equipment and personnel to and from the test sites and are also used to secure and monitor the designated test area.
2. Tow test events involve surface vessels that are used as tow platforms for vessel-deployable mine warfare systems tests.
3. Launch and recovery activities include surface craft that are used to perform the deployment and recovery of unmanned underwater vehicles (UUVs), sonobuoys, inert mines, mine-like objects (MLOs), versatile exercise mine (VEM) systems, and other test systems.
4. Developmental and operational testing involves tests of navigation and communication systems associated with various surface vessels including some unmanned surface vessels.

Subsurface Operations

Subsurface operations include diving, salvage, robotic vehicles, UUVs, and mooring and burying of mines. Diving operations are performed to conduct fundamental research in support of underwater life support equipment and systems and to test manned undersea mobility systems, underwater guidance, and navigation systems. Salvage operations include planting and recovering targets and locating RDT&E equipment jettisoned into and/or placed in the area. Robotic vehicles, such as crawlers, and UUVs are used to locate and classify underwater objects and mines while rejecting miscellaneous clutter that would not pose a threat. NSWC PCD develops, upgrades, and manages new underwater mine systems. The placement of temporary minefields at varying depths within the NSWC PCD Study Area is required in order to simulate bottom and moored mine threats and to test the survivability and efficiency of the system.

Sonar Operations

Sonar operations at NSWC PCD involve the testing of various sonar systems in the ocean and the laboratory as a means of demonstrating the system's capability to detect, locate, and characterize MLOs under various environmental conditions. The data collected is used to validate the sonar systems' effectiveness and capability to meet its mission. Low-frequency sonar is not proposed to be used during NSWC PCD operations. The various sonar systems proposed to be tested within the NSWC PCD Study Area range in frequencies of 1 kilohertz (kHz) to 5 megahertz (MHz) (5,000 kHz). The source levels associated with NSWC PCD sonar systems that require analysis in this EIS/OEIS based on their parameters range from between 200 decibels (dB) at 1 meter (m) to 235 dB at 1 m.

Electromagnetic Operations

NSWC PCD develops and tests an array of magnetic sensors that generate electromagnetic fields (EMFs) used in mine countermeasures (MCM) operations. NSWC PCD personnel conduct multiple sweeps via surface vessels over specified test areas that contain tethered MLOs and totally buried MLOs/inert mines and VEMs in an effort to demonstrate the systems' effectiveness to influence or trigger magnetic targets. NSWC PCD has experimented with deploying magnetic sensors onboard unmanned underwater swimming and crawling vehicles and has conducted tests to evaluate individual sensor capabilities during high-speed operations.

Laser Operations

Laser test operations within the NSWC PCD Study Area take place below and above the water surface. Systems employed by the Navy include light imaging detection and ranging (LIDAR), laser line scan (LLS), and directional systems. Generally, the LIDAR systems are mounted on a helicopter and emit a narrow, high-frequency laser beam. The directional systems are mounted on moving platforms and are identical to the LIDAR systems but are utilized underwater. The LLS has been developed for use on towed bodies and UUVs and are employed under water. Laser operations include two subcategories: underwater mine detection and identification and air-to-water mine detection and identification. NSWC PCD has been developing and testing laser systems that can be used independently or with sonar sensor packages attached to a towed body or UUV. NSWC PCD continues to evaluate the effectiveness of optical imaging systems using LLS and LIDAR in laser operations, primarily in underwater mine detection. For air-to-water mine identification, LIDAR system technology is used to detect, classify, and localize drifting, floating, and near-surface moored threats.

Ordnance Operations

Real-life test scenarios involving live explosives are required to demonstrate the capability and effectiveness of the MCM systems currently being developed and tested at NSWC PCD. Live testing is only conducted after a system has successfully completed inert testing and an adequate amount of data has been collected to support the decision for live testing. Testing with live targets or ordnance is closely monitored and uses the minimal number of live munitions necessary to meet the testing requirements. Depending on the test scenario, live testing may occur from the surf zone out to the outer perimeter of the NSWC PCD Study Area. The size and weight of the explosives used varies from the trinitrotoluene (TNT) equivalent net explosive weight (NEW) of 0.91 to 272 kilograms (kg) (2 to 600 pounds [lbs]). Line charges are also included within this category. The Navy must develop a capability to safely clear surf zone areas for sea-based expeditionary operations. To that end, NSWC PCD occasionally performs testing on various surf zone clearing systems that use either line charges or explosive arrays to neutralize mine threats. This is a systems development test and only assesses the in-water components of testing. Line charges consist of a 107 m (350 ft) detonation cord with explosives lined from one end to the other end in a series of 2 kg (5 lbs) increments.

Projectile Firing Operations

The capability of utilizing gunfire during test operations was identified as a future requirement. Rounds (individual shots) identified include 5 inch, 20 millimeter (mm), 25 mm, 30 mm, 40 mm, 76 mm, and various small arms ammunition (i.e., standard target ammo). Projectiles associated with these rounds are mainly armor-piercing projectiles. The 5-inch round is a high explosive (HE) projectile containing approximately 3.63 kg (8 lbs) of explosive material.

ES.5 DESCRIPTION OF THE NSWC PCD STUDY AREA

It is the mission of NSWC PCD to provide RDT&E, as well as in-service support for expeditionary maneuver warfare, diving, maritime special operations, mine warfare (mines and MCM), and other naval missions that take place in the coastal region. The infrastructure has been established at NSWC PCD to support this mission. A unique feature of NSWC PCD that is unduplicated in the U.S. is the natural operating environment provided by the ready access to the Gulf of Mexico (GOM) and its associated littoral and coastal regions. The GOM provides a surrogate environment for most of the littoral areas of the world in which the Navy will find itself operating for the foreseeable future. No other geographical area would meet the mission requirements.

The NSWC PCD EIS/OEIS addresses all of the RDT&E operations that occur within the NSWC PCD Study Area, which includes St. Andrew Bay (SAB) and military warning areas (areas within the GOM subject to military operations) W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), and W-470. The NSWC PCD RDT&E activities may be conducted anywhere within the existing military warning areas and SAB from the mean high water line (average high tide mark) out to 222 km (120 NM) offshore (Figure ES-1 and Figure ES-2).

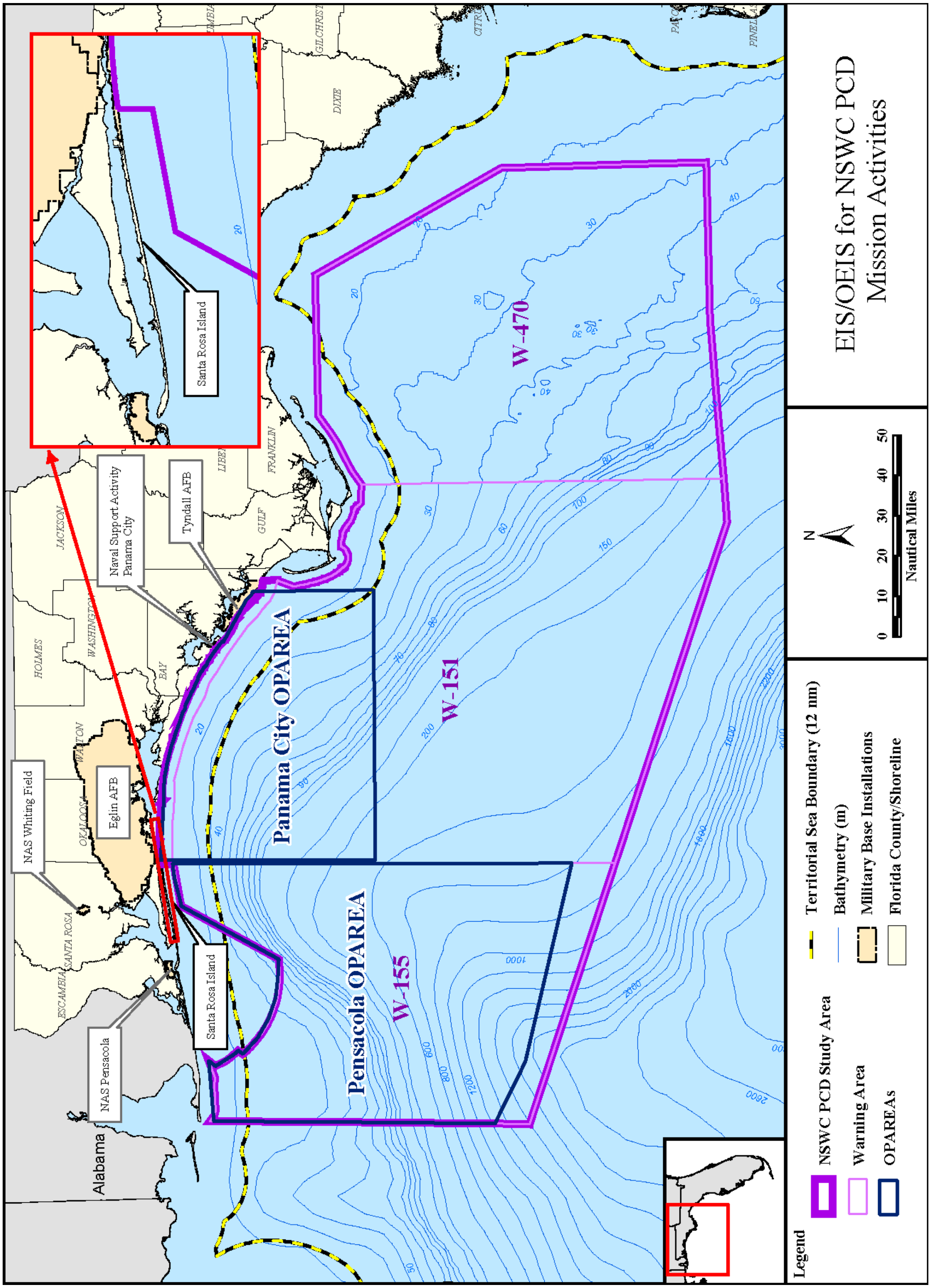

Figure ES-1. NSWC PCD Study Area: GOM

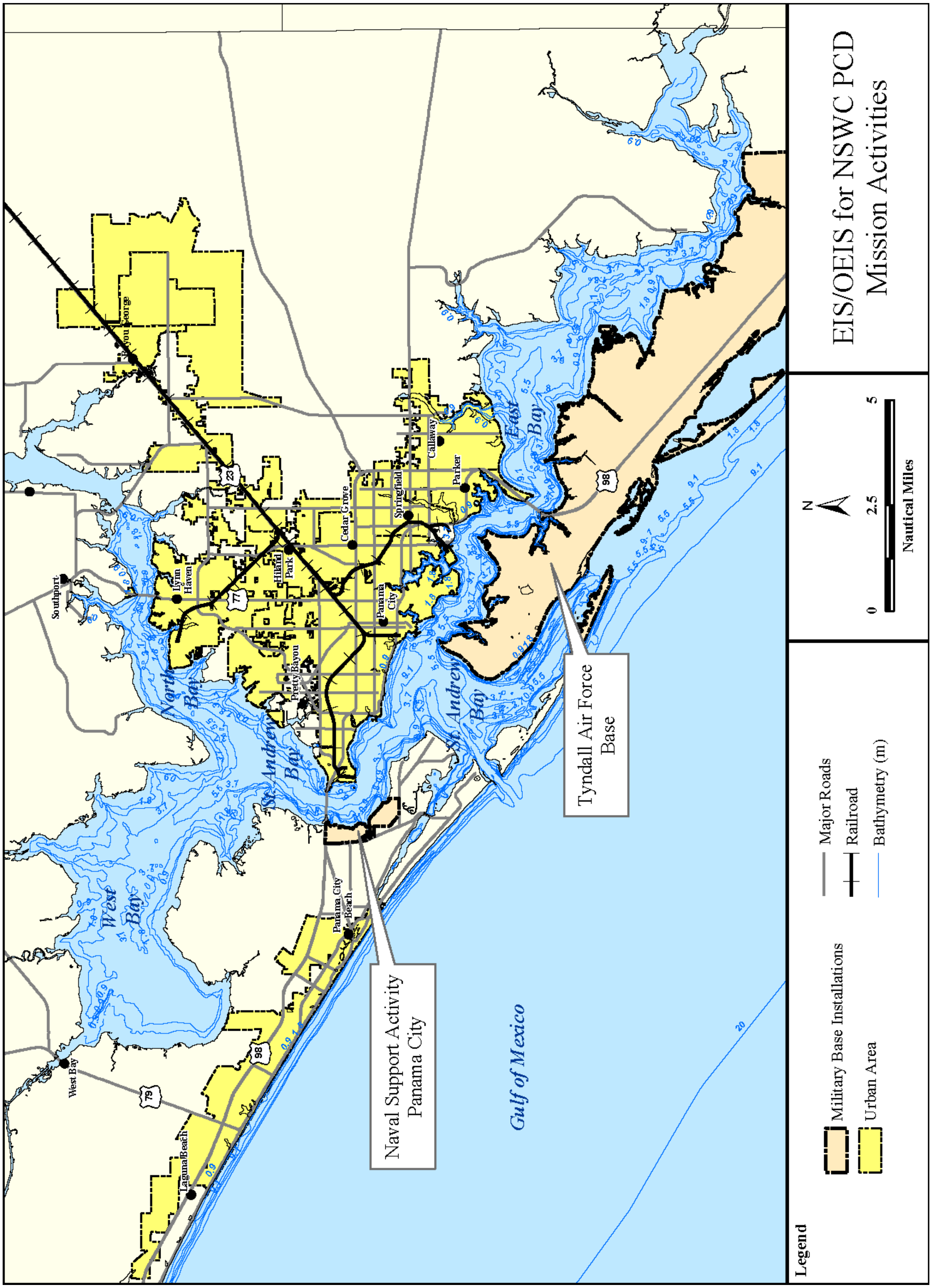

Figure ES-2. The NSWC PCD Study Area: Nearshore Environments and SAB

ES.6 ALTERNATIVES

Each alternative selected for consideration in this EIS/OEIS had to meet a set of criteria to ensure that each alternative would adequately meet the customer's needs. To quantify 10 years of historical and current NSWC PCD RDT&E activities (i.e., the baseline), NSWC PCD undertook a data collection effort using surveys and test plans. In an effort to accurately project future RDT&E activities, NSWC PCD conducted an interactive data call via electronic, telephone, and personal interviews. The interactive data call projected an estimate of the mission capability and activity levels that would be required over the next five years. After all of the information was received and validated, it was used to identify and quantify the eight NSWC PCD baseline mission operations addressed in Section ES.4. The data collected for each of these RDT&E activities did not necessarily depict the level of activity intensity on a per-year basis. Therefore, to determine each operation's expected yearly level of activity, the total hours associated with an individual RDT&E capability were added to reach a five-year total for that activity. The totals were then divided by five to annualize the overall baseline tempos for each of the eight mission operations. The development of action alternatives for the NSWC PCD EIS/OEIS focused on accommodating baseline activities, as well as future growth requirements for missions and activity levels identified during the data collection effort.

The No Action Alternative addresses historical and current mission activities (referred to cumulatively as "baseline mission activities") for the NSWC PCD Study Area. NSWC PCD anticipates that the No Action Alternative would not completely support the future mission requirements and activity levels identified during the data collection. Thus, the No Action Alternative would not fully meet the need of the Proposed Action.

Alternative 1 addresses baseline mission activities that would continue in conjunction with identified (known) future activities projected to occur at an increasing tempo over the next five years based on the data collection effort. Alternative 1 enhances current capabilities to meet future needs by incorporating new test capabilities as well as projected increases to the baseline tempo and intensity of RDT&E activities. Alternative 1 meets the purpose and need of the Proposed Action but does not enhance NSWC PCD's RDT&E capabilities because it does not include the anticipated increase in the overall tempo of RDT&E activities over the next five years.

Alternative 2 addresses baseline mission activities (as identified with the No Action Alternative), as well as identified (known) future NSWC PCD RDT&E activities projected to occur at an increasing tempo over the next five years (as identified with Alternative 1) in order to maximize NSWC PCD operational capability to accommodate future RDT&E activities. A theoretical threefold increase is generally used since it is estimated that RDT&E activity levels above a threefold (i.e., 200 percent) increase may not be accommodated at NSWC PCD without associated increases in equipment, infrastructure and test personnel for required RDT&E test support. Alternative 2 fully meets the purpose and need of the Proposed Action as this alternative provides NSWC PCD the ability to maximize operational capability for known activities over the next five years, as well as enhance RDT&E capacity by anticipating an increase in the overall tempo of RDT&E activities over the next five years. Thus, alternative 2 has been selected as the Navy's Preferred Alternative.

ES.7 ENVIRONMENTAL CONSEQUENCES

Chapter 3 contains descriptions of the existing environmental conditions for resources in the NSWC PCD Study Area potentially affected by the Proposed Action and the Alternatives. Chapter 4, Environmental Consequences, identifies and assesses the environmental consequences to the resources from the Proposed Action and the Alternatives. In Chapter 4, potential effects associated with each alternative are categorized into four areas: physical resources, biological resources, anthropogenic (man-made) resources, and coastal zone resources. Table ES-1 provides a detailed summary of the potential effects from each Alternative to the environmental resources discussed in Chapter 3. Table ES-2 summarizes potential marine mammal exposures from sonar operations for each Alternative. Table ES-3 and Table ES-4 summarize potential marine mammal exposures from ordnance and projectile firing operations, respectively. Table ES-5 and Table ES-6 summarize potential sea turtle exposures from ordnance and projectile firing operations, respectively. See Chapter 4 for a detailed discussion of all potential effects to environmental resources.

As part of the environmental documentation for the NSWC PCD EIS/OEIS, the Navy initiated consultation with NMFS in accordance with Section 7 of the Endangered Species Act (ESA) (16 United States Code [USC] 1531 to 1543) (Appendix A, Agency Correspondence) for threatened and endangered marine fish, sea turtles, and marine mammals. Consultation is complete once NMFS prepares a final Biological Opinion and issues an incidental take statement.

The ESA applies to federal actions in two separate respects. First, the ESA requires that federal agencies, in consultation with the responsible wildlife agency (e.g., NMFS), ensure that proposed actions are not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat (16 USC 1536 [a][2]). Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat. If an agency's Proposed Action would take a listed species, then the agency must obtain an incidental take statement from the responsible wildlife agency. The ESA defines the term "take" to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct" (16 USC 1532[19]).

Hazardous materials addressed in this EIS/OEIS are broadly defined as substances that could pose a hazard by virtue of their chemical or biological properties, in the event of a substantial public exposure (human health) or release (environment). The purpose of evaluating hazardous materials and hazardous wastes is to determine whether they pose a direct hazard to individuals or the environment, given the specified source concentrations, environmental pathways, environmental sinks, and whether fresh or marine surface waters, soils, or groundwater would be contaminated. Furthermore, the hazardous wastes evaluation, a regulated subcategory of hazardous materials, determines whether these materials are being stored and transported appropriately, and whether waste generation would exceed regional capacity of hazardous waste management facilities. Expended testing materials containing hazardous constituents that will be deposited in the NSWC PCD Study Area are addressed in Section 4.2.4, Water Quality. There will be no generation or handling of hazardous waste during RDT&E activities within the NSWC PCD Study Area.

Table ES-1. Effect Summary Chart

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Physical Resources	**Geology and Sediments**						
	Ordnance Operations (Sediment Area Affected)	**No Significant Impact**	**No Significant Impact**	**No Significant Impact**	**No Detonations in Non-Territorial Waters**	0 m^2 (0 ft^2); **No Significant Harm**	0 m^2 (0 ft^2); **No Significant Harm**
	Subsurface Operations (Sediment Area Affected Annually)	Crawler – 0.19 km^2 (0.073 mi^2); Mines – 108 m^2 (1,162.5 ft^2); **No Significant Impact**	Crawler – 0.52 km^2 (0.20 mi^2); Mines – 130.5 m^2 (1,404.69 ft^2); **No Significant Impact**	Crawler – 1.5 km^2 (0.58 mi^2); Mines – 392.66 m^2 (4,226.56 ft^2); **No Significant Impact**	Mines - 46.4 m^2 (499.4 ft^2); **No Significant Harm**	Mines – 56.3 m^2 (606.01 ft^2); **No Significant Harm**	Mines – 167.62 m^2 (1804.2 ft^2); **No Significant Harm**
	Air Quality						
	Air Operations and Surface Operations Combined (Pollutant Emissions)	Emission levels not exceeded; **No Significant Impact**	Emission levels not exceeded; **No Significant Impact**	Emission levels not exceeded; **No Significant Impact**	Emission levels not exceeded; **No Significant Harm**	Emission levels not exceeded; **No Significant Harm**	Emission levels not exceeded; **No Significant Harm**
	In-Air Sound						
	Air and Surface Operations Combined (dBA Noise Levels)	Below ambient noise; **No Significant Impact**	Below ambient noise; **No Significant Impact**	Below ambient noise; **No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Water Quality						
	Ordnance Operations (Explosion Products, Metal Leaching, Turbidity)	Levels not exceeded; **No Significant Impact**	Levels not exceeded; **No Significant Impact**	Levels not exceeded; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	**No Significant Harm**	**No Significant Harm**
Biological Resources	**Marine Habitats**						
	Surface Operations (Grounding/Turbidity)	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Subsurface Operations (Sediment Area Affected)	**No Significant Impact**	**No Significant Impact**	**No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Ordnance Operations (Habitat Destruction)	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Detonations in water column/ Protective measures implemented; **No Significant Harm**	Detonations in water column/ Protective measures implemented; **No Significant Harm**
	Invertebrates						
	Sonar Operations (Underwater Noise)	**No Significant Impact**	**No Significant Impact**	**No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Ordnance Operations	Local effects insignificant to population; **No Significant Impact**	Local effects insignificant to population; **No Significant Impact**	Local effects insignificant to population; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Local effects insignificant to population; **No Significant Harm**	Local effects insignificant to population; **No Significant Harm**
	Laser Operations (Laser Exposure)	Rapid absorption/ scattering; **No Significant Impact**	Rapid absorption/ scattering; **No Significant Impact**	Rapid absorption/ scattering; **No Significant Impact**	Rapid absorption/ scattering; **No Significant Harm**	Rapid absorption/ scattering; **No Significant Harm**	Rapid absorption/ scattering; **No Significant Harm**
	Fish						
	Air Operations (Noise)	Frequency above sensitivity; **No Significant Impact/No Effect**	Frequency above sensitivity; **No Significant Impact/No Effect**	Frequency above sensitivity; **No Significant Impact/No Effect**	Frequency above sensitivity; **No Significant Harm/No Effect**	Frequency above sensitivity; **No Significant Harm/No Effect**	Frequency above sensitivity; **No Significant Harm/No Effect**

Table ES-1. Effect Summary Chart (Cont'd)

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Biological Resources, Cont'd	*Sonar Operations (Underwater Noise)*	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**
	Electromagnetic Operations (EMF Exposure)	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/small area; **No Significant Impact/No Effect**	Low strength/small area; **No Significant Harm/No Effect**	Low strength/small area; **No Significant Harm/No Effect**	Low strength/small area; **No Significant Harm/No Effect**
	Laser Operations (Laser Exposure)	Rapid absorption/ scattering; **No Significant Impact/No Effect**	Rapid absorption/ scattering; **No Significant Impact/No Effect**	Rapid absorption/ scattering; **No Significant Impact/No Effect**	Rapid absorption/ scattering; **No Significant Harm/No Effect**	Rapid absorption/ scattering; **No Significant Harm/No Effect**	Rapid absorption/ scattering; **No Significant Harm/No Effect**
	Ordnance Operations (Shock Wave)	Effects insignificant to population; **No Significant Impact/May Affect**	Effects insignificant to population; **No Significant Impact/May Affect**	Effects insignificant to population; **No Significant Impact/May Affect**	**No Detonations in Non-Territorial Waters**	Effects insignificant to population; **No Significant Harm/No Effect**	Effects insignificant to population; **No Significant Harm/No Effect**
	Essential Fish Habitat						
	Subsurface and Ordnance Operations Combined (Habitat Disturbance)	Relative habitat area affected negligible; **No Significant Impact/No Adverse Effect**	Relative habitat area affected negligible; **No Significant Impact/No Adverse Effect**	Relative habitat area affected negligible; **No Significant Impact/No Adverse Effect**	Relative habitat area affected negligible; **No Significant Harm/No Adverse Effect**	Relative habitat area affected negligible; **No Significant Harm/No Adverse Effect**	Relative habitat area affected negligible; **No Significant Harm/No Adverse Effect**
	Birds						
	Air Operations (Noise)	Frequency above maximum sensitivity; **No Significant Impact**	Frequency above maximum sensitivity; **No Significant Impact**	Frequency above maximum sensitivity; **No Significant Impact**	Frequency above maximum sensitivity; **No Significant Harm**	Frequency above maximum sensitivity; **No Significant Harm**	Frequency above maximum sensitivity; **No Significant Harm**
	Sonar Operations (Underwater Noise)	Underwater exposure unlikely **No Significant Impact**	Underwater exposure unlikely **No Significant Impact**	Underwater exposure unlikely **No Significant Impact**	Underwater exposure unlikely **No Significant Harm**	Underwater exposure unlikely **No Significant Harm**	Underwater exposure unlikely **No Significant Harm**
	Ordnance Operations	Underwater exposure unlikely; **No Significant Impact**	Underwater exposure unlikely; **No Significant Impact**	Underwater exposure unlikely; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Underwater exposure unlikely; **No Significant Harm**	Underwater exposure unlikely; **No Significant Harm**
	Marine Mammals						
	Air Operations (Noise)	Dive Characteristics/ Exposure Unlikely; **No Significant Impact/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Impact/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Impact/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Harm/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Harm/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Harm/No Effect**
	Surface Operations (Vessel Collisions)	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**
	Sonar Operations (Exposures-Marine Mammals)	Level B Harassment/ MMPA Authorization Required; **No Significant**	Level B Harassment/ MMPA Authorization Required; **No Significant**	Level B Harassment/MMPA Authorization Required; **No Significant Impact/No Effect**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant**

Table ES-1. Effect Summary Chart (Cont'd)

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Biological Resources, Cont'd		**Impact/No Effect**	**Impact/No Effect**		**Harm/May Affect**	**Harm/May Affect**	**Harm/May Affect**
	Electromagnetic Operations (EMF Exposure)	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**
	Laser Operations (Laser Exposure)	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**
	Ordnance Operations (# of Exposures)	No Exposures; **No Significant Impact/No Effect**	Level B Harassment/ MMPA Authorization Required; **No Significant Impact/No Effect**	Level B Harassment/MMPA Authorization Required; **No Significant Impact/No Effect**	**No Detonations in Non-Territorial Waters**	Level B Harassment/MMPA Authorization Required; **No Significant Harm/No Effect**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant Harm/May Affect**
	Projectile Firing	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Non-Territorial Waters**	No Exposures/ Protective Measures; **No Significant Harm/No Effect**	Level B Harassment/MMPA Authorization Required; **No Significant Harm/No Effect**
	Sea Turtles						
	Surface Operations (Vessel Collisions)	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Affect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**
	Sonar Operations (Underwater Noise)	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**
	Electromagnetic Operations (EMF Exposure)	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**
	Laser Operations (Laser Exposure)	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**
	Ordnance Operations (# of Takes)	No Exposures; **No Significant Impact/No Effect**	No Exposures; **No Significant Impact/No Effect**	TTS Exposures/ESA Consultation Required; **No Significant Impact /May Affect**	**No Detonations in Non-Territorial Waters**	TTS Exposures/ESA Consultation Required; **No Significant Harm /May Affect**	TTS Exposures/ESA Consultation Required; **No Significant Harm/May Affect**
	Projectile Firing	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Non-Territorial Waters**	No Exposures/ Protective Measures; **No Significant Harm/No Effect**	No Exposures/ Protective Measures; **No Significant Harm/No Effect**

Table ES-1. Effect Summary Chart (Cont'd)

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Anthropogenic Resources	**Airspace Management**						
	Air Operations (# Flight Hours)	239 hrs; **No Significant Impact**	258 hrs; **No Significant Impact**	774 hrs; **No Significant Impact**	105 hrs; **No Significant Harm**	114 hrs; **No Significant Harm**	342 hrs; **No Significant Harm**
	Artificial Reefs						
	Subsurface Operations (Physical Strikes)	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Harm**	Reefs avoided; **No Significant Harm**	Reefs avoided; **No Significant Harm**
	Ordnance Operations (Shock Wave, Silting)	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Reefs avoided; **No Significant Harm**	Reefs avoided; **No Significant Harm**
	Environmental Justice & Risks to Children						
	All Operations Combined (Disadvantaged Groups Affected)	No disproportionate effects/no risks; **No Significant Impact**	No disproportionate effects/no risks; **No Significant Impact**	No disproportionate effects/no risks; **No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Cultural/Historical Resources						
	All Operations Combined	Resources avoided; **No Significant Impact**	Resources avoided; **No Significant Impact**	Resources avoided; **No Significant Impact**	Resources avoided; **No Significant Harm**	Resources avoided; **No Significant Harm**	Resources avoided; **No Significant Harm**

Table ES-2. Estimated Marine Mammal Exposures from Sonar Operations in Territorial and Non-Territorial Waters

Marine Mammal Species	No Action Alternative			Alternative 1			Alternative 2		
	Level A	Level B TTS	Level B Behavioral	Level A	Level B TTS	Level B Behavioral	Level A	Level B TTS	Level B Behavioral
Bryde’s whale	0	0	0	0	0	0	0	0	0
Sperm whale	0	0	1	0	0	1	0	0	1
Dwarf/Pygmy sperm whale	0	0	0	0	0	0	0	0	0
All beaked whales	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0
False killer whale	0	0	0	0	0	0	0	0	0
Pygmy killer whale	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	1	0	0	1	0	0	1
Short-finned pilot whale	0	0	0	0	0	1	0	0	1
Risso’s dolphin	0	0	1	0	0	1	0	0	1
Rough-toothed dolphin	0	0	0	0	0	0	0	0	0
Bottlenose dolphin	0	3	281	0	3	547	0	4	567
Atlantic spotted dolphin	0	1	221	0	2	430	0	3	447
Pantropical spotted dolphin	0	0	9	0	0	12	0	0	16
Striped dolphin	0	0	2	0	0	2	0	0	3
Spinner dolphin	0	0	8	0	0	10	0	0	13
Clymene dolphin	0	0	3	0	0	4	0	0	5
Fraser’s dolphin	0	0	0	0	0	0	0	0	0

Table ES-3. Estimated Marine Mammal Exposures from Ordnance Operations in Territorial and Non-Territorial Waters

Marine Mammal Species	No Action Alternative			Alternative 1			Alternative 2		
	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bryde's whale	0	0	0	0	0	0	0	0	0
Sperm whale	0	0	0	0	0	0	0	0	1
Dwarf/Pygmy sperm whale	0	0	0	0	0	0	0	0	0
All beaked whales	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0
False killer whale	0	0	0	0	0	0	0	0	0
Pygmy killer whale	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	1
Short-finned pilot whale	0	0	0	0	0	0	0	0	0
Risso's dolphin	0	0	0	0	0	0	0	0	1
Rough-toothed dolphin	0	0	0	0	0	0	0	0	0
Bottlenose dolphin	0	0	0	0	1	10	1	1	41
Atlantic spotted dolphin	0	0	0	0	1	5	1	1	20
Pantropical spotted dolphin	0	0	0	0	0	2	0	1	6
Striped dolphin	0	0	0	0	0	0	0	0	2
Spinner dolphin	0	0	0	0	0	3	0	1	10
Clymene dolphin	0	0	0	0	0	1	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0

Table ES-4. Estimated Marine Mammal Exposures from Projectile Firing Operations in Territorial and Non-Territorial Waters

Marine Mammal Species	No Action Alternative†			Alternative 1			Alternative 2		
	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bryde's whale	0	0	0	0	0	0	0	0	0
Sperm whale	0	0	0	0	0	0	0	0	0
Dwarf/Pygmy sperm whale	0	0	0	0	0	0	0	0	0
All beaked whales	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0
False killer whale	0	0	0	0	0	0	0	0	0
Pygmy killer whale	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0
Risso's dolphin	0	0	0	0	0	0	0	0	0
Rough-toothed dolphin	0	0	0	0	0	0	0	0	0
Bottlenose dolphin	0	0	0	0	0	1	0	0	2
Atlantic spotted dolphin	0	0	0	0	0	0	0	0	1
Pantropical spotted dolphin	0	0	0	0	0	0	0	0	1
Striped dolphin	0	0	0	0	0	0	0	0	0
Spinner dolphin	0	0	0	0	0	0	0	0	0
Clymene dolphin	0	0	0	0	0	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0

†No projectile firing operations will be conducted under the No Action Alternative
*Combined bottlenose and Atlantic spotted dolphins includes individuals that were not differentiated during scientific surveys
**Unidentified *Stenella* includes pantropical spotted, striped, spinner, and clymene dolphins that were not differentiated during scientific surveys

Table ES-5. Estimated Sea Turtle Exposures from Ordnance Operations in Territorial and Non-Territorial Waters

Sea Turtle Species	NO ACTION ALTERNATIVE		ALTERNATIVE 1		ALTERNATIVE 2	
	TM/lung Injury	TTS	TM/lung Injury	TTS	TM/lung Injury	TTS
Hardshell	0	0	0	1	0	3
Loggerhead	0	0	0	2	0	3
Leatherback	0	0	0	0	0	1

*Unidentified *chelonid* includes any hard-shelled turtle that could not be differentiated during scientific surveys.

Table ES-6. Estimated Sea Turtle Exposures from Projectile Firing Operations in Territorial and Non-Territorial Waters

Sea Turtle Species	NO ACTION ALTERNATIVE†		ALTERNATIVE 1		ALTERNATIVE 2	
	TM/lung Injury	TTS	TM/lung Injury	TTS	TM/lung Injury	TTS
Hardshell	0	0	0	0	0	0
Loggerhead	0	0	0	1	0	1
Leatherback	0	0	0	0	0	1

† No projectile firing operations will be conducted under the No Action Alternative.
*Unidentified *chelonid* includes any hard-shelled turtle that could not be differentiated during scientific surveys.

Incidental takes are allowed only if NMFS (operating under the National Oceanic and Atmospheric Administration [NOAA]) issues regulations governing the permissible methods of taking. To issue regulations, NMFS must make a determination that (1) the taking will have a negligible impact on the species or stock, and (2) the taking will not have an immitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

The Marine Mammal Protection Act (MMPA) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the high seas by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 United States Code [USC] 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of "harassment," Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act (NDAA) of fiscal year (FY) 2004 (Public Law 108-136) amended the definition of "harassment" for military readiness activities. Military readiness activities, as defined in Public Law 107-314, Section 315(f), includes all training and operations related to combat, and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat. This definition, therefore, includes RDT&E activities occurring in the NSWC PCD Study Area. The amended definition of "harassment" for military readiness activities, as applied in this EIS/OEIS, is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"), or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 USC 1362 [18][B][i],[ii]).

In support of the Proposed Action, the Navy requested a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. The application has been reviewed by NMFS and a Notice of Receipt of Application was published in the *Federal Register* on April 14, 2008 (NMFS, 2008b). Publication of the Notice of Receipt of Application initiated the 30-day public comment period, during which time anyone can obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of a LOA and published a Proposed Rule in the *Federal Register* on April 30, 2009 (NMFS, 2009). Specifically, the regulations for each allowed activity establish (1) permissible methods of taking, and other means of effecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence, and (2) requirements for monitoring and reporting of such taking. For military readiness activities (as described in the National Defense Authorization Act), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the DoD, of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

ES.8 MITIGATION MEASURES

NEPA regulations require an EIS to include appropriate mitigation measures not already included in the Proposed Action or alternatives (40 Code of Federal Regulations [CFR] 1502.12[f]). Each of the alternatives, including the Proposed Action considered in this EIS/OEIS, include mitigation measures intended to reduce environmental effects from Navy activities. These measures are detailed in Chapter 5, Mitigation and Protective Measures.

ES.9 CUMULATIVE IMPACTS

The approach taken in the analysis of cumulative impacts achieves the objectives of NEPA. Council on Environmental Quality (CEQ) regulations (40 CFR 1500 to 1508), which provide the implementing procedures for NEPA, define *cumulative impacts* as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7).

All resources analyzed in Chapter 4 were carried forward into the cumulative impacts analysis for the purpose of determining whether the Proposed Action would have an incremental impact when combined with other past, present, and reasonably foreseeable actions. These projects are described in Chapter 6, Cumulative Impacts and Other NEPA Considerations, and are considered on a resource-specific basis in the cumulative impacts analysis. It was concluded that NSWC PCD RDT&E activities would not contribute to a significant incremental cumulative impact on any of the resource areas when combined with other past, present, and reasonably foreseeable activities.

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1. PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 INTRODUCTION

Naval Surface Warfare Center, Panama City Division (NSWC PCD) is the United States (U.S.) Navy's premier research and development organization focused on littoral (coastal region) warfare and expeditionary (designed for military operations abroad) maneuver warfare. NSWC PCD provides in-water research, development, test, and evaluation (RDT&E) in support of expeditionary maneuver warfare, operations in extreme environments, mine warfare, maritime operations, and coastal operations. The mission descriptions associated with mission areas are as follows:

- ***Expeditionary Maneuver Warfare*** - Mission activities include the rapid clearing of surf, and beach zone mines and obstacles, rapid and reliable marking of breached lanes (paths that are safe for vessel travel within a minefield), and reliable precision navigation inside these marked lanes.
- ***Operations in Extreme Environments*** - Involves activities ranging from deep salvage to routine hull maintenance; all aspects of diving and life support requirements are addressed.
- ***Mine Warfare*** - Mission activities include: research, modeling, development, engineering, and testing of mine and mine countermeasures (MCM) systems; threat mine exploitation (evaluation of non-U.S. mines); mine and MCM tactics development; systems or platform integration (ensuring that all aspects—communications, logistics, and software—of the systems and equipment used during a test operation do not conflict with each other); and mine and MCM life cycle management.
- ***Maritime Operations*** - Provides focused technical expertise supporting research, development, and acquisition of special operations maritime systems and equipment. The primary types of support include: Manned Undersea Mobility Systems; Diving and Life Support Systems; Underwater Guidance and Navigation Systems; Outboard Engine Systems; and Unmanned Systems.
- ***Coastal Operations*** - Involves applying the knowledge and technology developed for military and warfighting arenas to diverse existing and emerging civil, commercial, and academic needs, such as coastal and maritime security.

NSWC PCD is the nation's principal repository of this expertise supported by a diverse technical workforce in these areas that are critical to the future of U.S. Navy and U.S. Marine Corps operations. In accordance with Department of Defense (DoD) Directive 5000.1, test and evaluation support is to be integrated throughout the defense acquisition process (the process that encompasses every aspect of identifying, developing, and procuring defense systems) and is structured to provide essential information to decision makers. Such testing is used to validate the technical performance parameters (whether a given system performs as expected) and to determine whether systems are operationally effective, suitable, survivable, and safe for their intended use.

1.1.1 Description of the Naval Surface Warfare Center Panama City Division Study Area

It is the mission of NSWC PCD to provide RDT&E, as well as in-service support for expeditionary maneuver warfare, diving, maritime special operations, mine warfare (mines and MCM), and other naval missions that take place in the coastal region. The infrastructure has been established at NSWC PCD to support this mission. A unique feature of NSWC PCD that is unduplicated in the U.S. is the natural operating environment provided by the ready access to the Gulf of Mexico (GOM) and its associated littoral and coastal regions. The GOM provides a surrogate environment for most of the littoral areas of the world in which the Navy will find itself operating for the foreseeable future. No other geographical area would meet the mission requirements. Thus, only the NSWC PCD Study Area was considered in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

The NSWC PCD EIS/OEIS addresses all of the RDT&E operations that occur within the NSWC PCD Study Area, which includes St. Andrew Bay (SAB) and military warning areas (areas within the GOM subject to military operations) W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), and W-470. The majority of activities occur in W-151 (includes Panama City Operating Area) and W-155 (includes Pensacola Operating Area) in the region from Pensacola, Florida to Apalachicola, Florida. The NSWC PCD Study Area includes W-470 and western portions of W-155 in consideration of potential environmental effects to provide mission flexibility. The NSWC PCD RDT&E activities may be conducted anywhere within the existing military warning areas and SAB from the mean high water line (average high tide mark) out to 222 kilometers (km) (120 nautical miles [NM]) offshore (Figure 1-1 and Figure 1-2). The locations and environments include:

- Test area control sites adjacent to NSWC PCD.
- Wide coastal shelf, 97 km (52 NM) distance offshore to 183 meters (m) (600 feet [ft]) water depth, including bays and harbors.
- Water temperature range of 27 degrees Celsius (°C) (80 degrees Fahrenheit [°F]) in summer to 10 °C (50 °F) in winter.
- Typically sand bottom and good underwater visibility.
- Seas less than 0.91 m (3 ft) 80 percent of the time (summer) and less than 0.91 m (3 ft) 50 percent of the time (winter).

1.2 PROPOSED ACTION

The Proposed Action is to improve NSWC PCD's capabilities to conduct new and increased mission operations for the Department of the Navy (DON) and other customers. The DON is evaluating potential environmental effects associated with the littoral and expeditionary maneuver warfare activities proposed for the NSWC PCD Study Area (Figure 1-1 and Figure 1-2). NSWC PCD's RDT&E activities occur either on or over the waters present within the NSWC PCD Study Area. All shoreside support activities are managed by Naval Support Activity Panama City (NSA PC). No hazardous waste is generated at sea during NSWC PCD RDT&E activities. Because the NSWC PCD Study Area is limited to water areas, the routine shoreside management functions performed by NSA PC are not included in this EIS/OEIS.

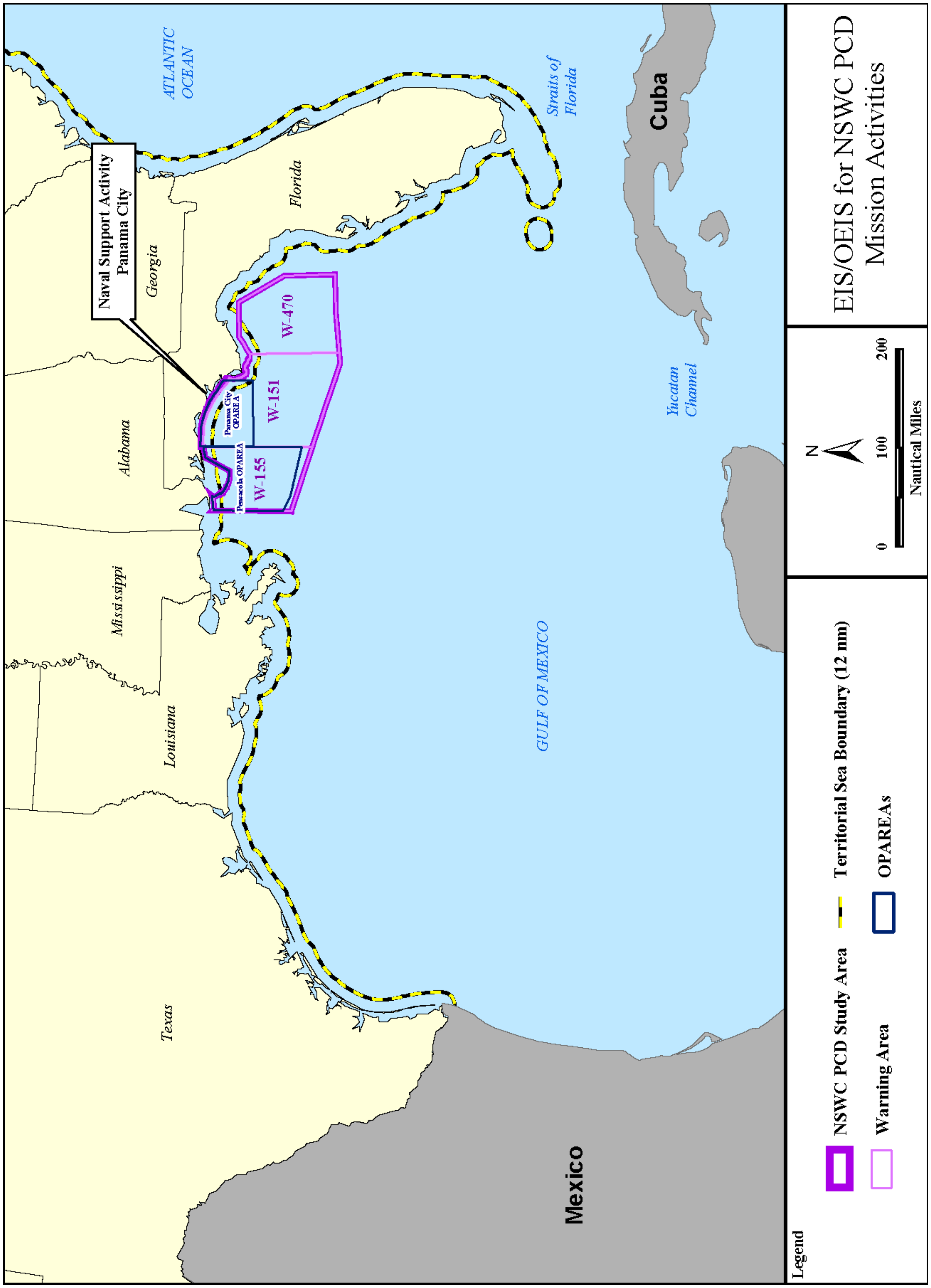

Figure 1-1. NSWC PCD Operations Study Area: Northern GOM

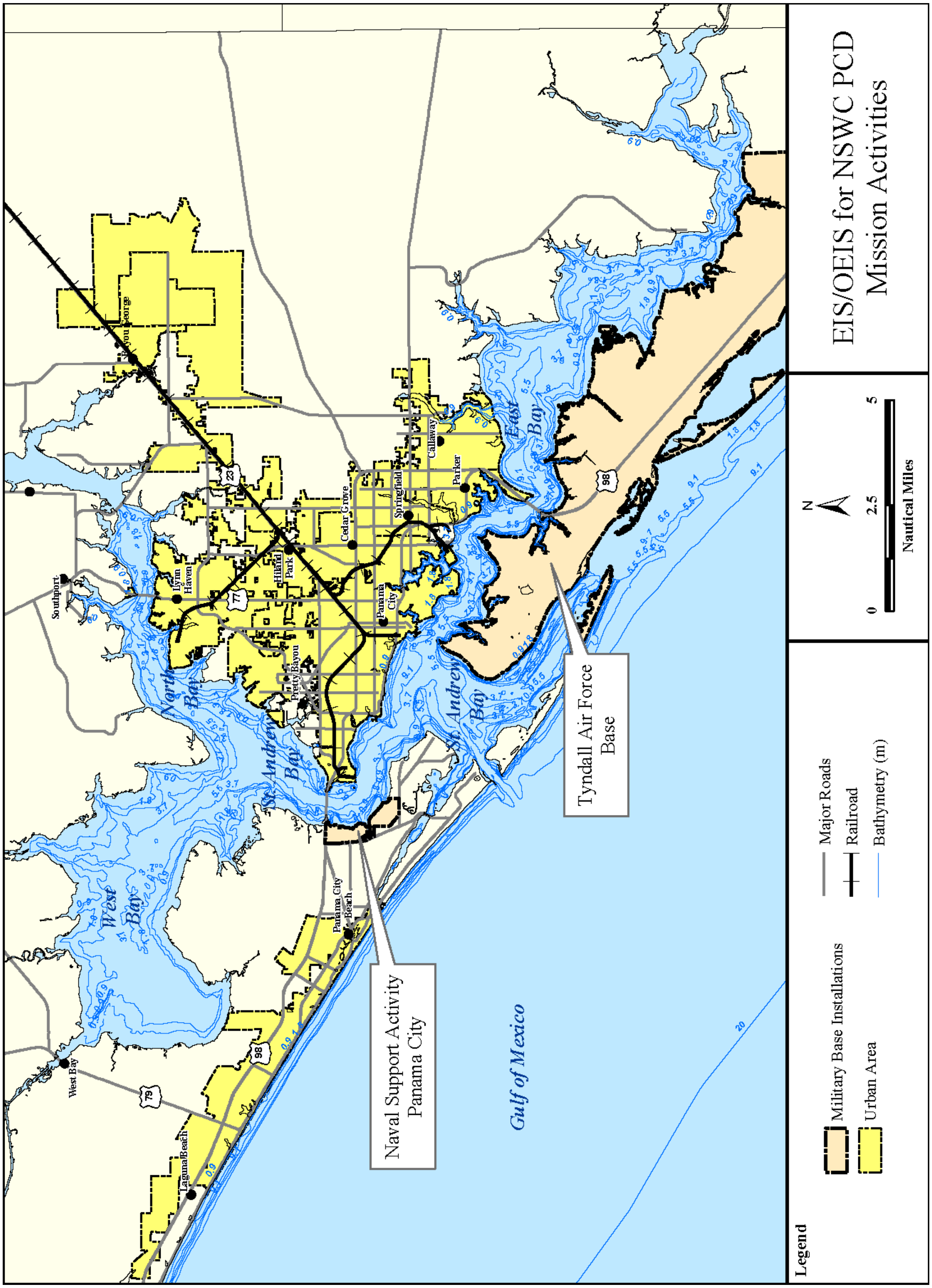

Figure 1-2. The NSWC PCD Study Area: Nearshore Environments and SAB

NSWC PCD's RDT&E activities involve a variety of naval assets, including surface crafts, aircraft, and underwater systems that support eight primary RDT&E capabilities: air operations, surface operations, subsurface operations, sonar operations, electromagnetic operations, laser operations, ordnance operations, and projectile firing.

1.3 PURPOSE AND NEED

The **Purpose** of the Proposed Action is to enhance NSWC PCD's capability and capacity to meet littoral and expeditionary maneuver warfare requirements by providing RDT&E and in-service engineering for expeditionary maneuver warfare, operations in extreme environments, mine warfare, maritime operations, and coastal operations.

The **Need** for the Proposed Action is for the Navy to successfully meet current and future national and global defense challenges by developing a robust capability to research, develop, test, and evaluate systems within the NSWC PCD Study Area. This allows the Navy to meet its statutory mission to deploy worldwide naval forces equipped to meet existing and emergent threats and to enhance its ability to operate jointly with other components of the armed forces.

NSWC PCD was established on the current site maintained by NSA PC after a thorough site selection process in 1942. The Navy considered locations along the east coast and in the GOM. NSWC PCD provides:

- Accessibility to deep water
- Tests in clear water
- Conducive sand bottom
- Available land and sheltered areas, and
- Average good weather (year–round testing).

In addition to these requirements for testing, the area was selected based on the moderate cost of living, the availability of personnel, and the low level of crowding from industries and development. In 1945, the station was re-commissioned as the U.S. Navy mine countermeasure station after its turnover as a section base for amphibious forces in 1944. The factors identified in 1942 during the selection process solidified the decision.

NSWC PCD provides the greatest number of favorable circumstances for the environment needed to conduct RDT&E focused on mine countermeasures, economically and efficiently. Many of the other locations have large amounts of ship traffic, rough waters and windy conditions, and closure of water ways seasonally due to water level. NSWC PCD has the established infrastructure, equipment, and personnel as well as the conditions required to fulfill the Proposed Action.

1.4 REGULATORY COMPLIANCE

This EIS/OEIS has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), which requires a detailed environmental analysis for major federal actions with the potential to significantly affect the quality of the human and natural environments on land ranges and within U.S. territorial waters. As defined in this document, territorial waters extend from shoreline seaward to 22.2 km [12 NM]).

This document was also prepared in accordance with Presidential Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions, which requires environmental documentation for effects to resources seaward of U.S. territorial waters. As defined in this document, non-territorial waters extend beyond 22.2 km (12 NM). Whether to apply NEPA or EO 12114 is determined by where the potential effects occur, not where the action takes place. Therefore, discussions of potential effects under the purview of NEPA are presented under Territorial Waters, and discussions of potential effects under the purview of EO 12114 are presented under Non-Territorial Waters.

In addition to NEPA and EO 12114, this document complies with a variety of other environmental regulations. The following subsections provide a brief description of the environmental requirements most relevant to this EIS/OEIS. Refer to Appendix A for a description of all relevant and pertinent laws, regulations, and policies.

1.4.1 National Environmental Policy Act of 1969

NEPA was enacted in 1969 and provides for the consideration of environmental issues in federal agency planning and decision-making. NEPA established the Council on Environmental Quality (CEQ) for the purpose of implementing the provisions of NEPA; CEQ implemented the procedural provisions of NEPA in 40 Code of Federal Regulations [CFR] Parts 1500–1508. These regulations outline federal agency's responsibilities under NEPA and provide detailed measures for the preparation of EISs. The Navy has published procedures for implementing NEPA in the Chief of Naval Operations (CNO) Environmental and Natural Resources Program Manual Instruction (OPNAVINST) 5090.1C, Chapter 5, "Procedures for Implementing the National Environmental Policy Act (NEPA)," as well as CNO 2004 Supplemental Environmental Planning Policy, containing guidance and procedures to ensure that the Navy complies with NEPA.

1.4.2 Presidential Executive Order 12114

EO 12114 directs federal agencies to provide for informed decision-making for major federal actions occurring outside the United States, including the global commons, the environment of a nonparticipating foreign nation, or impacts on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. "Global commons" are defined as "geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 22.2 km [12 NM] from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations" (32 CFR 187.3). The Navy has published procedures for implementing EO 12114 in 32 CFR 187, Environmental Effects Abroad of Major Department of Defense Actions, as well as the October 2007 Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C, Appendix E, "Conducting Environmental Planning for Major Navy Actions Outside of the U.S. and U.S. Territories and Possessions".

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document to reduce duplication as permitted under NEPA and

EO 12114. Therefore, the scoping requirements found in NEPA will be implemented with respect to actions occurring seaward of U.S. territorial waters, and discussions regarding scoping requirements will reference the combined EIS/OEIS.

1.4.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the high seas by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 United States Code [USC] 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of "harassment," Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act (NDAA) of fiscal year (FY) 2004 (Public Law 108-136) amended the definition of "harassment" for military readiness activities. Military readiness activities, as defined in Public Law 107-314, Section 315(f), includes all training and operations related to combat, and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat. This definition, therefore, includes RDT&E activities occurring in the NSWC PCD Study Area. The amended definition of "harassment" for military readiness activities, as applied in this EIS/OEIS, is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"), or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 USC 1362 [18][B][i],[ii]).

Section 101(a)(5) of the MMPA directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing) within a specified geographic region. These incidental takes may be allowed if the National Marine Fisheries Service (NMFS) determines the taking will have a negligible impact on the species or stock and the taking will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

1.4.4 Endangered Species Act

The ESA (16 USC 1531 to 1543) applies to federal actions in two separate respects. First, the ESA requires that federal agencies, in consultation with the responsible wildlife agency (i.e., NMFS), ensure that proposed actions are not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of a critical habitat (16 USC 1536 [a][2]). Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat.

Second, if an agency's proposed action would "take" a listed species, then the agency must obtain an incidental take statement from the responsible regulatory agency (i.e., NMFS). The ESA defines the term "take" to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct" (16 USC 1532[19]). The regulatory definitions of "harm" and "harass" are relevant to the Navy's determination as to whether the proposed RDT&E activities would result in adverse effects on listed species.

- *Harm* is defined by regulation as "an act which actually kills or injures" fish or wildlife (50 CFR 222.102).
- *Harass* is defined by regulation to mean an "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering" (50 CFR 17.3).

As part of the environmental documentation for this EIS/OEIS, the Navy entered into formal consultation with NMFS because certain actions under the Proposed Action would result in a "may affect" finding for listed species or designated critical habitat. Formal consultation began with the Navy submitting a Biological Evaluation (BE) to NMFS. Consultation ends once NMFS prepares a final Biological Opinion (BO) and issues an Incidental Take Statement, if required.

1.4.5 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1801 et seq.), was enacted to conserve and restore the nation's fisheries, and includes a requirement for NMFS and regional fishery councils to describe and identify essential fish habitat (EFH) for all species that are federally managed. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Under the Act, federal agencies must consult with NMFS regarding any activity or proposed activity that is authorized, funded, or undertaken by the agency that may adversely affect EFH. As described in Section 4.3.4, no adverse effects to EFH are anticipated from NSWC PCD mission activities; therefore, the Navy is not planning consultations with NMFS under this act.

1.4.6 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) provides assistance to states, in cooperation with federal and local agencies, for developing land and water use programs for their respective coastal zone. State territorial waters extend outward from the baseline (generally the shoreline) to a distance of 5.6 km (3 NM) on the east coast of Florida and from the shoreline out to 16.7 km (9 NM) on the west coast of Florida.

The CZMA requires all federal agency activities that affect any land or water use, or natural resource of the coastal zone be conducted in a manner consistent, to the maximum extent practicable, with the enforceable policies of the National Oceanic and Atmospheric Administration (NOAA)-approved state management program. This includes protecting natural resources and managing coastal development. In accordance with the CZMA, both direct and indirect effects are considered, and it is not required that the effects be adverse.

In accordance with 15 C.F.R. § 930.41, the state agencies have 60 days from receipt of this document in which to concur with or object to this Consistency Determination, or to request an extension, in writing, under 15 C.F.R. § 930.41(b). The federal agency may presume state agency concurrence if the state agency's response is not received within 60 days from receipt of the federal agency's consistency determination and supporting information.

The Navy prepared Consistency Determinations for the States of Florida and Alabama. Appendices J and K, respectively, contain Consistency Determinations for each state. The Navy received a letter from the Florida State Clearinghouse which provided concurrence with this Consistency Determination. The Alabama Department of Environmental Management, however, did not respond to or request an extension after the 90th day from receipt of the determination. Therefore the Navy concludes that Alabama concurred with the Consistency Determination.

1.4.7 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) was enacted to ensure the protection of shared migratory bird resources. The MBTA prohibits the intentional take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit. Current regulations authorize permits for the intentional taking of migratory birds for activities such as scientific research, education, and depredation control. However, these regulations do not expressly authorize the incidental taking of migratory birds resulting from actions where the take was not the intent of the action. The MBTA protects a total of 836 bird species, 58 of which are currently legally hunted as game birds.

Section 315, "Incidental Taking of Migratory Birds during Military Readiness Activities," of the 2003 NDAA (Public Law 107-314, Section 315) required the Secretary of the Interior to promulgate regulations to exempt the Armed Forces for the incidental taking of migratory birds during military readiness activities. This task was delegated to the U.S. Fish and Wildlife Service (USFWS), who published a final rule in the *Federal Register* (effective 30 March 2007), which directly amended 50 CFR 21, *Migratory Bird Permits*, to authorize takes resulting from otherwise lawful military readiness activities (USFWS, 2007). This rule does not authorize takes under the ESA, and USFWS retains the authority to withdraw or suspend the authorization for incidental takes occurring during military readiness activities under certain circumstances.

Under this rule, the Navy is still required under NEPA to consider the environmental effects of its actions and assess the adverse effects of military readiness activities on migratory birds. If it is determined that the Proposed Action may result in a significant adverse effect on a population of a migratory bird species, the Navy will consult with USFWS to develop and implement appropriate conservation measures to minimize or mitigate these effects. Conservation measures, as defined in 50 CFR 21.3, include project designs or mitigation activities that are reasonable from a scientific, technological, and economic standpoint, and are necessary to avoid, minimize, or mitigate the take of migratory birds or other adverse impacts. Furthermore, a significant adverse effect on a population is defined as an effect that could, within a reasonable period of time, diminish the capacity of a population of a migratory bird species to sustain itself at a biologically viable level. Based on the analysis provided in Section 4.3.5, which shows that no adverse effects to migratory birds are anticipated, the Navy is not planning consultations with USFWS under this act.

1.5 SCOPE OF THE ENVIRONMENTAL IMPACT STATEMENT

The scope of the environmental analysis encompasses potential environmental effects to the physical, biological, and anthropogenic (man-made) resources (e.g., artificial reefs) within the NSWC PCD Study Area that may result from specific NSWC PCD RDT&E activities (i.e., air operations, surface operations, subsurface operations, sonar operations, electromagnetic operations, laser operations, ordnance operations, and projectile firing). The specific locations within the NSWC PCD Study Area are depth dependent and may begin at the mean high water line (average high tide mark) in the coastal areas and extend to more than 222 km (120 NM) offshore. This EIS/OEIS evaluates the Proposed Action and alternatives that include the enhancement of test capabilities and an increase in the type and intensity of testing conducted at NSWC PCD. The EIS/OEIS identifies and addresses potential environmental effects within the NSWC PCD Study Area, which includes W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), W-470, and SAB. The EIS/OEIS addresses all of the reasonably foreseeable activities in the particular geographical areas affected by the Proposed Action and alternatives and focuses on the increase in the tempo (frequency) and intensity of future activities.

Consistent with CEQ regulations, the scope of the analysis presented in this EIS/OEIS was defined by the range of potential environmental effects that would result from implementation of the Proposed Action and alternatives including the No Action Alternative. The analysis includes known new technology where enough information was available, variations on existing technology, and other new RDT&E activities. Tests involving a new technology or variations of existing technology would be covered and allowed to proceed if they were found to be within the effect limits established by this EIS/OEIS. Actions that fall outside of the scope of this document as identified in Chapter 2 would be assessed separately as they are proposed.

Each resource area is discussed for each operational category and intensity level. Additionally, the environmental analysis includes a discussion of the proposed mitigation measures and protective measures that would be employed to reduce the level of effects. The environmental analysis also addresses the potential cumulative effects associated with the NSWC PCD Proposed Action related to other ongoing and planned activities within the GOM.

1.6 PUBLIC INVOLVEMENT

NSWC PCD has developed a website (http://nswcpc.navsea.navy.mil/Environment.htm) to provide a forum for the dissemination of materials, data, and notices for this EIS/OEIS. The document and materials are available by clicking on the word "Documents", which appears under the "Environment" heading in the navigation bar on the left side of the website. To navigate directly to the documents download page, use the address http://nswcpc.navsea.navy.mil/Environment-Documents.htm.

In addition to comments received during NSWC PCD public involvement, this EIS/OEIS also considers relevant information from comments made through public involvement activities during other ongoing Navy EIS/OEIS projects. Refer to Chapter 7 for additional details regarding public participation for this document.

1.6.1 Public Involvement Program

The purpose of the public involvement program is to determine the environmental issues of concern to be addressed; identify the significant public and regulatory issues related to the Proposed Action; and provide for the participation of interested persons, organizations, and agencies. The Navy has conducted two public scoping meetings in an effort to involve the public in the EIS/OEIS planning processes. Additionally, participants can attend public hearings after the release of the Draft EIS/OEIS. Scoping is discussed in further detail in the next subsection.

1.6.2 Scoping

The scoping process identifies the significant environmental issues relevant to the Proposed Action and alternatives including the No Action Alternative and provides an opportunity for public involvement in the development of the EIS/OEIS. In addition, potentially interested federal and state agencies were briefed on the overall scope of the EIS/OEIS and were given the opportunity to assist in the development of the EIS/OEIS as cooperating agencies. Of the six agencies approached, only NMFS has agreed that a mutual and beneficial role exists to serve NSWC PCD as a cooperating agency.

The Notice of Intent (NOI) to prepare this EIS/OEIS was published in the *Federal Register* on 19 August 2004 (DON, 2004). Notification of public scoping was also made through local media, as well as through letters to federal, state, and local agencies and officials, and interested groups and individuals. Formal scoping meetings were held in Panama City, Florida (05 October 2004), and Port St. Joe, Florida (06 October 2004).

Scoping of the Proposed Action and alternatives has taken place with dialogue and input from both internal and external stakeholders. Internally, the NSWC PCD Project Team, which includes representatives from Naval Sea Systems Command (NAVSEA), has met regularly to discuss aspects of the EIS/OEIS. Briefings and coordination with other Navy offices have taken place to ensure a wide range of input on the Proposed Action, alternatives, and issues. Scoping with external stakeholders has taken place since 2004, including discussions with federal and state agency officials and non-governmental organizations.

1.6.3 Comment Period for Draft EIS/OEIS

A notice of availability/notice of public hearings was published in the *Federal Register* on April 11, 2008, and in three newspapers. The document was then distributed to those individuals, agencies, and associations that requested the EIS/OEIS. NSWC PCD also sent notification of the availability of the NSWC PCD Draft EIS/OEIS and public hearing schedule to those individuals, agencies, and associations listed in Chapter 8, Section 8.2. The NSWC PCD Draft EIS/OEIS was made available for general review in five public libraries and on the NSWC PCD website.

Public hearings were also held to solicit public comments on a variety of issues associated with the document and the Proposed Action. NSWC PCD hosted three public hearings on the following dates at the specified locations:

- May 5, 2008 Panama City, FL
- May 6, 2008 Pensacola, FL
- May 7, 2008 Port St. Joe, FL

The public review period ended on May 19, 2008. Comments were submitted via U.S. mail and email. By the close of the comment period, a total of 10 agencies, organizations, and individuals had submitted 192 comments. This Final EIS/OEIS incorporates and formally responds to all substantive comments received on the Draft EIS/OEIS. Refer to Chapter 7 for additional information, including responses to comments.

1.6.4 Notification of Availability for the Final EIS/OEIS

The notice of availability of this Final EIS/OEIS was published in the *Federal Register* and three newspapers. Release of the Final EIS/OEIS is accompanied by a 30-day wait period, unless otherwise approved by the Environmental Protection Agency (EPA). The EPA may, on a showing by the lead agency of compelling reasons of national policy, reduce the prescribed periods and may, on a showing by any other Federal agency of compelling reasons of national policy, also extend prescribed periods, but only after consultation with the lead agency.

1.6.5 Decision Document

A Record of Decision (ROD) will be issued no less than 30 days after the Final EIS/OEIS is made available and published in the *Federal Register* and local newspapers. The ROD will be a concise summary of the decision made by the Navy from the alternatives presented in the Final EIS/OEIS. Specifically, the ROD will state the decision, identify alternatives considered (including that which was environmentally preferable), and discuss other (non-environmental) considerations that influenced the decision identified. The ROD will also describe the implementation of practical measures intended to avoid effects from the chosen alternatives and explain any decision not to implement any of these measures. Once the ROD is published, public involvement is considered complete, and the Navy can implement the Proposed Action.

1.7 ISSUES ELIMINATED FROM FURTHER ANALYSIS

Issues eliminated from further study that are typically addressed in NEPA documentation include topics primarily related to actions conducted within a land or coastal setting such as wetland impacts, floodplain impacts, and land use considerations. Table 1-1 lists all of the issues eliminated from further analysis and provides an explanation for their dismissal.

Table 1-1. Environmental Issues Eliminated from Further Analysis

Issues Eliminated	Reason for Dismissal
Terrestrial Biology	The Proposed Action only addresses NSWC PCD RDT&E activities occurring in and over the waters of the GOM.
Land Use	
Prime or Unique Farmland	
Parks and Forests Including National Parks	
Wetland Habitat	
Utilities	
Hazardous Materials and Waste	The Proposed Action only addresses NSWC PCD RDT&E activities occurring in and over the waters of the GOM. There would be minimal use of hazardous materials and no generation or handling of hazardous waste during RDT&E activities within the NSWC PCD Study Area. The majority of hazardous waste generated would occur during maintenance procedures conducted at the Naval Support Activity Panama City, (NSA PC) facilities and would be handled in accordance with existing NSA PC hazardous waste standard operating procedures.

NSWC PCD = Naval Surface Warfare Center, Panama City; RDT&E = Research, Development, Test, and Evaluation; GOM = Gulf of Mexico

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2. PROPOSED ACTION AND ALTERNATIVES

The Proposed Action and alternatives describe mission operations sufficiently to evaluate the potential environmental effects within the Naval Surface Warfare Center Panama City Division (NSWC PCD) Study Area, which includes St. Andrew Bay (SAB), and military warning areas W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), and W-470. These areas will be referred to as the "NSWC PCD Study Area." Alternatives include the No Action Alternative and two additional alternatives with varying mission components and activity frequencies associated with future mission requirements.

2.1 DESCRIPTION OF THE PROPOSED ACTION

The Proposed Action is to improve NSWC PCD's capabilities to conduct new and increased mission operations for the Department of Defense (DoD) and its customers within the NSWC PCD Study Area. The research, development, test, and evaluation (RDT&E) activities occurring in these areas include air operations, surface operations, subsurface operations, sonar operations, electromagnetic operations, laser operations, ordnance operations, and projectile firing. NSWC PCD primarily tests mine detection, mine deployment, and mine neutralization or other render-safe technology, not mine lethality. Thus, the vast majority of the tests are conducted with inert/non-explosive mine substitutes although occasionally testing requires actual mine detonation.

2.1.1 Air Operations

Aircraft are often an essential part of the RDT&E activities conducted by NSWC PCD. The majority of the aircraft utilized to support the RDT&E activities are helicopters (MH-53, MH-60, UH-1, and variants). In the case where multiple aircraft are required to support a test, one aircraft is usually designated as the test platform and the other aircraft are used for surveying and monitoring to determine that a particular test site is clear of other aircraft or surface vessels. Current air operations at NSWC PCD encompass approximately 344 hours every year. Of this time, 342 hours would involve helicopter flights and 2 hours would employ fixed-wing aircraft. Alternatives 1 and 2 would provide for increases in air operations for these two types of aircraft. Refer to Sections 2.3.2 and 2.3.3 for more detailed information on those alternatives. The following subsections describe the types of RDT&E activities that are conducted from aircraft within the NSWC PCD Study Area.

2.1.1.1 Support Platforms

Aircraft are often used to survey the RDT&E area to ensure it is clear of other air and surface vessels prior to testing and to perform post-test surveys following the completion of a test event. In addition, aircraft may be utilized as a monitoring platform during the test so the test sequence can be photographed and recorded.

2.1.1.2 Airborne Mine Countermeasures (AMCM) Tows

The MH-60S and the MH-53 are frequently utilized as the test platform during AMCM tow test events. A towed body is an object towed in the water from a surface or air platform and may contain active or passive sensors. The towed body is transported to the test area by a helicopter where it is then lowered to the required operating depth. The helicopter then begins to tow the body along the predetermined mission tracks. Upon completion of the test, the towed body is recovered and stowed for transport.

2.1.1.3 Captive Carriage and Jettison

In order to test the capability of the helicopter to safely carry and jettison a stowed system during an emergency event, tests are conducted using "shapes." Shapes are objects that represent towed systems. These shapes are typically the same form, size, and weight of the system they are representing and are made of wood or metal casings filled with concrete or sand. Captive carriage tests typically focus on how the stowed system affects the handling of the aircraft during transport and how the aircraft reacts to the immediate separation and release of the captive system from the helicopter. If at all possible, all shapes jettisoned during testing are recovered.

2.1.1.4 Aerial Separation of Expendables

Aerial delivery and separation of inert shapes, rockets, and mines may be needed to meet the requirements of some test events conducted within the NSWC PCD Study Area. Aerial deliveries of inert shapes, rockets, and mines typically focus on testing the deployed systems and the flight effects to the platform associated with the deployment. Most often, these inert expendables are delivered by a fixed-wing aircraft and are recovered following the completion of testing. The only form of live aerial expendables would be the firing of gun rounds at predetermined targets from a helicopter platform.

2.1.2 Surface Operations

Current NSWC PCD surface operations total 2,351 hours each year. These hours include 72 hours of operations involving Landing Craft Air Cushions (LCACs). The No Action Alternative detailed in Section 2.3.1 would include this amount of vessel use. Alternatives 1 and 2 would provide for increases in surface operations. Refer to Sections 2.3.2 and 2.3.3 for more detailed information on those alternatives. The following four subsections describe the types of surface test and operations conducted within the NSWC PCD Study Area.

2.1.2.1 Support Activities

Nearly all test activities conducted within the NSWC PCD Study Area involve surface craft support. The size of these vessels varies in accordance with the test requirements and vessel availability. Often multiple surface crafts are required to support a single test event. Acting as a support platform for testing, these vessels are utilized to carry test equipment and personnel to and from the test sites and are also used to secure and monitor the designated test area. Normally, these vessels remain on site and return to port following the completion of the test;

occasionally, however, they remain on-station throughout the duration of the test cycle for guarding sensitive equipment in the water. Testing associated with these operational capabilities may include a single test event or a series of test events spread out over consecutive days or as one long test operation that requires multiple days to complete.

2.1.2.2 Surface Vessel Tows

Surface vessels are often used as tow platforms for surface craft deployable mine warfare systems tests. Tow tests of this nature involve either transporting the system to the designated test area where it is deployed and towed over a pre-positioned inert minefield or towing the system from NSWC PCD to the designated test area. Surface vessels are also utilized as a tow platform for systems that are designed to be deployed by helicopters. Such tests normally entail system functionality testing to ensure the towed body and its associated subsystems are functioning correctly.

2.1.2.3 Launch and Recovery

Surface crafts are also used to perform the deployment and recovery of unmanned underwater vehicles (UUVs), sonobuoys, inert mines, mine-like objects (MLOs), versatile exercise mine (VEM) systems, and other test systems. Often the same surface vessel utilized as a test platform is used to launch and recover the associated test equipment. Surface vessels that are used in this manner normally return to port the same day. However, this is test dependent, and under certain circumstance (e.g., endurance testing), the vessel may be required to remain on site for an extended period of time.

2.1.2.4 Developmental and Operational Testing of Surface Vessels

Developmental and operational testing of surface vessels is also conducted within the NSWC PCD Study Area. These tests include operational testing of navigation and communication systems associated with various surface vessels including some unmanned surface vessels. In addition, some tests may focus on the hydrodynamics and alternative propulsion systems associated with these surface vessels.

2.1.3 Subsurface Operations

Subsurface operations currently take place at NSWC PCD and include a variety of underwater vehicles, robotic or autonomous systems, and items placed on the sea floor. All of the subsurface vehicles are retrieved after use, while most objects (i.e. inert mines) remain for a period of time to be used as testing fixtures. The amount of subsurface operations is broken down into the number of items deployed and/or retrieved per year from operations involving systems, MLOs/inert mines, and VEMs. Approximately 266 targets are deployed and/or retrieved per year, and approximately 176 hours are used for robotic and underwater vehicle systems. The No Action Alternative detailed in Section 2.3.1 would encompass the current operations. Alternatives 1 and 2 would provide for increases in subsurface operations. Refer to Sections 2.3.2 and 2.3.3 for more detailed information on those alternatives. Subsurface operations occurring within the NSWC PCD Study Area can be broken into five subcategories.

2.1.3.1 Diving

The Diving and Life Support Division conducts fundamental research in support of underwater life support equipment and systems. In an effort to meet the requirements associated with this research, specific dive operations ranging from deep salvage to routine hull maintenance may be conducted within the NSWC PCD Study Area.

NSWC PCD also supports the naval special warfare arena by testing manned undersea mobility systems, underwater guidance, and navigation systems. NSWC PCD manages the acceptance testing and delivery of all operational sea-air-land delivery vehicles (SDVs). The SDV is a manned battery-powered submersible vehicle shaped like a mini-submarine that is 6.8 meters (m) (22 feet [ft]) in length and can carry up to six divers.

SDV acceptance testing is conducted with a crew operating and navigating the submerged SDV while using underwater breathing apparatus for life support. The vehicle is battery-powered and is equipped with propulsion, navigation, communication, and life support equipment. The SDV is capable of delivering several fully-equipped divers to a mission area, loitering in the area, retrieving the divers, and retiring from the area while remaining completely submerged.

2.1.3.2 Salvage

NSWC PCD diving personnel, comprising both military and civilian divers, are responsible for providing diving and salvage services (i.e., planting and recovering MLOs/inert mines and VEMs) associated with locating and recovering RDT&E equipment jettisoned and/or placed into the NSWC PCD Study Area. The current operations involving MLOs/inert mines and VEMs encompass the deployment of 266 items per year. This number accounts for salvage, as well as, the mooring and burying of mines, which is detailed later in Section 2.1.3.5.

2.1.3.3 Robotic Vehicles

Crawlers are fully autonomous, battery-powered amphibious vehicles that are used for functions such as reconnaissance missions in territorial waters. The body of a representative crawler measures 72 centimeters (cm) (28 inches [in]) in length, 62 cm (24 in) in width and are 28 cm (11 in) in height. On average these devices weigh an estimated 41 kilograms [kg] (90 pounds [lbs]) and are used to classify and map underwater mines in the surf zone. The surf zone is the area in which wave activity occurs between the shoreline and the outermost limit of breaking waves, which could span a distance of several hundred feet depending on the location of offshore sandbars. The crawler is capable of traveling 0.61 m (2 ft) per second in the water and can avoid obstacles. The crawlers are equipped with various sonar sensors and communication equipment that enable these devices to locate and classify underwater objects and mines while rejecting miscellaneous clutter that would not pose a threat. Currently, subsurface operations encompass crawler use for 14 hours each year.

2.1.3.4 Unmanned Underwater Vehicles

Typically UUVs are battery-powered; however, some of the larger UUVs are diesel-powered. UUVs are typically propeller-driven and are capable of sustaining speeds of several knots. The body shape and size of UUVs varies in accordance with its launch platform, recovery platform, and overall mission. Historically, the UUVs tested at NSWC PCD have included vehicles of various sizes ranging from 32 cm (1 ft) to 7 m (23 ft) in length with a diameter of 25 cm (10 in) to 122 cm (4 ft) in width. The current and historic operations involving UUVs have been focused on integrating oceanographic and mine-hunting sensors into the UUV payload. Future testing would focus on extending the mission deployment and communication capabilities of these UUVs. UUVs make up 162 hours of subsurface operations each year in territorial waters at NSWC PCD.

2.1.3.5 Mooring and Burying of Mines

NSWC PCD develops, upgrades, and manages new underwater mine systems. In order to meet the specifications and operational requirements associated with developing such systems, testing is required to collect the data and information used to analyze the functionality of the system during various stages of development. In addition, other mine warfare testing conducted at NSWC PCD requires the placement of temporary minefields at varying depths (surf zone to 183 m [600 ft]) within the NSWC PCD Study Area. Temporary minefields placed in support of NSWC PCD testing typically consist of moored MLO/inert mines (i.e., any inert object or casing that resembles the shape of a mine/mines without the explosive component), and/or VEMs (i.e., mine casings containing programmable electronics and sensors used to simulate a mine and collect data). These test fields remain in the water throughout the test cycle. Live mines could be used in future tests that involve mine countermeasures to test the efficiency and survivability of the system. These live mines would be detonated and are included in the analysis under ordnance operations. All test minefields are deployed in accordance with and in cooperation with the United States (U.S.) Coast Guard including a Notice to Mariners (NOTMAR) and other safety measures, as appropriate. Global Positioning System (GPS) coordinates of the deployed MLOs/inert mines are identified and recorded to facilitate expedient recovery of mine targets following the completion of testing. Periodically, target minefield locations are confirmed. All maintenance related to recovered MLOs/inert mines and VEMs is performed back on shore.

These temporary target minefields consist of inert mines, MLOs, and VEMs, which are used to simulate both bottom and moored mine threats. Moored targets are placed at predetermined locations in both territorial and non-territorial waters via a surface vessel or fixed-wing aircraft depending on the type of MLOs/inert mines and VEMs to be used. Most moored mines deployed from surface vessels are secured with up to a 1,225 kg (2,700 lbs) concrete mooring block (approximately 76.2 × 76.2 × 76.2 cm [30 × 30 × 30 in]). Moored mines deployed from fixed-wing aircraft enter the water and impact the bottom, becoming semi-submerged. Upon impact, the mine casing separates and the semi-buoyant mine floats through the water column until it reaches the end of the mooring line. Bottom mines are typically positioned manually in shallow water (surf zone) and are allowed to free sink to the bottom to rest and are covered up with sand by the natural movement of sediments associated with wave action in the surf zone. Divers typically accomplish the placement of bottom mines in deeper waters outside the surf zone. Divers, if required, may bury some mines manually.

The current operations that involve MLOs/inert mines and VEMs within the NSWC PCD Study Area consist of 266 items per year.

2.1.4 Sonar Operations

NSWC PCD sonar operations involve the testing of various sonar systems in the ocean and laboratory environment as a means of demonstrating the system's capability to detect, locate, and characterize MLOs under various environmental conditions. The data collected is used to validate the sonar systems' effectiveness and capability to meet its mission.

As sound travels through water, it creates a series of pressure disturbances. Frequency is the number of complete cycles a sound or pressure wave generates per unit of time (measured in cycles per second, or hertz [Hz]). Generally speaking for acoustics, the Navy has characterized frequency as low, mid, or high:

- **Low frequency** – Below 1 kilohertz (kHz) (low frequency will not be used during any NSWC PCD operations)
- **Mid-frequency** – From 1 kHz to 10 kHz (proposed NSWC PCD operations would use a small number of mid-frequency sound sources)
- **High frequency** – Above 10 kHz (the majority of NSWC PCD operations would use high frequency sound sources)

NSWC PCD RDT&E activities include sonar operations in the mid- and high-frequency ranges. Low frequency sonar is not proposed to be used during NSWC PCD operations. The majority of operating hours for systems encompass high frequencies; less than 10 percent of the test hours involve mid-frequency systems while over 90 percent of all NSWC PCD RDT&E sonar activities encompass high-frequency sonar systems. The various sonar systems proposed to be tested within the NSWC PCD Study Area range in frequencies of 1 kHz to 5,000 kHz. The source levels associated with NSWC PCD sonar systems that require analysis in this EIS/OEIS based on their parameters range from between 186 decibels (dB) at 1 m to 235 dB at 1 m. Additional operating parameters of the sonar systems used at NSWC PCD can be found in Appendix M, Supplemental Information for Underwater Noise Analysis.

The test events differ significantly from major Navy exercises and training. Training involves preparing naval forces for deployments and operations overseas. Testing involves evaluating developing systems that may be used by naval forces overseas in the future or used as part of programs that result in systems used by naval forces when they deploy. Under some circumstances, testing may be integrated into some portion of naval exercise to evaluate and test the systems in settings and scenarios with navy personnel that more closely resemble real world conditions than many limited test and evaluation settings. For example, sonar systems are deployed for short periods of time by NSWC PCD personnel and its customers to evaluate systems while major Navy training involves the use of sonar over long periods of time. Unlike the training environment where the Navy may sometimes deploy multiple sonar systems or may sometimes operate many systems at once from multiple platforms, NSWC PCD RDT&E activities involves only one system and a limited number of acoustic sources activated at once. The sonar systems tested are typically a part of a towed array or part of a UUV sensor package. Arrays are towed in the water column and would not be dragged close to the seafloor. Additionally, sonar subsystems associated with surf zone crawler operations are included.

Current sonar operations at NSWC PCD encompass 499 hours every year. Of those 499 hours each year, 28 hours would employ sonars in the mid-frequency (1 kHz to 10 kHz) range, and 471 hours would use sonars in the high frequency (greater than 10 kHz) range, and 53 hours would employ jammers or mechanical minesweeping devices that operate over a mid- to high frequency range. Alternatives 1 and 2 would provide for increases in sonar operations. Refer to Sections 2.3.2 and 2.3.3 for more specific information on those alternatives.

2.1.5 Electromagnetic Operations

NSWC PCD develops and tests an array of magnetic sensors that generate magnetic fields used in mine countermeasures operations. NSWC PCD demonstrates the capability and effectiveness of deploying such sensors from aircrafts and surface vessels in the territorial and non-territorial waters of the NSWC PCD Study Area. In doing so, multiple sweeps are conducted over specified test areas containing both tethered MLOs and totally buried MLOs/inert mines and VEMs in an effort to demonstrate the systems' effectiveness to influence or trigger magnetic targets. A representative system tested is the Organic Airborne and Surface Influence Sweep (OASIS). The system emits an electromagnetic field (EMF) equivalent to 23 gauss (gauss [G] is a measure of magnetic intensity). NSWC PCD has experimented with deploying magnetic sensors onboard unmanned underwater swimming and crawling vehicles and has conducted tests to evaluate individual sensor capabilities during high-speed operations.

Current EMF use within the NSWC PCD Study Area includes 155 hours of missions every year. Alternatives 1 and 2 would provide for increases in EMF operations. Refer to Sections 2.3.2 and 2.3.3 for more detailed information on those alternatives.

2.1.6 Laser Operations

Laser test operations conducted within the NSWC PCD Study Area take place both below and above the water surface. Systems employed by the Navy include light imaging detection and ranging (LIDAR), laser line scan (LLS), and directional systems. Generally, the LIDAR systems are mounted on a helicopter and emit a narrow, high-frequency laser beam. When the laser light beam hits the water, part of the energy is reflected off the surface and the rest travels through the water column and reflects off targets in the water column or sea floor. The water surface reflects energy from the infrared pulse, while the blue-green pulse penetrates the water column and is reflected off targets in the water column, on the sea floor, or off the sea floor itself. The directional systems are mounted on moving platforms and are identical to the LIDAR systems but are utilized under water. The LIDAR systems that would be tested within the NSWC PCD Study Area are very similar to those LIDAR systems used by the National Oceanic and Atmospheric Administration (NOAA) to map benthic habitats.

The LLS has been developed for use on towed bodies and UUVs. Unlike the LIDAR systems, the LLS systems are employed under water. In its simplest form, the LLS system is a sensor that takes advantage of a laser to concentrate intense light over a small area in order to illuminate distant targets. The LLS system is a commercial off-the-shelf system utilized by agencies such as NOAA to map underwater habitat and bottom contours. However, NSWC PCD is testing the capability of this technology in identifying MLOs.

Current laser operations at NSWC PCD include 244 mission hours every year. Of this time, 104 hours would involve LLS systems, 128 hours would employ LIDAR systems, and 12 hours of operations would involve directional systems. Alternatives 1 and 2 would provide for increases in laser operations for these three types of systems. Refer to Sections 2.3.2 and 2.3.3 for more detailed information on those alternatives.

2.1.6.1 Underwater Mine Identification

In an effort to improve the Navy's capabilities in underwater mine detection, NSWC PCD has been developing and testing laser systems that can be utilized independently or in conjunction with sonar sensor packages attached to a towed body or UUV. NSWC PCD continues to demonstrate the effectiveness of optical imaging systems that employ LLS and Streak Tube Imaging LIDAR (STIL) for the identification of fully exposed, partially buried, and moored mines in shallow and very shallow waters. LIDAR is the part of the Electro-optic Identification (EOID) subsystem that is used to identify bottom mines.

2.1.6.2 Air-to-Water Mine Identification

In addition to the LLS technology, NSWC PCD also pursues LIDAR system technology as a means to meet the Navy's mine warfare requirements for detecting, classifying, and localizing drifting, floating, and near-surface moored threats. This technology is capable of providing three-dimensional (3-D) imagery of objects and has the ability to provide accurate bathymetry (measurement of the depth) of the ocean floor while at a sufficient standoff range. Test operations involving LIDAR technology are normally conducted from an aircraft platform, but vessel-based test operations are also conducted. Systems employing this technology (i.e., Airborne Laser Mine Detection System [ALMDS]) have demonstrated the capability to operate effectively in the shallow water ranges.

2.1.7 Ordnance Operations

NSWC PCD has become the leader in developing naval airborne, surface, organic (readily available units in place), and shallow water MCM systems. In order to truly demonstrate the capability and effectiveness of the MCM systems currently being developed and tested at NSWC PCD, real-life test scenarios involving live explosives are required.

Live testing is only conducted after a system has successfully completed inert testing and an adequate amount of data has been collected to support the decision for live testing. Testing with live targets or ordnance is closely monitored and uses the minimal number of live munitions necessary to meet the testing requirement. Depending on the test scenario, live testing may occur from the surf zone out to the outer perimeter of the NSWC PCD Study Area. The size and weight of the explosives used varies from 0.91 to 272 kg (2 to 600 lbs) trinitrotoluene (TNT) equivalent net explosive weight (NEW) depending on the test requirements. For this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), ordnance was analyzed based on three Ranges of NEW: 0.45 to 4.5 kg (1 to 10 lbs), 5 to 34 kg (11 to 75 lbs), and 34.5 to 272 kg (76 to 600 lbs). Detonation of ordnance with a NEW less than 34 kg (75 lbs) are conducted in territorial waters, and detonations of ordnance with a NEW greater than 34 kg (75 lbs) are conducted in non-territorial waters. In addition, some RDT&E activities may require the use of line charges or projectile firing. Line charge testing will only be conducted in the surf zone along the portion of Santa Rosa Island that is part of Eglin Air Force Base (AFB).

Current ordnance operations at NSWC PCD include only three detonations of charges in the Range 1 (between 0.45 and 4.5 kg [1 and 10 lbs]) each year. The No Action Alternative detailed in Section 2.3.1 would encompass the current level. Alternatives 1 and 2 would provide for increases in the number of ordnance operations in this category as well as for additional detonations to occur in the Range 2 (5 to 34 kg [11 to 75 lbs]) and/or Range 3 (34.5 to 272 kg [76 to 600 lbs]). Refer to Sections 2.3.2 and 2.3.3 for more specific information on those alternatives.

2.1.7.1 Line Charges

The Navy must develop a capability to safely clear surf zone areas for sea-based expeditionary operations. To that end, NSWC PCD occasionally performs testing on various surf zone clearing systems that use either line charges or explosive arrays to neutralize mine threats. These tests are typically conducted from a surface vessel (e.g., LCAC) and are deployed using either a single or dual rocket launch scenario. This is a systems development test and only assesses the in-water components of testing. Line charges consist of a 107-m (350-ft) detonation cord with explosives lined from one end to the other end in a series of 2-kg (5-lb) increments. Currently, NSWC PCD only conducts one test of a line charge with a NEW of 1,750 lbs per year in territorial waters. The No Action Alternative detailed in Section 2.3.1 would include this event. Alternatives 1 and 2 would provide for increases in the number and size of line charges. Refer to Sections 2.3.2 and 2.3.3 for specific information on those alternatives.

2.1.8 Projectile Firing

Current projectile firing includes 50 rounds of 30 millimeter (mm) ammunition each year within the NSWC PCD Study Area. The No Action Alternative detailed in Section 2.3.1 would encompass these rounds. The capability of utilizing gunfire during test operations was identified as a future requirement. Rounds (individual shots) identified include 5 inch, 20 mm, 25 mm, 30 mm, 40 mm, 76 mm, and various small arms ammunition (i.e., standard target ammo). Projectiles associated with these rounds are mainly armor-piercing projectiles. The 5-in round is a high explosive (HE) projectile containing approximately 3.63 kg (8 lbs) of explosive material. Alternatives 1 and 2 would provide for increases in the number of 30-mm rounds as well as for expansion of projectile firing operations to 5 in, 20 mm, 40 mm, 76 mm, 25 mm, and small arms ammunition. All projectile firing will occur over non-territorial waters. Refer to Sections 2.3.2 and 2.3.3 for detailed information on those alternatives.

2.2 DEVELOPMENT OF ALTERNATIVES

To quantify 10 years of historical and current NSWC PCD RDT&E activities (i.e., the baseline), NSWC PCD undertook a data collection effort using surveys and test plans. In an effort to accurately project future RDT&E activities, NSWC PCD conducted an interactive data call via electronic, telephone, and personal interviews. The interactive data call projected an estimate of the mission capability and activity levels that would be required over the next five years.

After all of the information was received and validated, it was used to identify and quantify the eight NSWC PCD baseline mission operations addressed in Section 2.1. The eight baseline mission operations include air operations, surface operations, subsurface operations, sonar operations, electromagnetic operations, laser operations, ordnance operations, and projectile firing. The data collected for each of these RDT&E activities did not necessarily depict the level of activity intensity on a per-year basis. Therefore, to determine each operation's expected yearly level of activity, the total hours associated with an individual RDT&E capability were added to reach a five-year total for that activity. The totals were then divided by five to annualize the overall baseline tempos for each of the eight mission operations.

The development of action alternatives for the NSWC PCD EIS/OEIS focused on accommodating baseline activities, as well as future growth requirements for missions and activity levels identified during the data collection effort. The development process incorporated the needs to support future test capabilities identified during data collection, expand required mission capabilities, and increase the baseline tempo and intensity of activities. Sections 2.3.1, 2.3.2, and 2.3.3 describe the alternatives developed for this EIS/OEIS. Alternatives analyzing other locations, other than the NSWC PCD Study Area, were not considered since they would not meet the purpose and need of the Proposed Action to improve capabilities at NSWC PCD.

Testing occurs at NSWC PCD year-round based on program requirements as relevant to all of the alternatives discussed in the following sections. The siting of tests for each of the RDT&E activities addressed in this EIS/OEIS cannot be determined based on a particular season or location. NSWC PCD and its customers test various systems within each of the eight activity categories; tests among and even within each of the categories require different environments based on the mission objectives and system performance. Planning for tests encompassed by this EIS/OEIS requires flexibility and consideration for both mission requirements and any relevant, identified mitigation and protective measures. Therefore, this EIS/OEIS analyzes the missions in each RDT&E activity category for all four seasons and across the entire NSWC PCD Study Area with the following location-related exceptions:

1) crawler operations only take place in territorial waters because they only operate in shallow waters;
2) ordnance testing has been divided into two areas to minimize effects from large detonations (NSWC PCD will conduct detonations of 75 lb (34 kg) or less in territorial waters while all detonations over 76 lb (34 kg) will occur in non-territorial waters.) Larger detonations are in deeper water to minimize effects to the bottom;
3) line charge tests occur in territorial waters only because they are used in the surf zone; and
4) projectile firing only occurs in non-territorial waters.

2.3 DESCRIPTION OF ALTERNATIVES

2.3.1 No Action Alternative

The ***No Action Alternative*** addresses historical and current mission activities (referred to cumulatively as "baseline mission activities") for the NSWC PCD Study Area. NSWC PCD anticipates the No Action Alternative would not completely support the future mission requirements and activity levels identified during the data collection. The No Action Alternative, therefore, would not fully meet the need of the Proposed Action.

To address both NEPA and EO 12114 requirements, Table 2-1 presents the actual baseline tempo of activities as they would occur with the No Action Alternative in territorial or non-territorial waters. Each of the eight operations is listed on the far left column of the table, where the associated units are also given. The specific systems and/or their characteristics that fall within a given operation are provided on the same row as the operation and divided under the two headings (territorial or non-territorial waters). The number of hours or items associated with each system or characteristic is provided in the cell directly below the cell that names the equipment or system characteristics. The total number of items or hours per year for each category is given in the far right column. These total numbers will be spread across multiple locations throughout the NSWC PCD Study Area and will occur throughout the year at various times and frequencies based on mission requirements. Therefore, NSWC PCD will not expend all total materials or conduct all total hours of operations in one concentrated area at one particular time of the year.

2.3.2 Alternative 1

Alternative 1 addresses baseline mission activities, as well as identified (known) future NSWC PCD RDT&E activities projected to occur at an increasing tempo over the next five years based on the data collection effort. Alternative 1 will maximize NSWC PCD's future operational capability. Specifically, Alternative 1 enhances current capabilities to meet future needs by incorporating new test capabilities as well as projected increases to the baseline tempo and intensity of RDT&E activities. Alternative 1 meets the purpose and need of the Proposed Action as this alternative provides NSWC PCD the ability to maximize operational capability for known activities over the next five years. However, Alternative 1 does not enhance NSWC PCD's RDT&E capacity because it does not include the anticipated increase in the overall tempo of RDT&E activities over the next five years.

Table 2-1. No Action Alternative in Territorial and Non-Territorial Waters

	NEPA (Territorial Waters)							*EO 12114 (Non-Territorial Waters)*							*Total*
AIR OPS (hrs/yr)	**Helicopters**			**Fixed Wing**				**Helicopters**			**Fixed Wing**				**Hrs/yr**
	239			0				103			2				344
SURFACE OPS (hrs/yr)	**Boats**			**LCAC**				**Boats**			**LCAC**				**Hrs/yr**
	1,709			54				570			18				2,351
SUBSURFACE OPS (items/yr) (hrs/yr)	**MLOs**			**VEMs**				**MLOs**			**VEMs**				**Items/yr**
	180			6				77			3				266
	Crawlers			**UUVs**				**Crawlers**			**UUVs**				**Hrs/yr**
	14			162				0			0				176
SONAR OPS (hrs/yr)	**Mid-frequency (1-10 kHz)**			**High Frequency (>10 kHz)**				**Mid- frequency (1-10 kHz)**			**High Frequency (>10 kHz)**				**Hrs/yr**
	26			385				2			86				499
EM OPS (hrs/yr)	**Electromagnetic Energy**							**Electromagnetic Energy**							**Hrs/yr**
	108							47							155
LASER OPS (hrs/yr)	**Laser Line Scan**		**LIDAR**			**Directional**		**Laser Line Scan**		**LIDAR**			**Directional**		**Hrs/yr**
	49		61			12		55		67			0		244
ORDNANCE OPS (dets/yr) (lines/yr)	**Detonations**							**Detonations**							**Items/yr**
	Range 1 (1–10 lbs) (0.45 to 4.5 kg) (dets/yr)		**Range 2 (11–75 lbs) (5 to 34 kg) (dets/yr)**			**Range 3 (76–600 lbs) (34 to 272 kg) (dets/yr)**		**Range 1 (1–10 lbs) (0.45 to 4.5 kg) (dets/yr)**		**Range 2 (11–75 lbs) (4 to 34 kg) (dets/yr)**			**Range 3 (76–600 lbs) (34 to 272 kg) (dets/yr)**		**Items/yr**
	3		0			0		0		0			0		3
	Line charges*							**Line charges***							**Items/yr**
	1							0							1
Projectile Firing (rnds/yr)	**5 in**	**40mm**	**30mm**	**20mm**	**76mm**	**25mm**	**Small Arms**	**5 in**	**40mm**	**30mm**	**20mm**	**76mm**	**25mm**	**Small Arms**	**Items/yr**
	0	0	0	0	0	0	0	0	0	50	0	0	0	0	50

dets = detonations; hrs = hours; lbs = pounds; rnds = rounds; ops = operations; yr = year; LIDAR = Light Imaging Detection and Ranging; EM - electromagnetic
An additional 53 hours (51 territorial hrs/2 non-territorial hrs) reflect jamming and mechanical sound sources occurring over broad frequency ranges (specific frequencies for these systems are classified); * Line charges = 1,750 lbs NEW, which is evenly distributed along a 107-m (350-ft) detonation cord

The tempos and operational ranges associated with Alternative 1 are provided in Table 2-2. The total hours associated with the operational capabilities for Alternative 1 have been distributed between territorial and non-territorial waters based on information received from NSWC PCD's Test Engineering Branch. The use of sonar and ordnance during proposed RDT&E activities have the most potential to affect marine animals. Under Alternative 1 circumstances, NSWC PCD sought authorization via a Letter of Authorization (LOA) with the National Marine Fisheries Service (NMFS) for the potential exposures of marine mammals protected under the Marine Mammal Protection Act (MMPA) that discussed the conclusions of the analyses and the associated mitigation measures and protective measures. NSWC PCD also consulted with NMFS on all actions that "may affect" listed species protected by the Endangered Species Act (ESA). The results of the LOA and Biological Evaluation (BE) consultations are addressed in this Final EIS/OEIS.

2.3.3 Alternative 2

Alternative 2 addresses baseline mission activities (as identified with the No Action Alternative), as well as identified (known) future NSWC PCD RDT&E activities projected to occur at an increasing tempo over the next five years (as identified with Alternative 1) in order to maximize NSWC PCD operational capability and to accommodate future RDT&E activities. A theoretical threefold increase is generally used since it is estimated that RDT&E activity levels above a threefold (i.e., 200 percent) increase may not be accommodated at NSWC PCD without associated increases in equipment, infrastructure and test personnel for required RDT&E test support. Alternative 2 fully meets the purpose and need of the Proposed Action as this Alternative provides NSWC PCD the ability to maximize operational capability for known activities over the next five years, as well as enhance their RDT&E capacity by anticipating an increase in the overall tempo of RDT&E activities over the next five years.

The tempos and operational ranges associated with Alternative 2 are provided in Table 2-3. Similar to the other two alternatives, the total hours associated with the operational capabilities for Alternative 2 have been distributed between territorial and non-territorial waters based on information received from NSWC PCD's Test Engineering Branch. To enhance NSWC PCD's RDT&E capacity, results of the environmental analyses associated with the NSWC PCD EIS/OEIS development were used to define the maximum increase levels for each of the identified RDT&E operational capabilities for Alternative 2. Refer to Chapter 4, Environmental Consequences, for additional information.

The environmental analyses conducted in Chapter 4, Environmental Consequences, demonstrate that increasing sonar and ordnance operations has the greatest potential to affect the environment. Thus, sonar and ordnance operations, as well as required RDT&E test support, are the factors involved in determining the maximum allowable increase in RDT&E capacity at NSWC PCD. Further, under Alternative 2, NSWC PCD applied for an LOA with NMFS for potential exposures of MMPA protected species and also consulted with NMFS on all actions that "may affect" listed species protected by the ESA.

Table 2-2. Alternative 1: Baseline Activities Plus Future Requirements in Territorial and Non-Territorial Waters

<table>
<tr><th></th><th colspan="7">NEPA (Territorial Waters)</th><th colspan="7">EO 12114 (Non-Territorial Waters)</th><th>Total</th></tr>
<tr><td rowspan="2">AIR OPS (hrs/yr)</td><td colspan="4">Helicopters</td><td colspan="3">Fixed Wing</td><td colspan="4">Helicopters</td><td colspan="3">Fixed Wing</td><td>Hrs/yr</td></tr>
<tr><td colspan="4">257</td><td colspan="3">1</td><td colspan="4">110</td><td colspan="3">4</td><td>372</td></tr>
<tr><td rowspan="2">SURFACE OPS (hrs/yr)</td><td colspan="4">Boats</td><td colspan="3">LCAC</td><td colspan="4">Boats</td><td colspan="3">LCAC</td><td>Hrs/yr</td></tr>
<tr><td colspan="4">1,806</td><td colspan="3">55</td><td colspan="4">602</td><td colspan="3">18</td><td>2,481</td></tr>
<tr><td rowspan="4">SUBSURFACE OPS (items/yr) (hrs/yr)</td><td colspan="4">MLOs</td><td colspan="3">VEMs</td><td colspan="4">MLOs</td><td colspan="3">VEMs</td><td>Items/yr</td></tr>
<tr><td colspan="4">186</td><td colspan="3">39</td><td colspan="4">80</td><td colspan="3">17</td><td>322</td></tr>
<tr><td colspan="4">Crawlers</td><td colspan="3">UUVs</td><td colspan="4">Crawlers</td><td colspan="3">UUVs</td><td>Hrs/yr</td></tr>
<tr><td colspan="4">38</td><td colspan="3">502</td><td colspan="4">0</td><td colspan="3">0</td><td>540</td></tr>
<tr><td rowspan="2">SONAR OPS (hrs/yr)</td><td colspan="4">Mid- frequency (1-10 kHz)</td><td colspan="3">High Frequency (>10 kHz)</td><td colspan="4">Mid-frequency (1-10 kHz)</td><td colspan="3">High Frequency (>10 kHz)</td><td>Hrs/yr</td></tr>
<tr><td colspan="4">64</td><td colspan="3">713</td><td colspan="4">3</td><td colspan="3">146</td><td>926</td></tr>
<tr><td rowspan="2">EM OPS (hrs/yr)</td><td colspan="7">Electromagnetic Energy</td><td colspan="7">Electromagnetic Energy</td><td>Hrs/yr</td></tr>
<tr><td colspan="7">171</td><td colspan="7">74</td><td>245</td></tr>
<tr><td rowspan="2">LASER OPS (hrs/yr)</td><td colspan="2">Laser Line Scan</td><td colspan="2">LIDAR</td><td colspan="3">Directional</td><td colspan="2">Laser Line Scan</td><td colspan="2">LIDAR</td><td colspan="3">Directional</td><td>Hrs/yr</td></tr>
<tr><td colspan="2">70</td><td colspan="2">88</td><td colspan="3">18</td><td colspan="2">79</td><td colspan="2">96</td><td colspan="3">0</td><td>351</td></tr>
<tr><td rowspan="6">ORDNANCE OPS (dets/yr) (lines/yr)</td><td colspan="7">Detonations</td><td colspan="7">Detonations</td><td>Items/yr</td></tr>
<tr><td colspan="2">Range 1 (1–10 lbs) (0.45 to 4.5 kg) (dets/yr)</td><td colspan="2">Range 2 (11–75 lbs) (5 to 34 kg) (dets/yr)</td><td colspan="3">Range 3 (76–600 lbs) (34 to 272 kg) (dets/yr)</td><td colspan="2">Range 1 (1–10 lbs) (0.45 to 4.5 kg) (dets/yr)</td><td colspan="2">Range 2 (11–75 lbs) (5 to 34 kg) (dets/yr)</td><td colspan="3">Range 3 (76–600 lbs) (34 to 272 kg) (dets/yr)</td><td>Items/yr</td></tr>
<tr><td colspan="2">17</td><td colspan="2">1</td><td colspan="3">0</td><td colspan="2">0</td><td colspan="2">0</td><td colspan="3">4</td><td>22</td></tr>
<tr><td colspan="7">Line charges*</td><td colspan="7">Line charges*</td><td>Items/yr</td></tr>
<tr><td colspan="7">2</td><td colspan="7">0</td><td>2</td></tr>
<tr><td rowspan="2">Projectile Firing (rnds/yr)</td><td>5 in</td><td>40mm</td><td>30mm</td><td>20mm</td><td>76mm</td><td>25mm</td><td>Small Arms</td><td>5 in</td><td>40mm</td><td>30mm</td><td>20mm</td><td>76mm</td><td>25mm</td><td>Small Arms</td><td>Items/yr</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20</td><td>160</td><td>200</td><td>989</td><td>80</td><td>175</td><td>2,000</td><td>3,624</td></tr>
</table>

dets = detonations; hrs = hours; lbs = pounds; rnds = rounds; ops = operations; yr = year; LIDAR = Light Imaging Detection and Ranging; EM - electromagnetic
An additional 130 hours (126 territorial hrs/4 non-territorial hrs) reflect jamming and mechanical minesweeping devices occurring over broad frequency ranges (specific frequencies for these systems are classified)
* Line charges = 1,750 lbs NEW, which is evenly distributed along a 107-m (350-ft) detonation cord

In summary, Alternative 2 is similar to Alternative 1 in that it increases NSWC PCD's capacity to meet identified (known) NSWC PCD future activities and satisfies the purpose and need. In addition, Alternative 2 increases the capacity and use of the NSWC PCD Study Area by DoD entities to the fullest optimal level without impact to operations caused by infrastructure restrictions. NSWC PCD has estimated that activity levels above those listed in Table 2-3 may not be accommodated at NSWC PCD without associated increases in equipment, infrastructure, and test personnel for required RDT&E test support.

2.3.4 Preferred Alternative

The Preferred Alternative is ***Alternative 2***. This alternative allows for the maximization of NSWC PCD operational capability to meet expanding projected increases in RDT&E requirements and provides NSWC PCD mission support to NAVSEA users and the greater Navy and DoD community.

Table 2-4 provides an overall summary of the total tempos associated with each alternative and can be used to compare the hours and/or numbers of operations that would occur with the No Action Alternative, Alternative 1, and Alternative 2. The eight operational areas are provided in the far-left column with subcategories below those areas. For each alternative, the ranges for the operations are given in the column, where appropriate. For example, sonar operations are divided into mid-frequency and high-frequency ranges. The values to the left of the double vertical line contain the amount of operations for each subcategory conducted in the territorial waters of the NSWC PCD Study Area. The values to the right of this demarcation, except those contained in the last column of each table, indicate the hours and/or numbers of operations that would occur in the non-territorial waters. The last column provides the total number of hours and/or numbers of operations in the NSWC PCD Study Area (or tempo in the territorial waters plus tempo in the non-territorial waters).

2.3.5 Conclusions for Environmental Consequences Associated with Each Alternative

Table 2-4 summarizes the potential effects associated with the NSWC PCD RDT&E activities. Where analysis included information that could be quantified, the calculated values are provided. In the absence of quantitative data, qualitative information is included in the table. Surface, subsurface, air, laser, and electromagnetic operations would result in no effects to any of the areas addressed including physical, biological, and anthropogenic resources. Where thresholds exist for these areas, the applicable criteria would not be exceeded. The use of sonar and ordnance within the NSWC PCD Study Area would result in limited effects. They would primarily include effects associated with marine mammals, sea turtles, and fish. Refer to Chapter 4 for the complete analysis of potential effects by resource area.

Table 2-3. Alternative 2: Alternative 1 Plus up to a Threefold Increase in Territorial and Non-Territorial Waters

	NEPA (Territorial Waters)							*EO 12114 (Non-Territorial Waters)*							*Total*
AIR OPS (hrs/yr)	**Helicopters**				**Fixed Wing**			**Helicopters**				**Fixed Wing**			**Hrs/yr**
	771				3			330				12			1,116
SURFACE OPS (hrs/yr)	**Boats**				**LCAC**			**Boats**				**LCAC**			**Hrs/yr**
	5,418				164			1,806				55			7,443
SUBSURFACE OPS (items/yr) (hrs/yr)	**MLOs**				**VEMs**			**MLOs**				**VEMs**			**Items/yr**
	559				118			239				50			966
	Crawlers				**UUVs**			**Crawlers**				**UUVs**			**Hrs/yr**
	114				1,506			0				0			1,620
SONAR OPS (hrs/yr)	**Mid-frequency (1-10 kHz)**				**High Frequency (>10 kHz)**			**Mid-frequency (1-10 kHz)**				**High Frequency (>10 kHz)**			**Hrs/yr**
	73				822			4				181			1,080
EM OPS (hrs/yr)	**Electromagnetic Energy**							**Electromagnetic Energy**							**Hrs/yr**
	514							221							735
LASER OPS (hrs/yr)	**Laser Line Scan**		**LIDAR**			**Directional**		**Laser Line Scan**		**LIDAR**			**Directional**		**Hrs/yr**
	211		263			53		237		289			0		1,053
ORDNANCE OPS (dets/yr) (lines/yr)	**Detonations**							**Detonations**							**Items/yr**
	Range 1 (1–10 lbs) (0.45 to 4.5 kg) (dets/yr)		**Range 2 (11-75 lbs) (5 to 34 kg) (dets/yr)**			**Range 3 (76-600 lbs) (34 to 272 kg) (dets/yr)**		**Range 1 (1-10 lbs) (0.45 to 4.5 kg) (dets/yr)**		**Range 2 (11-75 lbs) (5 to 34 kg) (dets/yr)**			**Range 3 (76-600 lbs) (34 to 272 kg) (dets/yr)**		**Items/yr**
	51		3			0		0		0			16		70
	Line charges*							**Line charges***							**Items/yr**
	3							0							3
Projectile Firing (rnds/yr)	**5 in**	**40mm**	**30mm**	**20mm**	**76mm**	**25mm**	**Small Arms**	**5 in**	**40mm**	**30mm**	**20mm**	**76mm**	**25mm**	**Small Arms**	**Items/yr**
	0	0	0	0	0	0	0	60	480	600	2,967	240	525	6,000	10,872

dets = detonations; hrs = hours; lbs = pounds; rnds = rounds; ops = operations; yr = year; LIDAR = Light Imaging Detection and Ranging; EM - electromagnetic

An additional 150 hours (144 territorial hrs/6 non-territorial hrs) reflect jamming and mechanical minesweeping devices occurring over broad frequency ranges (specific frequencies for these systems are classified);

* Line charges = 1,750 lbs NEW, which is evenly distributed along a 107-m (350-ft) detonation cord

Table 2-4. Effect Summary Chart

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Physical Resources	**Geology and Sediments**						
	Ordnance Operations (Sediment Area Affected)	**No Significant Impact**	**No Significant Impact**	**No Significant Impact**	**No Detonations in Non-Territorial Waters**	0 m^2 (0 ft^2); **No Significant Harm**	0 m^2 (0 ft^2); **No Significant Harm**
	Subsurface Operations (Sediment Area Affected Annually)	Crawler – 0.19 km^2 (0.073 mi^2); Mines – 108 m^2 (1,162.5 ft^2); **No Significant Impact**	Crawler – 0.52 km^2 (0.20 mi^2); Mines – 130.5 m^2 (1,404.69 ft^2); **No Significant Impact**	Crawler – 1.5 km^2 (0.58 mi^2); Mines – 392.66 m^2 (4,226.56 ft^2); **No Significant Impact**	Mines - 46.4 m^2 (499.4 ft^2); **No Significant Harm**	Mines – 56.3 m^2 (606.01 ft^2); **No Significant Harm**	Mines – 167.62 m^2 (1804.2 ft^2); **No Significant Harm**
	Air Quality						
	Air Operations and Surface Operations Combined (Pollutant Emissions)	Emission levels not exceeded; **No Significant Impact**	Emission levels not exceeded; **No Significant Impact**	Emission levels not exceeded; **No Significant Impact**	Emission levels not exceeded; **No Significant Harm**	Emission levels not exceeded; **No Significant Harm**	Emission levels not exceeded; **No Significant Harm**
	In-Air Sound						
	Air and Surface Operations Combined (dBA Noise Levels)	Below ambient noise; **No Significant Impact**	Below ambient noise; **No Significant Impact**	Below ambient noise; **No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Water Quality						
	Ordnance Operations (Explosion Products, Metal Leaching, Turbidity)	Levels not exceeded; **No Significant Impact**	Levels not exceeded; **No Significant Impact**	Levels not exceeded; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	**No Significant Harm**	**No Significant Harm**
Biological Resources	**Marine Habitats**						
	Surface Operations (Grounding/Turbidity)	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Subsurface Operations (Sediment Area Affected)	**No Significant Impact**	**No Significant Impact**	**No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Ordnance Operations (Habitat Destruction)	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	Protective measures implemented; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Detonations in water column/ Protective measures implemented; **No Significant Harm**	Detonations in water column/ Protective measures implemented; **No Significant Harm**
	Invertebrates						
	Sonar Operations (Underwater Noise)	**No Significant Impact**	**No Significant Impact**	**No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Ordnance Operations	Local effects insignificant to population; **No Significant Impact**	Local effects insignificant to population; **No Significant Impact**	Local effects insignificant to population; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Local effects insignificant to population; **No Significant Harm**	Local effects insignificant to population; **No Significant Harm**
	Laser Operations (Laser Exposure)	Rapid absorption/ scattering; **No Significant Impact**	Rapid absorption/ scattering; **No Significant Impact**	Rapid absorption/ scattering; **No Significant Impact**	Rapid absorption/ scattering; **No Significant Harm**	Rapid absorption/ scattering; **No Significant Harm**	Rapid absorption/ scattering; **No Significant Harm**

Table 2-4. Effect Summary Chart (Cont'd)

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Biological Resources, Cont'd	**Fish**						
	Air Operations (Noise)	Frequency above sensitivity; **No Significant Impact/No Effect**	Frequency above sensitivity; **No Significant Impact/No Effect**	Frequency above sensitivity; **No Significant Impact/No Effect**	Frequency above sensitivity; **No Significant Harm/No Effect**	Frequency above sensitivity; **No Significant Harm/No Effect**	Frequency above sensitivity; **No Significant Harm/No Effect**
	Sonar Operations (Underwater Noise)	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**
	Electromagnetic Operations (EMF Exposure)	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/small area; **No Significant Impact/No Effect**	Low strength/small area; **No Significant Harm/No Effect**	Low strength/small area; **No Significant Harm/No Effect**	Low strength/small area; **No Significant Harm/No Effect**
	Laser Operations (Laser Exposure)	Rapid absorption/ scattering; **No Significant Impact/No Effect**	Rapid absorption/ scattering; **No Significant Impact/No Effect**	Rapid absorption/ scattering; **No Significant Impact/No Effect**	Rapid absorption/ scattering; **No Significant Harm/No Effect**	Rapid absorption/ scattering; **No Significant Harm/No Effect**	Rapid absorption/ scattering; **No Significant Harm/No Effect**
	Ordnance Operations (Shock Wave)	Effects insignificant to population; **No Significant Impact/May Affect**	Effects insignificant to population; **No Significant Impact/May Affect**	Effects insignificant to population; **No Significant Impact/May Affect**	**No Detonations in Non-Territorial Waters**	Effects insignificant to population; **No Significant Harm/No Effect**	Effects insignificant to population; **No Significant Harm/No Effect**
	Essential Fish Habitat						
	Subsurface and Ordnance Operations Combined (Habitat Disturbance)	Relative habitat area affected negligible; **No Adverse Impact**	Relative habitat area affected negligible; **No Adverse Impact**	Relative habitat area affected negligible; **No Adverse Impact**	Relative habitat area affected negligible; **No Adverse Harm**	Relative habitat area affected negligible; **No Adverse Harm**	Relative habitat area affected negligible; **No Adverse Harm**
	Birds						
	Air Operations (Noise)	Frequency above maximum sensitivity; **No Significant Impact**	Frequency above maximum sensitivity; **No Significant Impact**	Frequency above maximum sensitivity; **No Significant Impact**	Frequency above maximum sensitivity; **No Significant Harm**	Frequency above maximum sensitivity; **No Significant Harm**	Frequency above maximum sensitivity; **No Significant Harm**
	Sonar Operations (Underwater Noise)	Underwater exposure unlikely **No Significant Impact**	Underwater exposure unlikely **No Significant Impact**	Underwater exposure unlikely **No Significant Impact**	Underwater exposure unlikely **No Significant Harm**	Underwater exposure unlikely **No Significant Harm**	Underwater exposure unlikely **No Significant Harm**
	Ordnance Operations	Underwater exposure unlikely; **No Significant Impact**	Underwater exposure unlikely; **No Significant Impact**	Underwater exposure unlikely; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Underwater exposure unlikely; **No Significant Harm**	Underwater exposure unlikely; **No Significant Harm**
	Marine Mammals						
	Air Operations (Noise)	Dive Characteristics/ Exposure Unlikely; **No Significant Impact/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Impact/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Impact/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Harm/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Harm/No Effect**	Dive Characteristics/ Exposure Unlikely; **No Significant Harm/No Effect**
	Surface Operations (Vessel Collisions)	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**

Table 2-4. Effect Summary Chart (Cont'd)

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Biological Resources, Cont'd	*Sonar Operations (Exposures-Marine Mammals)*	Level B Harassment/ MMPA Authorization Required; **No Significant Impact/No Effect**	Level B Harassment/ MMPA Authorization Required; **No Significant Impact/No Effect**	Level B Harassment/MMPA Authorization Required; **No Significant Impact/No Effect**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant Harm/May Affect**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant Harm/May Affect**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant Harm/May Affect**
	Electromagnetic Operations (EMF Exposure)	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**
	Laser Operations (Laser Exposure)	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**
	Ordnance Operations (# of Exposures)	No Exposures; **No Significant Impact/No Effect**	Level B Harassment/ MMPA Authorization Required; **No Significant Impact/No Effect**	Level B Harassment/MMPA Authorization Required; **No Significant Impact/No Effect**	**No Detonations in Non-Territorial Waters**	Level B Harassment/MMPA Authorization Required; **No Significant Harm/No Effect**	Level B Harassment/MMPA Authorization & ESA Consultation Required; **No Significant Harm/May Affect**
	Projectile Firing	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Non-Territorial Waters**	No Exposures/ Protective Measures; **No Significant Harm/No Effect**	Level B Harassment/MMPA Authorization Required; **No Significant Harm/No Effect**
	Sea Turtles						
	Surface Operations (Vessel Collisions)	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Impact/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Affect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**	Vessel Ops/ Protective Measures; **No Significant Harm/No Effect**
	Sonar Operations (Underwater Noise)	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Impact/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**	Frequency above maximum sensitivity; **No Significant Harm/No Effect**
	Electromagnetic Operations (EMF Exposure)	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Impact/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**	Low strength/ small area; **No Significant Harm/No Effect**
	Laser Operations (Laser Exposure)	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Impact/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**	Eye exposure unlikely; **No Significant Harm/No Effect**
	Ordnance Operations (# of Takes)	No Exposures; **No Significant Impact/No Effect**	No Exposures; **No Significant Impact/No Effect**	TTS Exposures/ESA Consultation Required; **No Significant Impact/May Affect**	**No Detonations in Non-Territorial Waters**	TTS Exposures/ESA Consultation Required; **No Significant Harm /May Affect**	TTS Exposures/ESA Consultation Required; **No Significant Harm/May Affect**
	Projectile Firing	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Territorial Waters**	**No Firing in Non-Territorial Waters**	No Exposures/ Protective Measures; **No Significant Harm/No Effect**	No Exposures/ Protective Measures; **No Significant Harm/No Effect**

Table 2-4. Effect Summary Chart (Cont'd)

		Territorial Waters			Non-Territorial Waters		
		No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Anthropogenic Resources	**Airspace Management**						
	Air Operations (# Flight Hours)	239 hrs; **No Significant Impact**	258 hrs; **No Significant Impact**	774 hrs; **No Significant Impact**	105 hrs; **No Significant Harm**	114 hrs; **No Significant Harm**	342 hrs; **No Significant Harm**
	Artificial Reefs						
	Subsurface Operations (Physical Strikes)	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Harm**	Reefs avoided; **No Significant Harm**	Reefs avoided; **No Significant Harm**
	Ordnance Operations (Shock Wave, Silting)	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	Reefs avoided; **No Significant Impact**	**No Detonations in Non-Territorial Waters**	Reefs avoided; **No Significant Harm**	Reefs avoided; **No Significant Harm**
	Environmental Justice & Risks to Children						
	All Operations Combined (Disadvantaged Groups Affected)	No disproportionate effects/no risks; **No Significant Impact**	No disproportionate effects/no risks; **No Significant Impact**	No disproportionate effects/no risks; **No Significant Impact**	**No Significant Harm**	**No Significant Harm**	**No Significant Harm**
	Cultural/Historical Resources						
	All Operations Combined	Resources avoided; **No Significant Impact**	Resources avoided; **No Significant Impact**	Resources avoided; **No Significant Impact**	Resources avoided; **No Significant Harm**	Resources avoided; **No Significant Harm**	Resources avoided; **No Significant Harm**

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER ANALYSIS

The requirements discussed in Section 2.2 were used to develop alternatives, which were based on a rigorous data collection effort. The alternatives discussed in subsequent sections were considered but were not reasonable because they could not meet the purpose and need of the Proposed Action identified in Section 1.3. Furthermore, these alternatives could not meet specific NSWC PCD requirements to accommodate baseline levels and future growth requirements.

2.4.1 Conduct No Active Sonar Activities

Development of littoral and expeditionary maneuver warfare requirements at NSWC PCD relies on RDT&E and in-service engineering of sonar systems. The testing of sonar systems is essential. Conducting NSWC PCD RDT&E activities in the Gulf of Mexico without the use of active sonar would not allow the Navy to be able to meet its obligations. In accordance with Department of Defense (DoD) Directive 5000.1, test and evaluation support is to be integrated throughout the defense acquisition process as previously described in Section 1.1. Without the use of active sonar, NSWC PCD and its customers would not be able to validate the technical performance parameters and would not be able to determine whether systems are operationally effective, suitable, survivable, and safe for their intended use. Eliminating the use of active sonar fails to meet the purpose and need of the Proposed Action. Therefore, this alternative was eliminated from further study and analysis

2.4.2 Use Other Operating Areas

As detailed in Section 1.3, NSWC PCD provides the greatest number of favorable environmental circumstances optimal to conduct NSWC PCD RDT&E mine countermeasures activities. NSWC PCD also has the established support and infrastructure to meet the Purpose and Need of the

Proposed Action and to facilitate the conduct of all RDT&E operations. Because of the favorable environmental conditions and the established personnel and infrastructure, as well as the low level of crowding, development, and ship traffic, this alternative was eliminated form further study or analysis.

2.4.3 Conduct All Active Sonar Activities through Simulation

Simulation assists in developing software for sonar systems. However, computer modeling simulations cannot adequately mimic the bathymetry, sound propagation properties, or oceanography to the degree necessary to serve as a substitute for actual at-sea sonar testing. Furthermore, simulations are inadequate for NSWC PCD RDT&E activities in the development of sonar systems because they cannot provide the dynamic and challenging scenarios that are encountered in the ocean environment. Therefore, conducting all activities through simulation does not meet the Purpose and Need of the Proposed Action and this alternative was eliminated from further study and analysis.

2.4.4 Conduct No RDT&E Activities

Not engaging in any RDT&E activities does not meet the purpose and need of the Proposed Action, and fails to comply with DoD Directive 5000.1. NSWC PCD's mission is to provide RDT&E, as well as in service support for expeditionary maneuver warfare, diving, maritime special operations, mine warfare (mines and MCM), and other naval missions that take place in the coastal region. Therefore, this alternative was eliminated from further analysis.

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3. AFFECTED ENVIRONMENT

3.1 INTRODUCTION

The proposed Naval Surface Warfare Center Panama City Division (NSWC PCD) Study Area for activities that would be conducted under this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) encompasses the waters and their associated substrates (bottom-lying materials) in the Gulf of Mexico (GOM) that fall within the boundaries of the NSWC PCD Study Area, which includes St. Andrew Bay (SAB), and military warning areas W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), and W-470 (Figure 3-1 and Figure 3-2). The GOM is almost entirely surrounded by the United States, Mexico, and Cuba. The GOM's near enclosure categorizes it as a restricted oceanic basin. In the southeastern portion of the GOM, the Yucatan and the Florida Straits connect the GOM with the Caribbean and western Atlantic Ocean, respectively (Dames and Moore, 1979).

This chapter will describe the GOM's natural and anthropogenic (man-made) environment that has the potential to be affected by NSWC PCD research, development, test, and evaluation (RDT&E) activities detailed in Chapter 2. Four environmental resource areas are addressed: physical, biological, anthropogenic, and coastal zone resources. Discussion of the physical resources includes geology and sediments, air quality, in-air sound, water quality, and underwater sound. Biological resource areas that are addressed include marine habitats, plankton, invertebrates, fish, essential fish habitat (EFH), birds, marine mammals, and sea turtles. The anthropogenic resource areas include socioeconomics, airspace management, artificial reefs, cultural and historical resources, and environmental justice and risks to children.

Within each section, resources are further separated into GOM and nearshore coastal waters and the SAB system (Figures 3-1 and 3-2). In resource descriptions where conditions in the affected environment do not differ between the GOM and SAB, the information is presented without the two categories. Delineation between territorial and non-territorial waters is not distinguished because the natural and anthropogenic environment is best described by physical parameters such as sediment type or water quality (features that do not follow political boundaries). Chapter 4 (Environmental Consequences) differentiates between the National Environmental Policy Act of 1969 (NEPA) and Executive Order (EO) 12114 by differentiating between territorial and non-territorial waters. It is relevant here to note that activities would not be conducted along the coastlines or in estuaries in Alabama; therefore, information for resources such as wetlands, seagrasses, and other coastal resources is limited to Florida, and in particular cases to W-151 (includes Panama City Operating Area). Furthermore, the NSWC PCD Study Area is typical of the eastern GOM and, therefore, surveys conducted anywhere in the eastern GOM apply to the NSWC PCD Study Area.

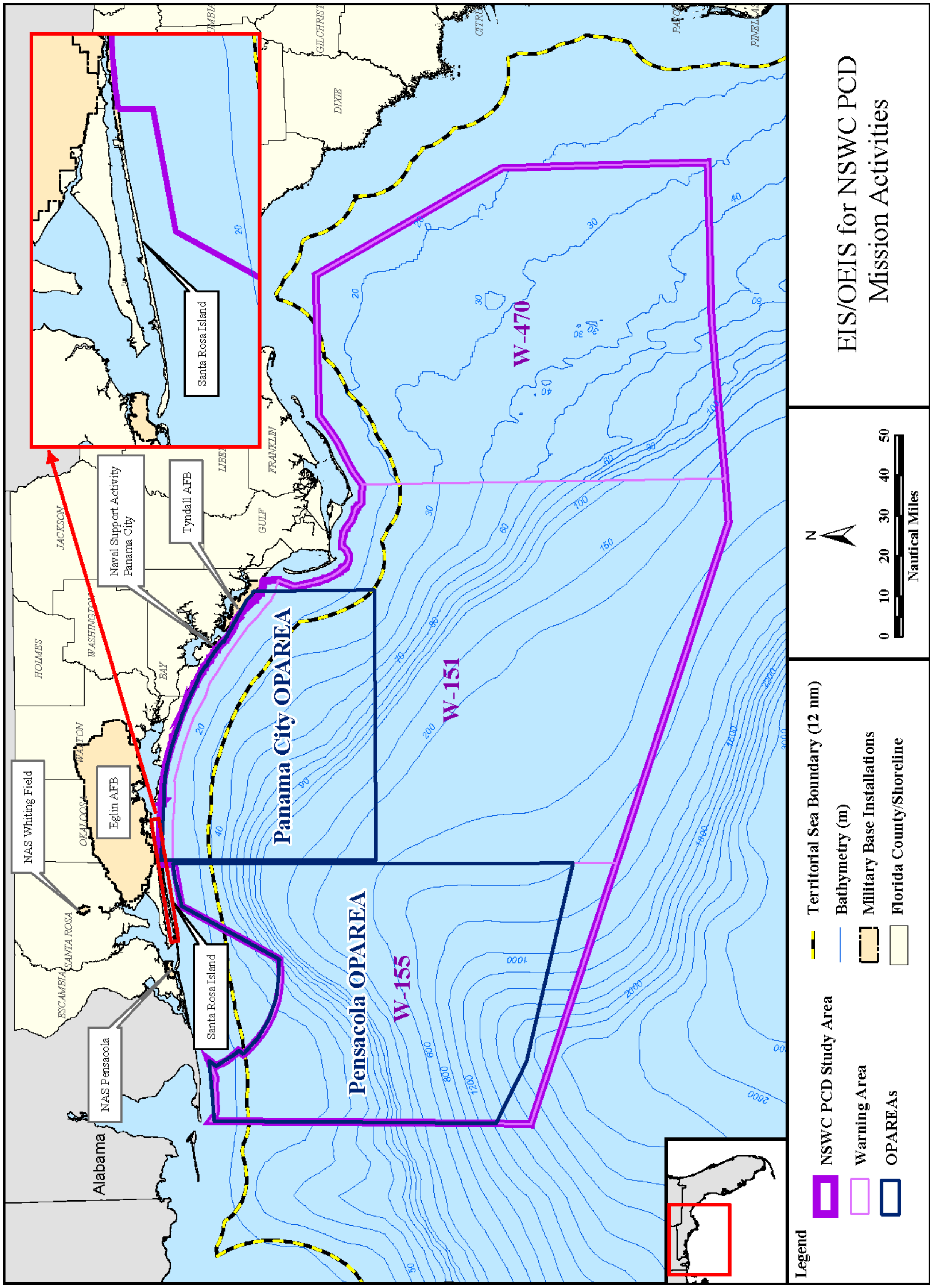

Figure 3-1. NSWC PCD Study Area: Gulf of Mexico

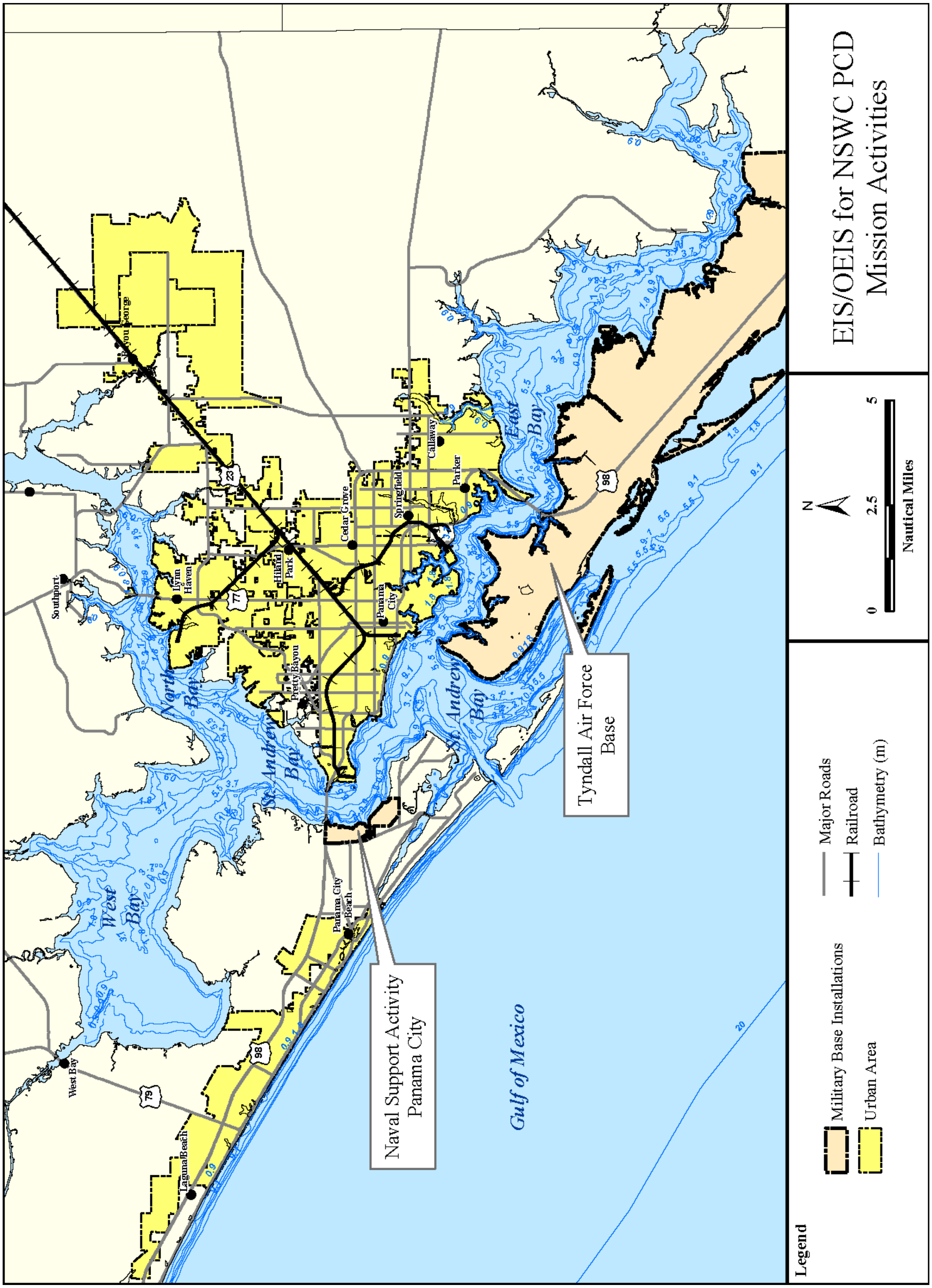

Figure 3-2. The NSWC PCD Study Area: Nearshore Environments and SAB

3.2 MARINE RESOURCE ASSESSMENT

The Navy Marine Resources Assessment (MRA) program was implemented by the Commander, U.S. Fleet Forces Command, to initiate collection of data and information concerning the protected and commercial marine resources found in the Department of the Navy's (DON's) Operating Areas. Specifically, the goal of the MRA program is to describe and document the marine resources present in each of the Navy's Operating Areas. As such, an MRA has been completed for the GOM Testing and Training Areas, which comprise three adjacent Operating Areas. The NSWC PCD Study Area includes two of those areas, the Panama City and Pensacola Operating Areas (DON, 2007a).

The MRA represents a compilation and synthesis of available scientific literature (e.g., journals, periodicals, theses, dissertations, project reports, and other technical reports published by government agencies, private businesses, or consulting firms) and the National Marine Fisheries Service (NMFS) reports including stock assessment reports, recovery plans, and survey reports. The MRAs provide a summary of the physical environment (e.g., marine geology, circulation and currents, hydrography, and plankton and primary productivity) for each test area. In addition, an in-depth discussion of the biological environment (marine mammals, sea turtles, fish, and EFH), as well as fishing grounds (recreational and commercial) and other areas of interest (e.g., maritime boundaries, navigable waters, marine managed areas, recreational diving sites) are also provided. Where applicable, the information contained in the MRA was used.

3.3 PHYSICAL RESOURCES

The affected physical environment consists of the geology and sediments, air quality, in-air sound, water quality, and underwater sound.

3.3.1 Geology and Sediments

This section discusses the baseline conditions of the geology and sediments of the NSWC PCD Study Area. The portion of the NSWC PCD Study Area consisting of W-470, W-151 (includes Panama City Operating Area), and W-155 (includes Pensacola Operating Area) is located in the North Central portion of the GOM and is characterized by a shallow and, in places, broad continental shelf, steep slopes leading from the shelf, two large deep water plains, and scattered regions where the bottom is somewhat higher (Weber et al., 1992; DON, 2007a). The average depth is more than 1 kilometer (km) (0.62 mile [mi]), and the maximum depths are more than 3 km (nearly 2 mi). The continental shelf is widest along the eastern margin (the West Florida Shelf); along the northwestern margin (the Texas-Louisiana Shelf); and along the southern margin (Campeche Shelf) (Dames and Moore, 1979).

The Florida Panhandle and the adjacent continental shelf formed 30 to 40 million years ago. This area occupies the Floridian Plateau, which is a thick, carbonate formation under the coastal and marine environment composed of limestone, dolomite, and anhydrite. This eastern area of the GOM geologically differs from the western portion (Weber et al., 1992; DON, 2007a) in that it was once a warm, shallow-water sea. During that time, limestone bedrock formed as sea levels increased and decreased, which deposited organisms on the plateau. Water combined with atmospheric carbon dioxide and with dissolved organic matter (i.e., product resulting from the decomposition of organisms) to form a carbonic solution. This solution dissolved portions of the limestone bedrock, which created caves, sinkholes, drainage basins, and similar formations. Underneath this formation, volcanic rocks have been documented (Weber et al., 1992).

On top of the limestone bedrock, a clay layer formed. This layer contained deposits from ancient rivers of the Appalachians (Wolfe et al., 1988). The porous limestone was filled by clay, and therefore water could not seep into or out of it. The Mississippi River and other smaller rivers that enter the GOM continue to deposit sediment and thicken this clay layer (Weber et al., 1992). The geology of the eastern portion of the GOM provides rich ventures for oil and gas exploration and development. The area is also high in sulfur, quartz sand, and phosphate (Weber et al., 1992; DON, 2007a).

Sediments within north Florida estuaries like SAB are primarily unconsolidated, that is, composed of mud, quartz sand, and fine silt (Wolfe et al., 1988). A review of the scientific literature (Science Applications International Corporation [SAIC], 1997) found that most researchers documented fine quartz sands approximately 0.3 meter (m) (1 feet [ft]) thick in SAB. Coarser grained sediments, particularly with shell fragments, were also recorded. Although the majority of SAB contains soft, sandy sediment on the floor, hardbottom substrates may occur in association with or near rock jetties or other artificial structures (Northwest Florida Water Management District [NWFWMD], 2000).

Moderate contaminant amounts have been found in the sediments of SAB. The pollutants found include heavy metals, hydrocarbons, and excess organic compounds and nutrients (SAIC, 1997). However, the levels found are less than those found in the majority of other estuaries adjacent to this portion of the GOM. Generally, differences in communities, such as seagrasses visible to the naked eye, have been exhibited in polluted versus unpolluted waters of SAB (SAIC, 1997).

3.3.2 Air Quality

Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. The levels of pollutants are generally expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). The quantitative air quality analysis for the proposed activities occurring over territorial waters, centers on the following counties: Escambia, Santa Rosa, Bay, Gulf, Okaloosa, Walton, Taylor, Wakulla, Franklin, and Jefferson Counties, Florida, as well as Baldwin and Mobile Counties, Alabama, since the proposed activities will occur offshore from these counties. There are no air quality standards for activities occurring over non-territorial waters; however, since naval activities will occur in waters near the U.S. mainland, an evaluation utilizing the same criterion established for territorial waters was completed for the purposes of determining significant effects to this resource.

3.3.2.1 National Ambient Air Quality Standards

The National Ambient Air Quality Standards (NAAQS) represent the maximum allowable atmospheric concentration of certain pollutants that may occur and still protect public health and welfare within a reasonable margin of safety. The NAAQS identify maximum allowable concentrations for the following "criteria" pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), and lead (Pb) (40 Code of Federal Regulations [CFR] Part 50). In the case of SO_2, the

State of Florida has established more stringent standards in Florida Administrative Code (FAC) 62-204.240 (1)(a-b). The State of Alabama has adopted the NAAQS. Details of the NAAQS and the State of Florida air quality requirements are provided in Appendix B, Air Quality.

Based on measured ambient air pollutant concentrations, the United States Environmental Protection Agency (USEPA) designates whether areas of the United States (U.S.) meet the NAAQS. Those areas demonstrating compliance with the NAAQS are considered "in attainment" while those that are not are known as "in non-attainment." Those areas that cannot be classified on the basis of available information as meeting or not meeting the NAAQS for a particular pollutant are "unclassifiable" and are treated as attainment until proven otherwise. Both the Florida Department of Environmental Protection (FDEP) and the Alabama Department of Environmental Management (ADEM) operate air quality monitors in various counties throughout the states. Of those counties in the NSWC PCD Study Area, monitoring stations are located in Escambia, Santa Rosa, Bay, and Wakulla Counties in Florida, as well as Baldwin and Mobile Counties in Alabama. All of the counties in Florida bordering the NSWC PCD Study Area are considered "in attainment" for criteria pollutants (USEPA, 2004a). Additionally, Mobile and Baldwin Counties in Alabama are considered in attainment.

3.3.2.2 Air Resources Criteria

The emissions associated with the NSWC PCD RDT&E activities are from mobile sources (airplane, vessel, or any kind of vehicle or equipment with a gasoline or diesel engine). NSWC PCD established a baseline using total cumulative NSWC PCD RDT&E activities' emissions on a pollutant-by-pollutant basis compared to the NSWC PCD Study Area's 2002 National Emissions Inventory (NEI). All of the counties that border the NSWC PCD Study Area are "in attainment" and, therefore, the General Conformity Rule does not apply. Details regarding the General Conformity Rule requirements are provided in the Appendix B, Air Quality.

3.3.2.3 Existing Conditions

An air emissions inventory qualitatively and quantitatively describes the amount of emissions from a facility or within an area. Emissions inventories are designed to locate pollution sources, define the type and size of sources, characterize emissions from each source, and estimate the total mass of emissions generated over a period of time, normally a year. These annual rates are typically represented in tons per year. Due to the absence of air emissions data for the NSWC PCD Study Area, air emission data for the adjacent counties was used to provide a baseline for existing air quality conditions (Table 3-1).

Table 3-1. No Action Alternative (Baseline) Emissions Data

Emission Sources	Metric Tons/yr (Tons/yr)				
	NO_x	CO	VOC	PM_{10}	SO_x
NSWC PCD Study Area (county emissions)*	124,339 (137,060)	545,692 (601,522)	107,788 (118,816)	132,332 (145,871)	136,689 (150,674)

* USEPA, 2002

NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides

3.3.3 In-Air Sound

Noise is considered to be unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment. It may be intermittent or continuous, steady or impulsive. It may be stationary or transient. Stationary sources are normally related to specific land uses (e.g., industrial plants or some military training activities). Transient noise sources move through the environment, either along relatively established paths (e.g., highways, railroads, and aircraft flying a specific flight track), or randomly (e.g., military training conducted in a training area). There is a wide diversity in responses to noise that vary not only according to the type of noise and the characteristics of the sound source, but also according to the sensitivity and expectations of the receptor (a person or animal), the time of day, and the distance between the noise source (e.g., an aircraft) and the receptor.

In the NSWC PCD Study Area, noise currently exists as a result of aircraft using the military training airspace overlying the area and marine vessels operating on the surface. The majority of all NSWC PCD flight activities occur above the waters of the GOM during daylight hours. Takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land.

Public annoyance is often the most common effect associated with exposure to elevated sound levels; thus, in-air sound is most applicable to activities occurring over territorial waters where public annoyance is most likely to occur. When subjected to day-night average sound level (L_{dn}) of 65 A-weighted decibels (dBA), approximately 12 percent of persons so exposed will be "highly annoyed" by the noise. At levels below 55 dBA, the percentage of annoyance is correspondingly lower (less than 3 percent). The percentage of people annoyed by noise never drops to zero (some people are always annoyed), but at levels below 55 dBA, it is reduced enough to be essentially negligible (Finegold et al., 1994).

The DON has adopted criteria that integrate land use guidelines with predictions of percentages of the population that would be "highly annoyed" when exposed to given L_{dn}. These sound levels have been categorized into "noise zones," and are shown in Table 3-2. It is desirable that Noise Zone 1 criteria not be exceeded (DON Office of the Chief of Naval Operations Instruction [OPNAVINST], 2002).

Table 3-2. Noise Zones

Noise Zone	Noise Type / Criteria L_{dn} / L_{dnmr}	Percent Population "Highly Annoyed"
1	less than 65	<15%
2	65–74	15–39%
3	75 or greater	>39%

L_{dn} = day-night average sound level; L_{dnmr} = onset-rate adjusted monthly day-night average sound level
Source: DON OPNAVINST, 2002; Finegold et al., 1994

Under current conditions, NSWC PCD flies a small number of fixed- and rotary–wing sorties in three warning areas over the territorial waters of the GOM. The majority of all NSWC PCD flight activities occur during daylight hours. Moreover, takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land.
However, aircraft from other military installations also use this airspace for training and exercises. Table 3-3 shows the current estimated sound levels in these Warning Areas from all

users and the contribution to those sound levels from aircraft supporting NSWC PCD RDT&E activities (Lucas and Calamia, 1996).

Table 3-3. Current Average Sound Levels in the NSWC PCD Study Area's Territorial Waters

Airspace	Current Sound Levels (in L_{dnmr}) from All Users [1]	Arithmetic Level	NSWC PCD Contribution (in L_{dnmr})	Arithmetic Level	NSWC PCD Percentage Contribution
W-470	41–44	12,589.25	13.4	21.88	0.17%
W-151	40–41	10,000	11.8	15.14	0.15%
W-155	30	1,000	14.6	28.84	2.88%

L_{dnmr} = onset-rate adjusted monthly day-night average sound level
1. U.S. Air Force, 2000. Range of sound levels shown as calculations in source document were based on subsets of total airspace.
Source: Lucas and Calamia, 1996

The sound levels provided in Table 3-3 were calculated utilizing a logarithmic scale. In order to calculate the actual percentage increase, the sound level data must be reduced to a number that is suitable for arithmetic calculations using the following equation.

$$AN = 10^{\frac{NL}{10}}$$

Where: AN = Arithmetic Number
NL = Noise Level

For example: the all-users sound level of 41_{Ldnmr} (onset-rate adjusted monthly day-night average sound level) equals 12,589.25 and the NSWC PCD contribution of 13.4_{Ldnmr} equals 21.87762, which equates to a 0.17 percent contribution.

Thus, in-air sound associated with current NSWC PCD RDT&E activities over the territorial waters of the NSWC PCD Study Area equates to only 3.2 percent of the overall sound level within the NSWC PCD Study Area.

3.3.4 Water Quality

This section discusses water quality parameters for portions of the GOM and SAB located in the NSWC PCD Study Area (Figure 3-1 and Figure 3-2). No water quality data is available for the amount of suspended or dissolved solids (turbidity) caused by current subsurface operations. However, turbidity in the GOM generally decreases from nearshore to offshore, and bottom turbidities tend to be higher than turbidity levels at the surface. On average the turbidity levels within the GOM range between 0.05-0.15 nephelometric turbidity units (NTUs). This would equate to a diver having an approximate 23 m (75 ft) of visibility. Low NTU measurements indicate clearer water. In SAB, turbidity in East Bay typically ranges from 0.9 NTUs to 5.3 NTUs and from 1.1 NTUs to 2.5 NTUs in SAB proper (Baywatch, 2003).

SAB and the nearshore waters within 4.8 km (3 nautical mile [NM]) of the coast are designated as Class III water bodies by FDEP. Thus, these waters are suitable for recreation, as well as maintenance of a healthy, well-balanced population of fish and wildlife. Additional marine water information is provided in Appendix C, Water Quality. No water quality standards for non-territorial waters currently exist.

Little information is available on contaminant levels within the waters of the NSWC PCD Study Area. However, numerous elements that would be produced by underwater explosions and ammunition firing, such as nitrogen, iron, zinc, aluminum, manganese, and organic carbon compounds, are found naturally in GOM waters (Riley and Chester, 1971).

3.3.5 Underwater Sound

The emphasis of this section is to describe the ambient sound environment, comprising physical, biological, and anthropogenic sources. Refer to Appendix D, Underwater Ambient Sound, for more information. Sound is characterized by the properties of sound waves and includes frequency, wavelength, and amplitude. The frequency of sound is described as the number of waves that pass a given point for a set period of time. This measurement is typically given as a form of hertz (Hz) or waves per second. Frequency influences the pitch of the sound, which can be heard as a high or low tone (National Oceanic and Atmospheric Administration [NOAA], 2007). Wavelength, or the length of the wave, is the measurement from one peak to the adjacent peak. The amplitude, or the height of the wave, determines the loudness (intensity) of the sound and is typically expressed as decibels (dB). Thus, tall pressure waves produce louder sounds as compared with short waves (NOAA, 2007). The speed of sound changes in water with temperature, salinity, and depth (NOAA, 2007).

Very few studies have been conducted to determine ambient sound levels in the ocean. However, ambient sound levels for the Eglin Gulf Test and Training Range, which includes the Pensacola and Panama City Operating Areas, range from approximately 40 decibels referenced to 1 micropascal (dB re 1 μPa) to about 110 dB re 1 μPa (U.S. Air Force, 2002a). Figure 3-3 illustrates the variability from all of the potential sound sources described in this section. The frequencies of each of the sound sources are provided along the X-axis, while the sound levels for each sound source are plotted along the Y-axis. The sound levels depicted in this graphic have not been added to the other various sources.

3.3.5.1 Physical Sources of Sound

Physical sound sources can include wind blowing across the sea surface, rain and hail striking the sea surface, lightning, thunder, and seismic activity. These sound sources can contribute to a rise in the ambient sound levels on an intermittent basis. Wind produces frequencies between 0.1 and 30 kHz, while wave-generated sound is a significant contributor in the infrasonic range (i.e., 0.001 to 0.020 kHz) (Simmonds et al., 2004). Based on historical data in the Gulf of Mexico, wind sounds are highest between the months of October through January and lowest in the month of July, with the exception of an active tropical storm season (Snyder, 2007). In addition to adding to the overall ambient sound level, high winds can also affect the extent of sound propagation in the water. In periods of high winds, the mixed layer depth increases and has the potential to trap some of the energy from specific sound sources. As a result, frequencies above a given cut-off frequency based on the mixed layer depth, will stay trapped in the mixed layer, while frequencies below that will penetrate the mixed layer and travel further in the water. As the mixed layer depth increases, the cut-off frequency decreases (Snyder, 2007). In other words, during windy conditions the mixed layer depth is greater and will retain frequencies above a lower cut-off frequency as opposed to calm conditions where the mixed layer depth is less and will retain frequencies above a higher cut-off frequency.

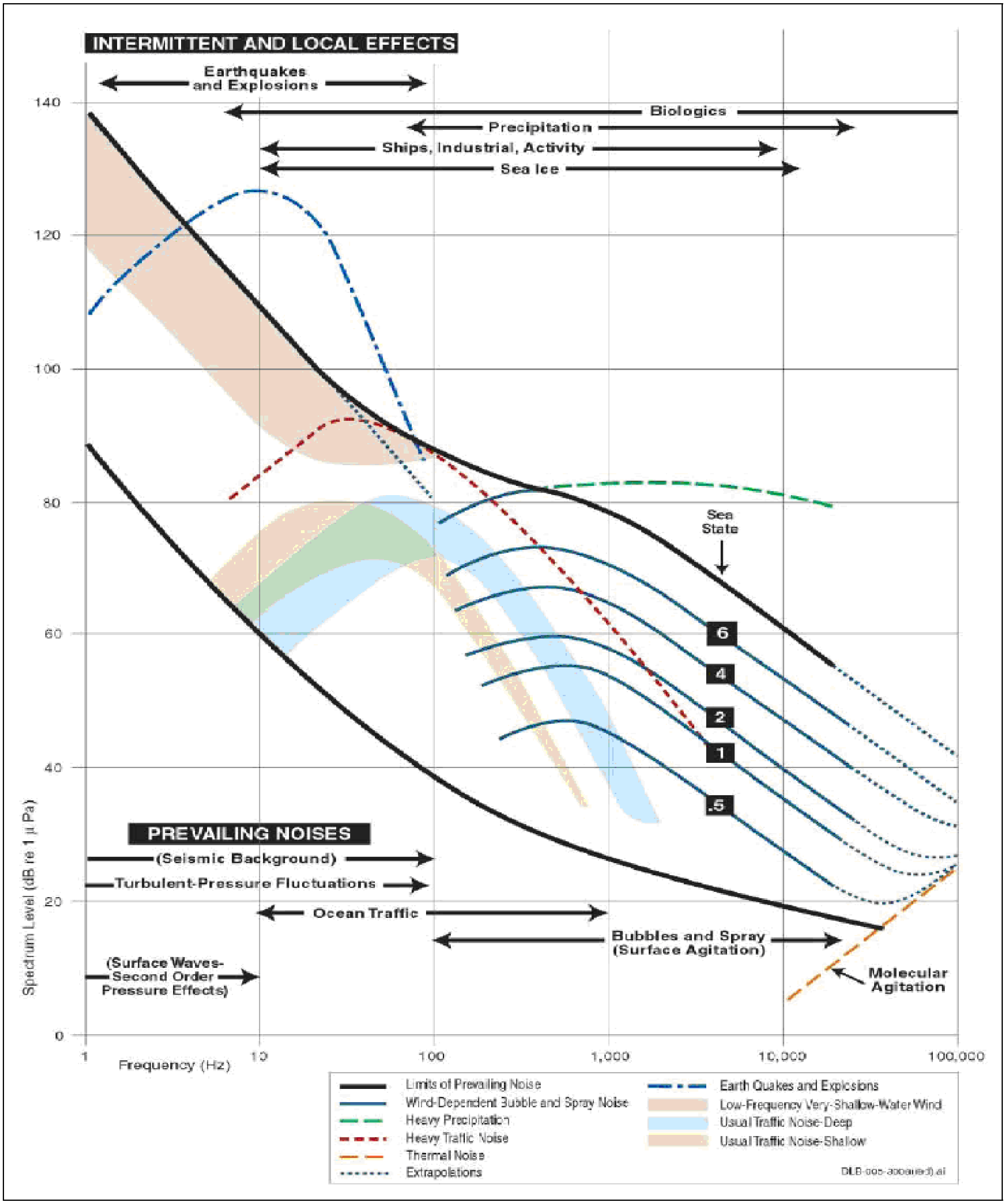

Figure 3-3. Ambient Sound Levels
(Source: National Research Council, 2003)

Rain produces noise in much the same manner as does wind. However, rain noise differs from wind noise in that its peak contribution to the field occurs at a slightly higher frequency, typically between 1 and 3 kilohertz (kHz). Even at moderate rain rates, the noise generated at these frequencies can easily exceed contributions from wind. For instance, the onset of rain can raise high-frequency noise levels by 10 dB or more (U.S. Air Force, 2002a).

In addition, seismic activity results in the production of low-frequency sounds that can be heard for great distances (Discovery of Sound in the Sea [DOSITS], 2007). For example, in the Pacific Ocean, sounds from a volcanic eruption have been heard thousands of miles away (DOSITS, 2007).

3.3.5.2 Biological Sources of Sound

Various types of marine life contribute to the noise environment, producing sounds at various frequencies and raising ambient noise levels. Marine animals use sound to navigate, communicate, locate food, reproduce, and protect themselves underwater (Scowcroft et al., 2006). For example, reproductive activity, including courtship and spawning, accounts for the majority of sounds produced by fish. During the spawning season, croakers vocalize for many hours and often dominate the acoustic environment (Scowcroft et al., 2006).

Crustaceans and fish produce sounds in the range of a few kilohertz. These contributions in turn raise the ambient noise levels. Marine mammals emit sounds as low as 20 hertz (e.g., fin calls); however most of the sounds produced by marine mammals are in the frequency range greater than 1 kHz. Marine mammal sounds reach as high as tens to hundreds of kilohertz (e.g., dolphin click). For instance, bottlenose dolphin clicks and whistles have a dominant frequency range of 110 kHz to 130 kHz and 3.5 kHz to 14.5 kHz, respectively. Whistles, clicks, squawks, barks, growls, and chirps have been recorded for the Atlantic spotted dolphin. Whistles have dominant frequencies ranging from 6.7 kHz to 17.8 kHz. Clicks, growls, and barks have a frequency range of 0.1 kHz to 8 kHz; squawks have a range of 0.1 kHz to 3 kHz; and chirps have a range of 4 kHz to 8 kHz (DON, 2007a). While sound produced by an animal is limited by the location and the call duration, when this sound is present, sound levels up to 30 dB or greater than background levels can be produced (U.S. Air Force, 2002a). Figure 3-3 illustrates the variability from all of these potential sound sources.

3.3.5.3 Anthropogenic Sources of Sound

Anthropogenic sound is introduced into the ocean by a number of sources, including transportation, dredging, onshore construction, oil and gas drilling and production, geophysical (seismic) surveys, active sonars, and explosions. Noise levels from these activities are typically greatest at low frequencies, and it is possible that more than one of these sources may simultaneously contribute to the overall sound levels in a given place at a given time (Richardson et al., 1995).

Transportation sound sources include not only surface and subsurface vessels, but also aircraft such as helicopters and fixed-wing aircraft. Vessels are known as the primary persistent anthropogenic sound source in the open ocean. Surface ships generate sound via a number of mechanisms, including the machinery and bubbles created by the rotation of the propeller blades, also known as cavitation. Sounds from machinery can come from the engines, transmissions, rotating propeller shafts and mechanical friction. However, the dominant source of underwater sound from vessels typically comes from propeller cavitation. In general, larger vessels emit more sound than smaller vessels. Furthermore, vessels with larger propellers produce sounds of lower frequencies whereas vessels with smaller propellers produce sounds of higher frequencies. As a result, larger commercial shipping vessels will produce louder sounds at lower frequencies than the sounds produced by smaller vessels, such as recreational fishing boats (MMS, 2007c).

At any given time, there are approximately 20,000 large commercial vessels at sea worldwide. As shown in Figure 3-3, commercial vessels have the highest sound levels at lower frequencies. Propeller cavitation is the dominant mechanism of sound production for surface ships and can generate sounds between 40 and 100 Hz. Since sound propagation is most favorable at frequencies within this range, particularly in deep water, surface ships can often be heard at distances greater than 100 km (54 NM). Thus, at many deep-water locations, it is not unusual for a low-frequency sound to be influenced by contributions from tens or even hundreds of surface ships (U.S. Air Force, 2002a).

As mentioned above, transportation sound sources are not limited only to vessels. Helicopters and fixed-wing aircraft may also have the potential to add to underwater sound in a given area. Similar to vessels, sounds from both helicopters and fixed-wing aircraft originate from their engines and rotating rotors or propellers, which tend to be at frequencies less than 500 Hz (M.J.T. Smith, 1989; Hubbard, 1995). Since aircraft are not in contact with the water, the levels and propagation of underwater sound from passing aircraft are dependent on a variety of factors including, but not limited to the altitude and incident angle of the aircraft, sound receiver depth, and aircraft size. As altitude increases or as receiver depth increases, peak received noise levels in the water will decrease. At incident angles greater than 13 degrees from the vertical, the majority of the noise from the passing aircraft is reflected and does not enter the water (Urick, 1972). Comparing among the various types of aircraft, large multi-engine aircraft tend to produce louder sounds than smaller aircraft while helicopters are typically louder and emit a larger number of acoustic tones and higher broadband sound levels than a fixed-wing aircraft of similar size (Richardson et al., 1995). However, unlike sounds produced by vessels, underwater sounds from aircraft are transient and may not significantly contribute to underwater ambient sound levels.

Dredging and construction are common activities within the coastal waters of the GOM. Dredge vessels produce sounds that are continuous in duration and strongest at low frequencies and vary depending on the type of dredge (Greene, 1985, 1987). Sounds derived from onshore construction activities are most likely present only within shallow waters, but depending on the specific activity may have the potential to propagate into coastal waters as well (Richardson et al., 1995).

Offshore drilling and production includes a variety of activities that emit underwater sound. Sounds generated by drilling activities from fixed, metal-legged platforms are not very intense and are typically at very low frequencies (MMS, 2007c). Similarly, sound associated with offshore oil and gas production also tends to be weak and at very low frequencies (Gales, 1982).

Oil and gas operations also have the need for support activities such as supply/anchor handling and crew boats and helicopters. Sounds produced by these activities are the same as those for small vessels and aircraft as discussed above.

Seismic surveys are used to find oil and gas reservoirs below the surface of the seafloor. These activities utilize direct high-intensity, low-frequency sound waves through layers of rock, which are then reflected back and recorded and processed to give information about the structure and composition of the subsurface geological formations. Airguns typically perform these operations and are used in sets or arrays, and are therefore the most common source of seismic survey noise. Even though airgun pulses are directed downward towards the seafloor, the sound can propagate horizontally for over 100 km (54 NM) in deep waters (Richardson et al., 1995).

Active sonars are utilized to detect objects underwater. In addition to military uses, most ships and boats use depth-finding sonar systems called fathometers, which produce sounds at mid-frequencies (Richardson et al., 1995). Acoustic pingers generate high-frequency sounds, and are used for locating and positioning of oceanographic and geophysical equipment. Active sonars used for military operations, such as those discussed in the Proposed Action are infrequent events within the GOM when compared to other anthropogenic sources (MMS, 2007c). Combined with all the other factors that contribute to the acoustic environment in the GOM, it is not likely that these infrequent military sonar RDT&E activities will significantly conflict with other sound sources in the region.

Underwater explosions are used for both military testing and non-military activities, such as offshore structure removals. They are the strongest point sources of anthropogenic sound in the GOM. Explosives produce initial shock waves that later become conventional acoustic pulses as they propagate. Similar to military sonar operations, the use of explosives in military ordnance activities, including the operations discussed in the Proposed Action is also very limited in the GOM (MMS, 2007c).

3.4 BIOLOGICAL RESOURCES

The potentially affected biological environment includes animal species inhabiting the water column and birds that traverse the area. Species are described as plankton (free-floating plants and animals ranging in size from microscopic to several feet in length), benthic species (animals that live in or on the seafloor or attached to some other surface), and nekton (animals that actively move through the water column). In addition to many species of fish and invertebrates, other organisms that swim freely include turtles and marine mammals. This section summarizes the marine habitats, plankton community, invertebrates, fish, marine and neotropical birds, sea turtles, and marine mammals potentially present in the NSWC PCD Study Area.

3.4.1 Marine Habitats

3.4.1.1 Hardbottom Areas

Hardbottom areas are hard or rocky outcroppings or formations that support the growth of algae, sponges, and a few stony coral species. Hardbottom within the NSWC PCD Study Area provides habitat for other animals such as crabs, lobsters, sea anemones, grouper, and snapper. Hardbottom areas are sensitive and can be negatively affected by direct contact or continuous silting from bottom disturbances. They provide important habitat for marine life in the GOM (Wolfe et al., 1988). Subtidal softbottom areas include all areas offshore except for rocky outcropping and are the most extensive type of bottom habitat (Figure 3-4). Table 3-4 provides an overview of the amount of known coral reefs and the scattered coral heads and other hardbottom obtained from geographic information system (GIS) coverages of the three Warning Areas (including the adjacent waters up to the shoreline. Warning Area surface areas include: W-151, W-155, and W-470 at 36,560 square kilometers (km^2) (14,116 square miles [mi^2]), 18,873 km^2 (7,287 mi^2), and 25,599 km^2 (9,884 mi^2), respectively. The amount of softbottom was estimated from these coverages, and the total amount of hardbottom area compared with the softbottom estimates was used to determine the final column of Table 3-4, which presents the percentages of hardbottom area (e.g., W-151 = 76.74 km^2 / 36,560 km^2 = 0.21 percent cover of total hardbottom).

Table 3-4. Coverage of Hardbottom Area in the NSWC PCD Study Area

Warning Area	Coral Reef Area in km^2 (mi^2)	Scattered Coral Heads and Other Hardbottom Area in km^2 (mi^2)	Total Hardbottom Area in km^2 (mi^2)	Total Area Encompassed By Warning Area in km^2 (mi^2)	Percent Cover of Total Hardbottom Area (%)
151	76.74 (29.63)	0.00	76.74 (29.63)	36,650 (14,150.89)	0.21
155	103.69 (40.03)	0.00	103.69 (40.03)	18,873 (7,287.04)	0.55
470	508.48 (196.33)	870.45 (336.08)	1,378.93 (532.42)	25,599 (9,884.00)	5.39
Total	**688.91 (265.99)**	**870.45** (336.08)	**1,559.36 (602.08)**	**81,032 (31,287.18)**	**1.92**

km^2 = square kilometers; mi^2 = square miles

3.4.1.2 Estuarine Environments

Estuarine environments are found along coastlines where freshwater and saltwater mix (DON, 2007a). The SAB estuarine system refers to protected nearshore waters such as bays and lagoons. This ecosystem encompasses 244 km^2 (94 mi^2) and consists of four main bays, West Bay, North Bay, SAB, and East Bay. The St. Andrews State Park Aquatic Preserve surrounds the entrance of SAB and includes West and East Pass, Shell Island, and portions of the St. Andrews State Recreation Area (FDEP, 2005). The temperature of these shallow waters can range from 0 to 38 degrees Celsius (°C) (32 to 100 degrees Fahrenheit [°F]) throughout the course of a year (Sargent et al., 1995).

The protected environment and abundant food provided by estuaries support an ideal location for fish and shellfish to reproduce (USEPA, 2005). Additionally, many species of birds depend on estuaries for foraging and nesting areas. Migratory birds use estuaries as stopover points for resting and feeding before continuing their migration. Marine mammals also use estuaries as feeding and nursery grounds. A healthy estuary produces between four and ten times as much organic production as a cornfield of the same size. Estuaries provide a wide range of habitats leading to a great diversity of marine life (USEPA, 2005).

3.4.1.3 Seagrasses

Seagrasses, also referred to as submerged aquatic vegetation, lie completely under the surface of the water and possess all the structures of terrestrial plants (Wolfe et al., 1988). These marine angiosperms (flowering plants) occur in estuaries, lagoons, and shallow open shelves off the coast of Florida. Grassbeds are distributed closer toward shore in shallower water depths and increasing water clarity (Figure 3-4).

Seagrass ecosystems are widely recognized as some of the most productive benthic (sea floor) habitats in estuarine and nearshore waters of the GOM coast (Neckles, 1994). Seagrasses cover 30,000 km^2 (8,735 square nautical miles [NM^2]) of the floor in the entire GOM. Of this coverage, 10,000 km^2 (2,912 NM^2) are in Floridian waters (Sargent et al., 1995). SAB contains the highest amount of coverage in northwest Florida (Gulfbase, 2004). Five types of seagrasses occur in SAB. They include turtle (*Thalassia testudinum*), shoal (*Halodule wrightii*), manatee (*Syringodium filliforme*), widgeon (*Ruppia maritima*) and star (*Halophila englemanni*) seagrasses. Of these species, the most abundant seagrass in SAB is turtle grass while shoal and manatee grasses are also prevalent (NWFWMD, 2000). A review of the literature (SAIC, 1997) on SAB found that shoal grass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*) were located around bayheads. Turtle grass (*Thalassia testudinum*) was dominant in more pristine parts of the estuary system (SAIC, 1997). The seagrasses that occur in SAB provide important functions for the ecosystems they inhabit. For example, they supply habitat for a variety of invertebrate, fish, and algal species and serve as a food source for species higher in the food chain. Turtle, shoal, and manatee grass are among the most preferred species of the 60 plant species that the West Indian manatee consumes (FDEP, 1993).

Total grassbed coverage in Bay County amounts to 42.61 km^2 (12.41 NM^2), nearly half of which has been subjected to some form of damage from boat propeller contact, a condition known as scarring, visible as unvegetated streaks through the beds (Sargent et al., 1995). Seagrasses are vulnerable to effects other than boat damage that are natural and human-induced. For example, storms and salinity limit seagrass growth, while dredging-and-filling projects, as well as pollution effects, jeopardize meadows (Wolfe et al., 1988; Sargent et al., 1995). Table 3-5 lists the area of seagrass coverage in the GOM within and adjacent to the NSWC PCD Study Area by county. The coverage was divided by the scarred coverage to arrive at the percentage of scarred seagrass in each county.

3.4.1.4 Special Biological Resource Areas

Special Biological Resource Areas are offshore habitats that contain both unique flora and fauna. These may be areas that are important as feeding grounds, critical habitats, or principal places of productivity in the GOM. They are all unique ecosystems and support a large variety of species, many still unidentified. They can be found on the continental shelf, slope, and deep sea floor within the eastern GOM (Figure 3-5).

Table 3-5. Seagrass Coverage and Scarring, Florida Coastal Counties in the NSWC PCD Study Area, GOM

County on Gulf Coast	Coverage in km^2 (NM^2)	Scarred Coverage in km^2 (NM^2)	Percentage of Scarred Seagrass
Bay	42.61 (12.41)	20.03 (5.83)	47.01
Escambia	11.13 (3.24)	2.83 (0.82)	25.43
Franklin	80.29 (23.38)	3.28 (0.96)	4.09
Gulf	33.06 (9.63)	19.59 (5.70)	59.26
Jefferson	42.49 (12.37)	2.06 (0.60)	4.85
Okaloosa	13.96 (4.06)	1.58 (0.46)	11.32
Santa Rosa	11.01 (3.21)	2.27 (0.66)	20.62
Taylor	659.07 (191.91)	33.02 (9.61)	5.01
Wakulla	119.91 (34.92)	11.29 (3.29)	9.42
Walton	2.87 (0.84)	0.04 (0.01)	1.39
NSWC PCD Study Area	1,016.4 (114.27)	95.99 (27.95)	9.44
State: Florida	10,757.72 (3132.44)	703.99 (204.99)	6.54
Region: Florida GOM Waters	9,887.49 (2,879.05)	620.62 (180.71)	6.28

Source: Modified from Sargent et al., 1995
km^2 = square kilometers; NM^2 = square nautical miles

The Florida Middle Grounds

The Florida Middle Grounds, the principal hardbottom in the eastern GOM, is located about 160 km (99 mi) west-northwest of Tampa as shown in Figure 3-5. It rises from a depth of about 40 m (131 ft), and its shallowest portion is approximately 23 m (75 ft) deep. The Florida Middle Grounds are similar to a typical Caribbean reef community; however, species may differ between the two communities. The area is the most biologically developed hardbottom area in the eastern GOM and represents the northernmost extent of coral reefs in the GOM. Up to 197 species of fish occupy the area. Invertebrates, including hard and soft corals, sponges, algae, and anemones inhabit the area as well (Hopkins et al., 1977; Rezak and Bright, 1981).

The Gulf of Mexico Fishery Management Council (GMFMC) has designated the area as a Habitat of Particular Concern. Removal of coral at this site is prohibited except as authorized by permit issued under 50 CFR 638.4. Within this area, the use of traps, pots, bottom longlines, and bottom trawls is prohibited unless authorized by a permit from NMFS (USEPA, 1994). Rezak and Bright noted that the Florida Middle Grounds are sensitive to environmental change as are most coral reef systems (Odum, 1971).

Desoto Canyon Closed Area

The Desoto Canyon Closed Area, established in November 2000 under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), consists of two rectangular areas covering nearly 85,000 km^2 (24,750 NM^2) (Figure 3-5) (GMFMC, 2000). The area was created as a federal fisheries management zone for the purpose of reducing the number of undersized swordfish, billfish, and other species incidentally caught with pelagic longline gear. As such, longlining is prohibited year-round. The managed area consists of the water column up to the surface, but does not include bottom features (GMFMC, 2000).

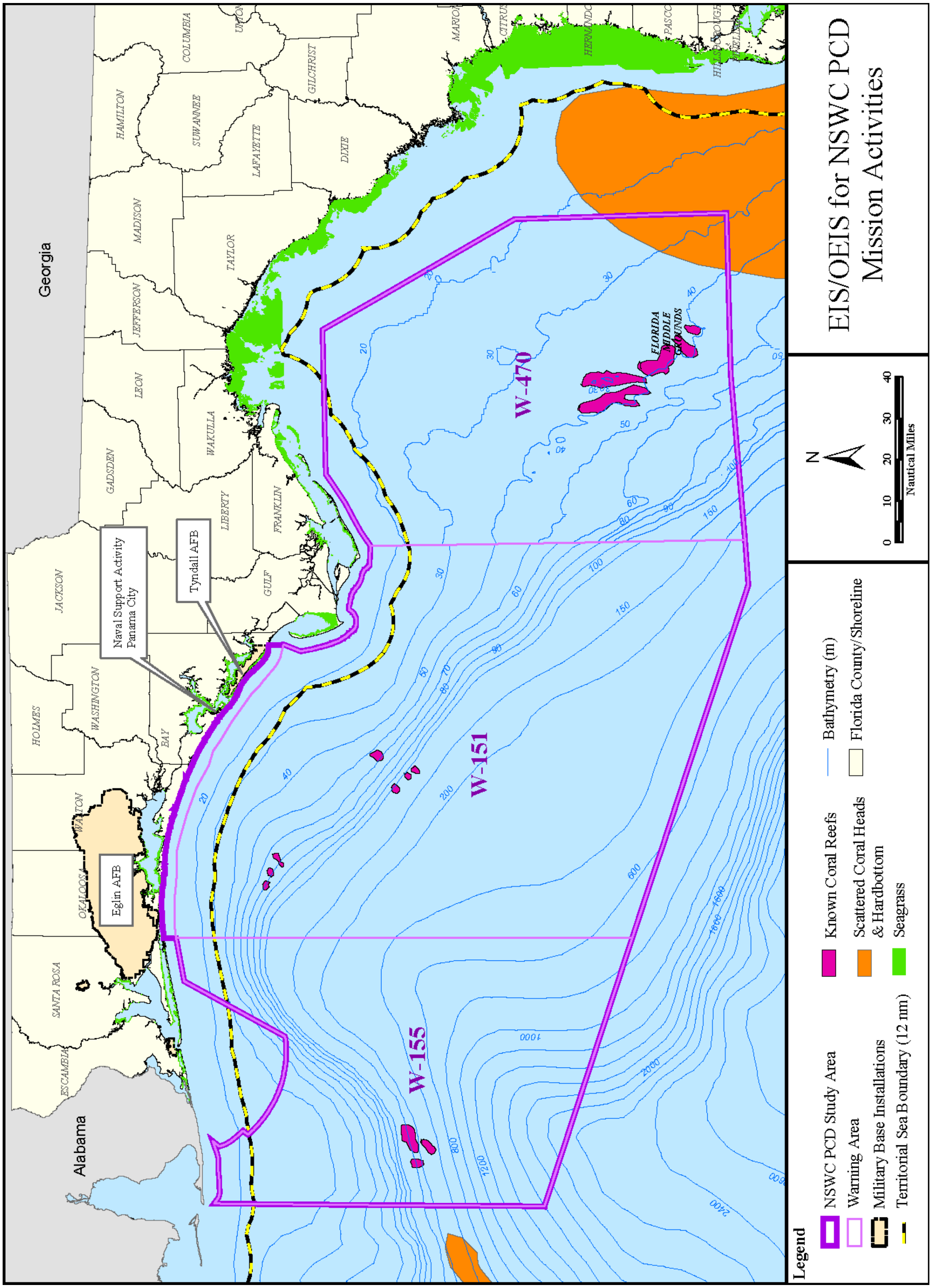

Figure 3-4. GOM Resources, Marine Habitat

Reef Fish Stressed Area

The Reef Fish Stressed Area was established in February 1990 under the MSA (50 CFR 622.34). The area consists of a band of inshore waters extending around the entire GOM except for areas that have been designated as having an even higher sensitivity level such as the marine preserves located off the coast of Mexico Beach (Figure 3-5). The entire water column and associated bottom features are protected to help rebuild declining reef fish stocks. The use of fish traps, roller trawls, and powerheads on spear guns is prohibited within the area. There is also a total length minimum size limit of 38 centimeters (cm) (15 inches [in]) on red snapper (50 CFR 622.34) for recreational fishermen and a total length minimum size limit of 33 cm (13 in) on this species for commercial fishermen (NOAA, 2008).

Steamboat Lumps and Madison-Swanson Spawning Site

Federally managed sites were established on June 19, 2001 in the GOM to protect spawning aggregations of gag grouper (*Mycteroperca microlepis*), reef, and coastal migratory pelagic fish (Figure 3-5). The areas were also established to protect deepwater habitat from fishery activities (GMFMC, 2003). Steamboat Lumps is located in offshore waters, southeast of Panama City and Port St. Joe. The area encompasses 269 km^2 (104 mi^2). The Madison-Swanson Spawning Site is located to the southwest of Panama City and directly south of Port St. Joe in the deep, offshore waters of the GOM. The areas were to remain closed until June 15, 2004 (GSMFC, 2001) to commercial and recreational consumptive fishing, which includes bottom trawls, traps, and lines (GMFMC, 2003). However, in May 2004, the GMFMC extended the fishing restrictions to July 2010. NMFS and the U.S. Coast Guard (USCG) are charged with enforcement. The GMFMC co-manages the Steamboat Lumps and Madison-Swanson Spawning Sites (GMFMC, 2003).

Coastal Preserve: St. Andrews Aquatic Preserve

The area of concern includes submerged lands that are part of an aquatic preserve. Preserves are designated by the Florida Legislature for “outstanding, biological, aesthetic, and/or scientific value,” under Chapters 253 and 258, Florida Statute (F.S.), and Chapters 18–21, FAC. The aquatic preserve encompasses the entrance of the SAB (Figure 3-5). The area includes East and West Passes, Shell Island, and a portion of the St. Andrews State Recreation Area. The preserve is important, particularly because it possesses the largest expanse of seagrass beds in the panhandle and because water entering and exiting SAB must pass through it (FDEP, 2005). Table 3-6 lists some of the species found in the preserve.

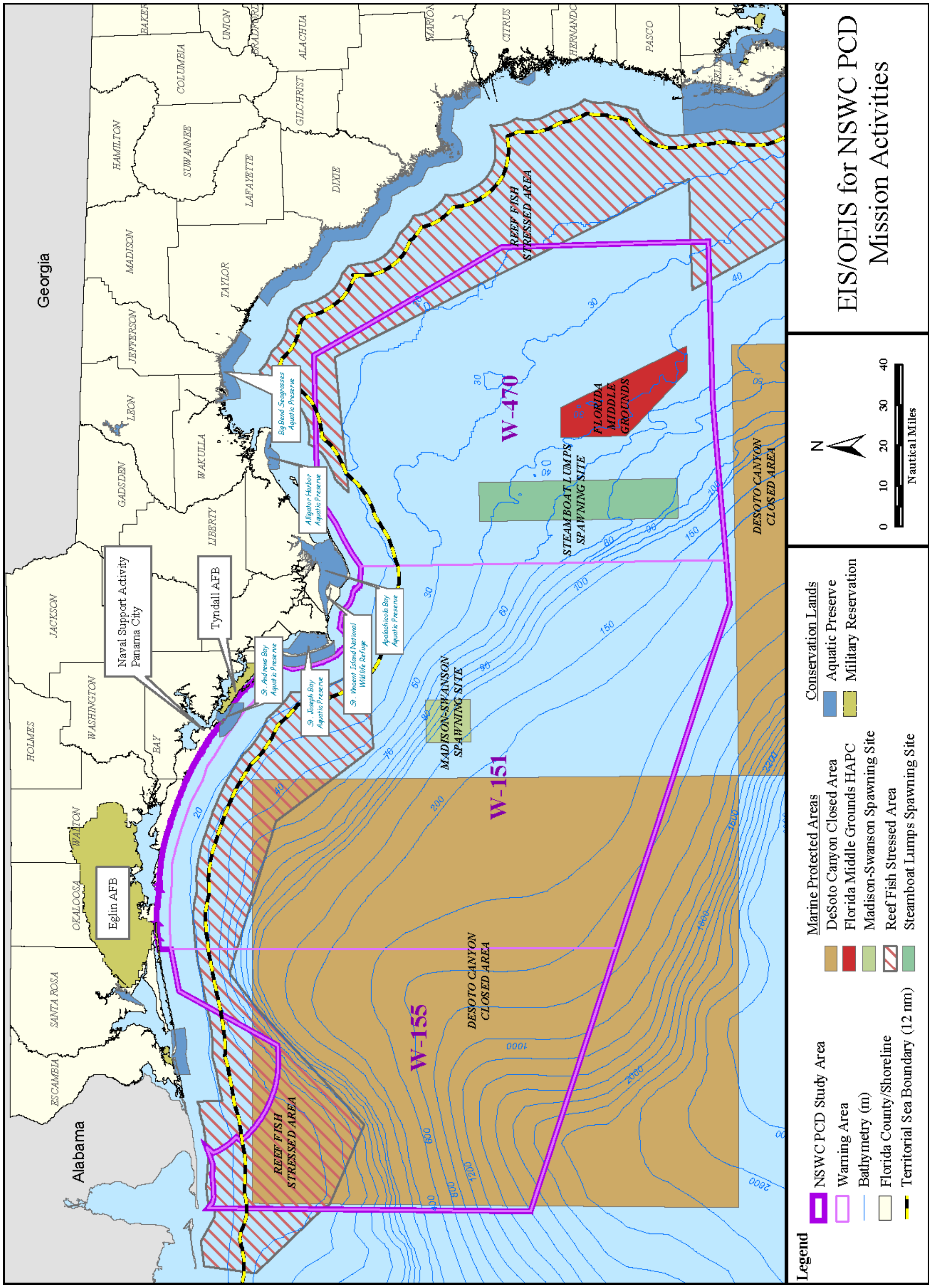

Figure 3-5. Protected Areas

Table 3-6. Species Found in the St. Andrews Aquatic Preserve

Common Name	Scientific Name	Common Name	Scientific Name
Shoal grass	*Halodule wrightii*	Rosemary	*Rosmarinus officinalis*
Manatee grass	*Syringodium filiforme*	Saw palmetto	*Serenoa serrulata*
Turtle grass	*Thalassia testudinum*	Slash pine	*Pinus elliottii*
Widgeon grass	*Rupia maritime*	Woody goldenrod	*Chrysoma pauciflosculosa*
Black needlerush	*Juncus roemerianus*	Sea oats	*Chasmanthium latifolium*
Smooth cordgrass	*Spartina alterniflora*	Sea rocket	*Cakile edentula*
Saltmeadow cordgrass	*Spartina patens*	Bitter panicum	*Panicum amarum*
Saltgrass	*Distichlis spicata*	Sand pine	*Pinus clausa*
Hurricane grass	*Fimbristylis spathacea*	Snowy plover	*Charadrius alexandrinus*
Cruise's golden aster	*Chrysopsis cruisiana*	Piping plover	*Charadrius melodus*
Myrtle oak	*Quercus myrtifolia*	Loggerhead sea turtle	*Caretta caretta*
Sand live oak	*Quercus geminata*	Green sea turtle	*Chelonia mydas*
Large, leaved jointweed	*Polygonella macrophylla*	Choctawhatchee beach mouse	*Peromyscus polionotus allophrys*

Source: FDEP, 2005

3.4.2 Plankton Community

A variety of plankton species are distributed throughout the GOM and in its adjacent bays. This community is composed of organisms moved about passively by drifting or floating with the ocean currents. In general, this group of organisms is very small or microscopic, although there are exceptions. Jellyfish and pelagic (open ocean) *Sargassum*, for example, are unable to move against the surrounding currents and therefore are considered plankton even though some jellyfish can grow to 3 m (9.8 ft) in diameter (DON, 2007a). Plankton include bacterioplankton (bacteria), zooplankton (animals) including ichthyoplankton (larval fish), phytoplankton (plant-like organisms), and virioplankton (viruses). Zooplankton are tiny, free-floating animals that provide an important link between phytoplankton and higher trophic levels, including fish and marine mammals (Steidinger, 1973). Of these plankton species, virioplankton dominate the communities in most aquatic systems (Wommack and Colwell, 2000).

Although the types of plankton found in SAB do not highly differ from the GOM, variation in species composition, diversity, and abundance among coastal and oceanic systems has been documented for some of the groups. For instance, researchers studying bacterioplankton have found higher abundance in estuary versus oceanic waters (Boehme et al., 1993). The number of virioplankton also appears to increase in coastal areas.

3.4.3 Invertebrates

There are over 50,000 different species of marine invertebrates, including crustaceans, cephalopods, mollusks, sponges, and corals, among many others. They can range in size from less than a single millimeter to several meters long, or even bigger. Marine invertebrate habitats range from intertidal zones to the deep sea and everywhere in between. (NBII, 2008). Oceanic invertebrates include benthic fauna associated with the sediments as well as free-swimming animals that live on the ocean floor or float in the water column. Benthic invertebrates include the infauna, which are animals living in the substrate (such as burrowing worms and mollusks), and the epifauna, which are animals that live on the substrate (such as mollusks, crustaceans, hydroids, sponges, and echinoderms). Free swimming invertebrates include cephalopods (such as octopus and squid) and jellyfish.

Just as there is a wide range of species of marine invertebrates, so is the range of functions they perform for the overall ecological health of the surrounding environment. Smaller invertebrates typically feed off nutrients found in the sediments or floating in the water column, while the larger invertebrates typically consume the smaller invertebrates. They can form symbiotic (mutually beneficial) relationships with other species, but they can also be prey for other invertebrates, fish, marine mammals, sea turtles, and even humans. Given the structure of food chains, adverse effects to even the smallest individuals can have an ecosystem-level impact. For example, depending on the characteristics of potential contaminants present within the sediments, bioaccumulation up through the food chain may occur, thus multiplying the magnitude of impact as trophic levels increase. In other words, if a group of individuals feed off contaminated sediments and are then eaten by a larger organism, the severity of contamination is then multiplied by the number of individuals it consumed. Taking that another trophic level higher, if a group of individuals, who fed off the originally contaminated group, was consumed by an even larger individual, the contamination level for that individual would be several magnitudes greater. While sources of contamination can either be natural or man-made, the extent of bioaccumulation from man-made contaminants in marine invertebrates is not known, but is currently under investigation.

3.4.3.1 Gulf Of Mexico

The majority of live bottom, which typically supports invertebrate communities, in the northeastern GOM is found in the transition zone between the nearshore and offshore environments. In fact, there have not been many studies of live bottom on the shallow, inner shelf of the northeastern GOM (Thompson et al., 1999). One study examined hard bottom areas in water depths of 18 to 40 m (59 to 131 ft) off the northwest Florida and Alabama gulf coasts, and found these areas to include reef-like outcrops with vertical relief of less than 2 m (7 ft), moderately sloping ridges of rock rubble and shell hash, and surficial rock and shell rubble with little or no vertical relief (Thompson et al., 1999). In addition, based on other studies, it is estimated that only 3 percent of the GOM continental shelf within the NSWC PCD Study Area consists of reef habitat (Thompson et al., 1999). The types of environments described above are typical marine invertebrate habitats. Information on the occurrence of these habitat areas in the nearshore NSWC PCD Study Area and on the marine invertebrate communities that they may support is limited. Therefore, this section focuses on the offshore marine invertebrate communities that may be present within the NSWC PCD Study Area and considers that much of the nearshore benthic fauna is represented by similar communities.

The benthic fauna of the offshore NSWC PCD Study Area are characteristic of temperate species found in sandy substrates. Benthic habitats, or substrates, of the northeastern GOM differ from other GOM regions, mainly due to lack of deposits from the Mississippi River. The eastern GOM has a primary substrate of thin sand layers and hardbottom over carbonate rock. This substrate supports a diverse collection of epifauna, which are derived from the more southern tropical areas. A greater array of hardbottom epibiotic (relic, or a remnant of old living hardbottom) substrate is found off the southwest Florida shelf due to a more tropical climate.

At least 1,497 species of invertebrate epibiota (organisms living on the substrate), including mollusks (20 percent), crustaceans (19 percent), cnidarians (10 percent), echinoderms (8 percent), sponges (6 percent), and others (11 percent) have been collected from live-bottom stations on the Florida shelf. Non-invertebrate groups, fish (15 percent), and algae (11 percent) account for the rest of epibiotic species. More than 90 species of sponges and 53 species of scleractinian coral have been identified (Phillips et al., 1990).

3.4.3.2 St. Andrew Bay

Keppner (2002) inventoried invertebrates occurring in the SAB estuary. The inventory was based on a search of the existing and available literature, such as scientific journals, consultant's reports to agencies, theses, state and federal agency reports and publications, and specimens in various collections in Bay County. Although the author indicated many more may actually be present, a total of 1,837 species were identified including annelids (21 percent), arthropods (32 percent), mollusks (19 percent), and nematodes (15 percent) (Keppner, 2002).

3.4.4 Fish

Marine fish occupy an important part of the marine food chain, and serve as prey for many other species including other fish, seabirds, and marine mammals. Most marine fish spend part of their lives in saltwater and part of their lives in freshwater. Different life cycles for marine fish include:

- Estuarine-dependant fish depend on bays and/or estuaries for part of their life cycle.
- Catadromous fish spawn in saltwater, then migrate into freshwater to grow to maturity.
- Anadromous fish are born in fresh water, migrate to the ocean to grow into adults, and return to fresh water to spawn (USFWS, 2007).
- Some fish are totally marine species and spend their entire lives at sea.

The northeastern GOM provides a wide variety of resources for fish to inhabit and utilize. These habitats are dependent on their physical and chemical environment. Variables include salinity, temperature, depth, bottom type, primary productivity, oxygen content, turbidity, and currents. Table 3-7 illustrates the more common fish of the eastern GOM grouped by water temperature preferences.

3.4.4.1 Gulf Of Mexico

Fish may be characterized by where they live in the water column. Benthic and reef fish live at the bottom of waters and around artificial or natural reef systems. Typical fish species associated with bottom habitats include triggerfish, toadfish, flounder, stingrays, snappers, grunts, and groupers.

Table 3-7. Fish of the Northeastern GOM Delineated by Temperature Preference

Temperature Preference	Scientific Family Name	Common Name
Temperate*	*Acipenseridae*	Sturgeons
	Atherinidae	Silversides
	Clupeidae	Herring, menhaden
	Cyprinodontidae	Mummichogs, killifish
	Engraulidae	Anchovies
	Exocoetidae	Flying fish
	Percichthyidae	Striped bass
	Pomatomidae	Bluefish
Subtropical**	*Albulidae*	Bonefish
	Carangidae	Jacks
	Ephippidae	Spadefish
	Holocentridae	Squirrelfish
	Istiophoridae	Marlins
	Labridae	Wrasses
	Lutjanidae	Snappers
	Mullidae	Goatfish
	Scaridae	Parrotfish
	Sciaenidae	Drums
	Scombridae	Mackerel, bonito, tunas
	Serranidae	Groupers
	Sparidae	Porgies
	Xiphiidae	Swordfish
Tropical***	*Centropomidae*	Snooks
	Chaetodontidae	Butterflyfish, angelfish
	Coryphaenidae	Dolphinfish
	Elopidae	Tarpon
	Gerreidae	Mojarras
	Lutjanidae	Snappers
	Pomacentridae	Damselfish
	Pomadasyidae	Grunts
	Rachycentridae	Cobia
	Sciaenidae	Drums
	Sphymidae	Hammerhead sharks
	Sphyraenidae	Barracudas

*Species that prefer water temperatures of 10ºC or below, with a maximum temperature tolerance of 15ºC.
**Species that tolerate a minimum water temperature between 10º to 20ºC.
***Species that prefer waters greater than 20 degrees Celsius or above.

Pelagic fish spend most of their lives in the open waters of the GOM and make seasonal, latitudinal migrations along the west coast of Florida. These migrations are caused by seasonal changes in temperature, movement of their food resources, and spawning instincts.

Coastal pelagic families include jacks, herrings, mullet, bluefish, cobia, tunas, and mackerels, all of which migrate along the shelf waters of the GOM throughout the year. During the spring and summer, menhaden are typically found near the Mississippi Delta in the GOM, in large surface-feeding schools. Predatory species such as jacks, bluefish, cobia, and King and Spanish mackerels leave their wintering areas in south Florida to move northward in the spring along the continental shelf possibly due to the presence of large congregations of prey species in those areas, such as herring and menhaden. These species spawn over the continental shelf from northwestern Florida to the northwestern GOM off of Texas. The shallow portion of the continental shelf at the high-nutrient areas near river plumes is likely used for nursery areas (Minerals Management Service [MMS], 1990). Oceanic pelagic species include dolphinfish, marlins, tuna, and swordfish. During winter and spring, yellowfin and bluefin tuna are mainly found beyond the continental shelf off of the west coast of Florida but move through the Florida Straits into the Atlantic Ocean after spawning. Billfish, which include black marlin, white marlin, sailfish, and swordfish, spawn off northwestern Florida in areas beyond the continental shelf (MMS, 1990). Table 3-8 provides an overview of pelagics found within the NSWC PCD Study Area.

Table 3-8. Typical Pelagic Fish Found in the Northeastern GOM

Scientific Name	Common Name
Carangidae	Jacks
Clupeidae	Herrings, menhaden
Coryphaenidae	Dolphinfish
Istiophoridae	Marlins
Mugilidae	Mullets
Pomatomidae	Bluefish
Rachycentridae	Cobia
Scombridae	Tunas, mackerels, bonito
Xiphiidae	Swordfish

3.4.4.2 St. Andrew Bay

An inventory documenting fish species occurring in the SAB estuary was completed in 2002 (Keppner, 2002). The inventory was based on a search of the existing and available literature, such as scientific journals, consultant's reports to agencies, theses, state and federal agency reports and publications, and specimens in various collections in Bay County. The inventory documented 309 species of finfish (excludes shellfish) from the SAB Estuary (Keppner, 2002). Included in the inventory was the endangered Gulf sturgeon, as well as the dusky shark, which is a candidate for federal listing under the Endangered Species Act (ESA).

3.4.4.3 Threatened and Endangered Fish

A list of fish species in the GOM that are protected under or are candidates for listing under the ESA are provided in Table 3-9. The subadult and adult Gulf sturgeon is currently listed as a threatened species, and the smalltooth sawfish is currently listed as an endangered species. In addition, a critical habitat has been designated for the Gulf sturgeon (Figure 3-6). Details of all fish species protected under the ESA, or candidates for listing, are provided in Appendix F, Biological Resources.

Table 3-9. Fish Species in the GOM Protected Under or Eligible for Listing Under the ESA

Species	Status[a]	Areas of Occurrence
Gulf sturgeon *Acipenser oxyrinchus desotoi*	ESA: FT	Lives predominately in the northeastern GOM; typically occurs in waters less than 10 m (33 ft) deep. May venture into nearshore waters, as far offshore as the northern boundaries of W-151 (includes Panama City OPAREA), W-155 (includes Pensacola OPAREA), and W-470. Moves inland to spawn. Spawning takes place in the Choctawhatchee River to the east of Eglin AFB and the Apalachicola River to the east of Tyndall AFB during April through June.
Smalltooth sawfish *Pristis pectinata*	ESA: FE	Once common throughout the GOM from Texas to Florida, current distribution ranges primarily throughout peninsular and southern Florida. Resides typically within 1 mile of land in estuaries, shallow banks, sheltered bays, and river mouths with sandy and muddy bottoms.

[a] FE = Federal endangered, FT = Federal threatened

3.4.4.4 Hearing in Marine Fish

Marine fish spend at least part of their life in salt water. All fish have two sensory systems that are used to detect sound in the water including the inner ear, which functions very much like the inner ear found in other vertebrates, and the lateral line, which consists of a series of receptors along the body of the fish (Popper, 2008). The inner ear generally detects higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper, 2005). A sound source produces both a pressure wave and motion of the medium particles (water molecules in this case), both of which may be important to fish. Fish detect particle motion with the inner ear. Pressure signals are initially detected by the gas-filled swim bladder or other air pockets in the body, which then re-radiate the signal to the inner ear (Popper, 2008). Because particle motion attenuates relatively quickly, the pressure component of sound usually dominates as distance from the source increases.

Broadly, fish can be categorized as either hearing specialists or hearing generalists (Scholik and Yan, 2002). Fish in the hearing specialist category have a broad frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels above 1 kHz. Generalists are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich, 2005). It is possible that a species will exhibit characteristics of generalists and specialists and will sometimes be referred to as an “intermediate” hearing specialist. For example, most damselfish are typically categorized as generalists, but because some larger damselfish have demonstrated the ability to hear higher frequencies expected of specialists, they are sometimes categorized as intermediate.

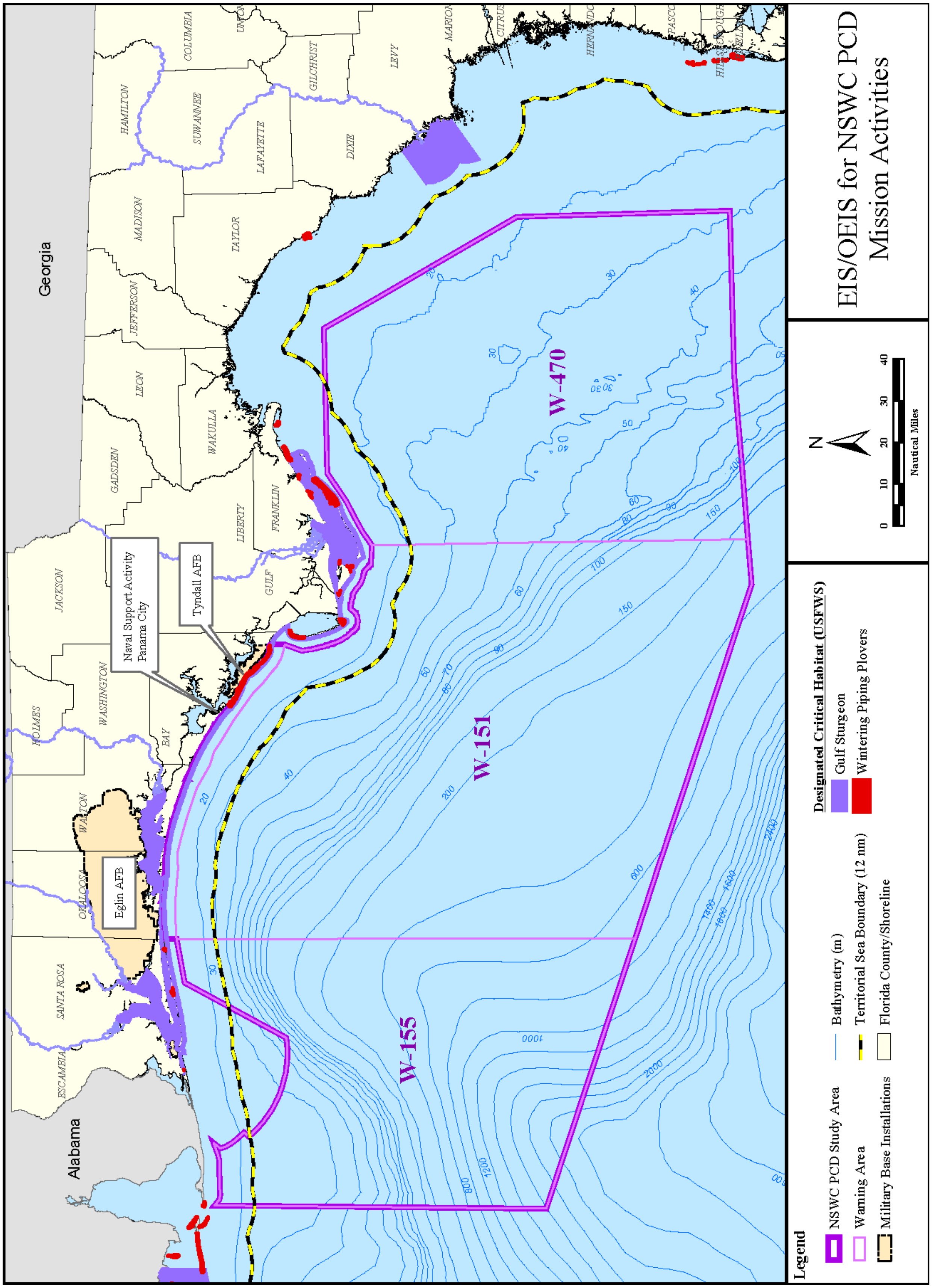

Figure 3-6. Critical Habitat

As mentioned above, the lateral line is the second component of the sensory system used by fish to detect acoustic signals. The lateral line system of a fish allows for sensitivity to sound (Hastings and Popper, 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally from below 1 Hz to a few hundred Hertz (Coombs and Montgomery, 1999; Webb et al., 2008). The only study on the effect of exposure to sound on the lateral line system (conducted on one freshwater species) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al., 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work, showing limited sensitivity to within a few body lengths and to sounds below a few hundred Hertz make the effect of the mid-frequency sonar of the Proposed Action unlikely to affect a fish's lateral line system. Therefore, further discussion of the lateral line in this analysis is unwarranted.

Hearing capability data only exists for approximately 100 of the 29,000 fish species (Popper, 2008) which equates to less than 0.4 percent of all fish species. Current data suggest that the predominance of fish hearing generally occurs from 0.05 to 1.0 kHz, with few fish hearing sounds above 4 kHz (Popper, 2008; NRC, 2003). Moreover, studies indicate that hearing specializations in marine species are quite rare and that most marine fish are considered hearing generalists (Popper, 2003; Amoser and Ladich, 2005). Examples of hearing generalists include elasmobranches (i.e., sharks and rays) (Casper et al., 2003; Casper and Mann, 2006; Myrberg, 2001), scorpaeniforms (i.e., scorpionfishes, searobins, sculpins) (Lovell et al., 2005), scombrids (i.e., albacores, bonitos, mackerels, tunas) (Iversen, 1967; Iversen 1969, Popper 1981; Song et la., 2006), damselfishes (Egner and Mann, 2005; Kenyon 1996; Wright et al., 2005; Wright et al., 2007), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass, 2003), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al., 2006). Moreover, it is believed that the majority of marine fish have their best hearing sensitivity at or below 0.3 kHz (Popper, 2003). However, it has been demonstrated that marine hearing specialists, such as some Clupeidae, can detect sounds above 100 kHz. Of all the fish species with distributions overlapping the NSWC PCD Study Area, hearing capability data is available for nearly half of them. Of those species, approximately 74 percent are classified as hearing generalists (Popper and Tavolga, 1981; Sisneros and Bass, 2003; Remage-Healey et al., 2006; Capser et al., 2003; Casper and Mann, 2006; Myberg, 2001; Egner and Mann, 2005; Popper, 2008; Kenyon, 1996; Ladich and Popper, 2004; Ramcharitar et al., 2006a; Ramcharitar et al., 2006b; Ramcharitar and Popper, 2004; Song et al., 2006; Iversen, 1967; Popper, 1981), while approximately 26 percent are classified as hearing specialists (Mann et al., 2001; Gregory and Clabburn, 2003; Ramcharitar et al., 2004). Refer to Table 3-10 for a list of marine fish hearing sensitivities and which species can be found in the NSWC PCD Study Area.

In contrast to marine fish, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich, 2005). It is also thought that Clupeidae may have evolved from freshwater habitats (Popper et al., 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich, 2005).

Some investigators (e.g., Amoser and Ladich, 2005) hypothesized that, within a family of fish, different species can live under different ambient noise conditions, which requires them to adapt their hearing abilities. Under this scenario, a species' probability of survival would be greater if it increased the range over which the acoustic environment, consisting of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources, can be detected (Amoser and Ladich, 2005). In the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae as a possible example of such environmentally-derived specialization. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper, 1979). However, as these two species live in close proximity on the same reefs, it is not certain that differing environmental conditions cause the hearing variations (Popper, 2008). Generally, a clear correlation between hearing capability and the environment cannot be asserted or refuted due to limited knowledge of ambient noise levels in marine habitats and a lack of comparative studies.

It has also been shown that susceptibility to the effects of anthropogenic sound can be influenced by developmental and genetic differences in the same species of fish. In an exposure experiment, Popper et al. (2007) found that experimental groups of rainbow trout (*Oncorhynchus mykiss*) had substantial differences in hearing thresholds. While fish were attained from the same supplier, it is possible different husbandry techniques may be reason for the differences in hearing sensitivity. These results emphasize that caution should be used in extrapolating data beyond their intent. A more detailed discussion on the potential effects of anthropogenic sounds on fish hearing is provided in Section 4.3.3.2.1.

Table 3-10. Marine Fish Hearing Sensitivities

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification	Present in NSWC PCD Study Area
				Low	High			
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis* (*Arius*) *felis**	0.05	1	0.1	Generalist	X
Batrachoididae	Toadfishes	Midshipman	*Porichthys notatus*	0.065	0.385		Generalist	X
		Gulf toadfish	*Opsanus beta*			<1	Generalist	X
Clupeidae	Herrings, shads, menhadens, sardines	Alewife	*Alosa psuedoharengus*		0.12		Specialist	
		Blueback herring	*Alosa aestivalis*		0.12		Specialist	
		American shad	*Alosa sapidissima*	0.1	0.18	0.2-0.8 and 0.025-0.15	Specialist	
		Gulf menhaden	*Brevoortia patronus*		0.1		Specialist	X
		Bay anchovy	*Anchoa mitchilli*		4		Specialist	X
		Scaled sardine	*Harengula jaguana*		4		Specialist	X
		Spanish sardine	*Sardinella aurita*		4		Specialist	X
		Pacific herring	*Clupea pallasii*	0.1	5		Specialist	
Chondrichthyes [Class]	Cartilaginous fishes, rays, sharks, skates			0.2	1		Generalist	X

Table 3-10. Marine Fish Hearing Sensitivities (Cont'd)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification	Present in NSWC PCD Study Area
				Low	High			
Gadidae	Cods, gadiforms, grenadiers, hakes	Cod	*Gadus morhua*	0.002	0.5	0.02	Generalist	
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	0.1	3.0	0.4-0.5	Specialist	
		Hawaiian squirrelfish	*Adioryx xantherythrus*	0.1	0.8		Generalist	
Pomacentridae	Damselfish	Sergeant major damselfish	*Abudefduf saxatilis*	0.1	1.6	0.1-0.4	Generalist/ intermediate	X
		Bicolor damselfish	*Stegastes partitus*	0.1	1.0	0.5	Generalist/ intermediate	X
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	0.1	2.0	<0.3	Generalist/ intermediate	
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<0.1	0.58		Generalist	
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulates*	0.1	1.0	0.3	Generalist	X
		Spotted sea trout	*Cynoscion nebulosus*				Generalist	X
		Kingfish	*Menticirrhus americanus*				Generalist	X
		Spot	*Leiostomus xanthurus*	0.2	0.7	0.4	Generalist	X
		Black drum	*Pogonias cromis*	0.1	0.8	0.1-0.5	Generalist	X
		Weakfish	*Cynoscion regalis*	0.2	2.0	0.5	Specialist	
		Silver perch	*Bairdiella chrysoura*	0.1	4.0	0.6-0.8	Specialist	X
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*		1.0		Generalist	X
		Yellowfin tuna	*Thunnus albacares*	0.5	1.1		Generalist	X
		Kawakawa	*Euthynnus affinus*	0.1	1.1	0.5	Generalist	
		Skipjack tuna	*Katsuwonus pelamis*				Generalist	X
Scorpaenidae	Scorpionfishes, searobins, sculpins	Sea scorpion	*Taurulus bubalis*				Generalist	

* Referenced as *Arius felis* by Popper and Tavolga, 1981.

Sources: Astrup, 1999; Astrup and Mohl, 1993; Casper and Mann, 2006; Casper et al., 2003; Coombs and Popper, 1979; Dunning et al., 1992; Egner and Mann, 2005; Gregory and Clabburn, 2003; Hawkins and Johnstone, 1978; Higgs et al., 2004; Iversen, 1967, 1969; Jorgensen et al., 2004; Kenyon, 1996; Lovell et al., 2005; Mann et al., 1997, 2001, 2005; Myrberg, 2001; Nestler et al., 2002; Popper, 1981; Popper and Carlson, 1998; Popper and Tavolga, 1981; Ramcharitar and Popper, 2004; Ramcharitar et al., 2001, 2004, 2006b, Remage-Healey, et al., 2006; Ross et al., 1996; Sisneros and Bass, 2003; Song et al., 2006; Wright et al., 2005, 2007; Seaworld, 2007

Among all fish studied to date, perhaps the greatest variability is found within the family Sciaenidae (i.e., drumfish, weakfish, croaker), where there is extensive diversity in inner ear structure and the relationship between the swim bladder and the inner ear. Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder has forwardly directed diverticulae that come near the ear but do not actually touch it. However, the swim bladders in the spot

(*Leiostomus xanthurus*) and black drum (*Pogonias cromis*) are further from the ear and lack anterior horns or diverticulae. These differences are associated with variation in both sound production and hearing capabilities (Ladich and Popper, 2004, Ramcharitar et al., 2006b). Ramcharitar and Popper (2004) discovered that the black drum responded to sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker responded to sounds from 0.1 to 1 kHz and was most sensitive at 0.3 kHz. Additional sciaenid research by Ramcharitar et al. (2006a) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*) and spot. Weakfish were found to detect frequencies up to 2 kHz, while spot detected frequencies only up to 0.7 kHz.

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has demonstrated auditory thresholds similar to goldfish, responding to sounds up to 4 kHz (Ramcharitar et al., 2004). Silver perch swim bladders have anterior horns that terminate close to the ear. The Ramcharitar et al. (2004) research supports the suggestion that the swim bladder can potentially expand the frequency range of sound detection. Furthermore, Sprague and Luczkovich (2004) calculated silver perch are capable of producing drumming sounds ranging from 128 to 135 dB. Since drumming sounds are produced by males during courtship, it can be inferred that silver perch detect sounds within this range.

The most widely noted hearing specialists are otophysans, which have bony Weberian ossicles (bones that connect the swim bladder to the ear), along which vibrations are transmitted from the swim bladder to the inner ear (Amoser and Ladich, 2003; Ladich and Wysocki, 2003). However, only a few otophysans inhabit marine waters. In an investigation of a marine otophysan, the hardhead sea catfish (*Ariopsis felis*), Popper and Tavolga (1981) determined that this species was able to detect sounds from 0.05 to 1 kHz, which is considered a much lower and narrower frequency range than that common to freshwater otophysans (i.e., above 3 kHz) (Ladich and Bass, 2003). The difference in hearing capabilities in the respective freshwater and marine catfish appears to be related to the inner ear structure (Popper and Tavolga, 1981).

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song et al. (2006) hypothesized that bluefin tuna probably do not detect sounds to much over 1 kHz (if that high). This research concurred with the few other studies conducted on tuna species. Iversen (1967) found that yellowfin tuna (*T. albacares*) can detect sounds from 0.05 to 1.1 kHz, with best sensitivity of 89 dB (re 1 μPa) at 0.5 kHz. Kawakawa (*Euthynnus affinus*) appear to be able to detect sounds from 0.1 to 1.1 kHz but with best sensitivity of 107 dB (re 1 μPa) at 0.5 kHz (Iversen, 1969). Additionally, Popper (1981) looked at the inner ear structure of a skipjack tuna (*Katsuwonus pelamis*) and found it to be typical of a hearing generalist. While only a few species of tuna have been studied, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or nonexistent (Song et al., 2006).

Furthermore, investigations into the inner ear structure of fishes belonging to the order Scorpaeniformes have suggested that these fishes have generalist hearing abilities (Lovell et al., 2005). Although an audiogram (which provides a measure of hearing sensitivity) has yet to be performed, the lack of a swimbladder is indicative of these species having poor hearing ability (Lovell et al., 2005). However, studies of the leopard robin (*Prionotus scitulus*), another species in this order that do contain swim bladders, indicated that they are hearing generalists as well (Tavolga and Wodinski, 1963) which makes extrapolation on hearing from this species to all members of the group very difficult to do (Popper, 2008).

Some damselfish have been shown to be able to hear frequencies of up to 2 kHz, with best sensitivity well below 1 kHz. Egner and Mann (2005) found that juvenile sergeant major damselfish (*Abudefduf saxatilis*) were most sensitive to lower frequencies (0.1 to 0.4 kHz); however, larger fish (greater than 50 millimeters) responded to sounds up to 1.6 kHz. Still, the sergeant major damselfish is considered to have poor sensitivity in comparison even to other hearing generalists (Egner and Mann, 2005). Kenyon (1996) studied another marine generalist, the bicolor damselfish (*Stegastes partitus*), and found the bicolor damselfish responded to sounds up to 1.6 kHz with the most sensitive frequency at 0.5 kHz. Further, larval and juvenile Nagasaki damselfish (*Pomacentrus nagasakiensis*) have been found to hear at frequencies between 0.1 and 2 kHz, however, they are most sensitive to frequencies less than 0.3 kHz (Wright et al., 2005; Wright et al., 2007). Thus, damselfish appear to be primarily generalists with some ability to hear slightly higher frequencies expected of specialists (Popper, 2008).

As mentioned above, investigations into the hearing ability of marine fishes have most often yielded results exhibiting poor hearing sensitivity. Experiments on elasmobranch fish (i.e., sharks and rays) have demonstrated poor hearing abilities and frequency sensitivity from 0.02 to 1 kHz, with best sensitivity at lower ranges (Casper et al., 2003; Casper and Mann, 2006; Myrberg, 2001). Though only five elasmobranch species have been tested for hearing thresholds, it is believed that all elasmobranchs will only detect low-frequency sounds because they lack a swim bladder, which resonates sound to the inner ear. Theoretically, fishes without an air-filled cavity are limited to detecting particle motion and not pressure and therefore have poor hearing abilities (Casper and Mann, 2006).

3.4.5 Essential Fish Habitat

As discussed in Section 1.4.5, the MSA (16 USC 1801), enacted in 1976, established the GMFMC. The GMFMC provides for the conservation and management of fishery resources within the U.S. Exclusive Economic Zone (EEZ). It also provides for fishery management authority over continental shelf resources and anadromous species (species of fish that spawn in fresh or estuarine waters then migrate to ocean waters) beyond the EEZ, except when they are found within a foreign nation's territorial sea or fishery conservation zone (or equivalent), to the extent that such sea or zone is recognized by the United States. The NSWC PCD Study Area encompasses EFH for a number of fish species.

As defined in Section 3 of the MSA, fish includes finfish, mollusks, crustaceans, and all other forms of marine animal and plant life, other than marine mammals and birds. Fish habitat utilized by a species can change with life history stage, abundance of the species and competition from other species, and environmental variability in time and space. The type of habitat available, its attributes, and its functions are important to species productivity and societal benefits. Some potential threats to habitat include certain fishing practices, marina construction, navigation projects, dredging, alteration of freshwater input into estuaries, and runoff.

GMFMC developed seven fishery management plans (FMPs) between 1979 and 1986. Two of the seven, those for coastal migratory pelagics and spiny lobster, were developed jointly with the South Atlantic Fishery Management Council (SAFMC) because the stocks of the managed species cross into both regions. The other five fishery management plans, those for reef fish, shrimp, stone crab, red drum, and coral and coral reefs were developed exclusively by the GMFMC. The councils have amended each FMP a number of times. Combined, 55 species are managed, excluding the coral complex. Several FMPs contain programs for license limitation, license moratoria, and/or trap limitations; other management actions work toward preventing overfishing or rebuilding overfished stocks; and certain actions establish seasonal or area closures to certain gear types. These actions either directly or indirectly reduce fishing effort and potential adverse fishing impacts to segments of EFH.

Once a FMP is finalized, NMFS becomes responsible for the implementation of the regulations and the USCG provides enforcement authority (GMFMC, 2007). EFH has been identified for several species within the GOM; these species and their habitat by life stage are presented in Table 3-11. Maps depicting EFH of several fisheries species within the GOM are provided in Appendix F, Biological Resources. For more information on EFH and specific EFH resources, refer to Appendix F, Biological Resources. Section 3.5.3 provides information about artificial reefs.

Table 3-11. Representative Managed Species with Essential Fish Habitat Identified in the GOM

Species	Life Stage	Habitat
Atlantic Sharpnose Shark	Neonate	Shallow areas; 0 to 5 m (0 to 16 ft)
Black Grouper	Adult, juveniles/subadults, larvae, eggs[sa]	Hardbottom; shore to 150 m (492.13 ft)
Blacknose Shark	Juvenile	Shallow estuaries; 0 to 5 m (0 to 16 ft)
Blacktip Shark	Neonate, juvenile	Shallow waters on seaward side of coastal islands; 0 to 5 m (0 to 16 ft)
Blue Marlin	Adult, juvenile/subadult	Pelagic; 100 to 2,000 m (328 to 6,562 ft) isobath
Bluefin Tuna	Adult	Pelagic; from 100 m (328 ft) isobath to the U.S. EEZ boundary
Bonnethead shark	Neonate, juvenile, adult	Shallow coastal waters, inlets, and estuaries; 5 to 25 m (16 to 82 ft) deep
Brown Shrimp	Adult	Softbottom; estuarine dependent
Bull Shark	Neonate, juvenile, adult	Shallow coastal waters; 0 to 25 m (0 to 82 ft)
Cobia	Adult, juveniles/subadults, larvae, eggs[sa]	Pelagic; drifting or stationary floating objects
Corals	All life stages	Hardbottom
Sargassum	All life stages	Pelagic
Dolphin (Mahi)	Adult, juveniles/subadults, larvae, eggs[sa]	Pelagic; floating objects
Dusky Shark	Juvenile	Shallow coastal waters, inlets, and estuaries to the 500 m (1,640 ft) isobath
Finetooth Shark	Neonate, juvenile, adult	Shallow coastal waters to the 25 m (82 ft) isobath
Gag Grouper	Adult	Hardbottom
Greater Amberjack	Adult, juveniles/subadults, larvae, eggs[sa]	Pelagic and epibenthic; reefs and wrecks; to 400 m (1,312.34 ft)
Gray Snapper	Adult	All bottom types; 0 to 130 m (0 to 426.51 ft)
Gray Triggerfish	Adult	Hardbottom
King Mackerel	Adult	Pelagic
Lesser Amberjack	Adult, juveniles/subadults, larvae, eggs[sa]	Pelagic
Lane Snapper	Adult, juveniles/subadults, larvae, eggs[sa]	Soft and hardbottom; 0 to 130 m (0 to 426.51 ft)
Little Tunny	Adult, juveniles/subadults, larvae, eggs[sa]	Pelagic
Longfin Mako Shark	All life stages	Pelagic; 200 m (656 ft) isobath to U.S. EEZ

Table 3-11. Representative managed Species with Essential Fish Habitat Identified in the GOM (Cont'd)

Species	Life Stage	Habitat
Oceanic Whitetip Shark	Juvenile	Pelagic; 200 m (656 ft) to the U.S. EEZ
Pink Shrimp	Adult[sa]	Soft, hardbottom; inshore to 65 m (213.26 ft)
Red Drum	Adult[sa]	Softbottom, oyster reefs, estuarine to 40 m (131.23 ft)
Red Grouper	Adult, juveniles/subadults, larvae, eggs[sa]	Hardbottom; 3 to 200 m (9.84 to 656.17 ft)
Red Snapper	Adult, juveniles/subadults, larvae, eggs[sa]	Hardbottom, pelagic
Sailfish	Adult, juvenile/subadult	Pelagic and coastal waters; 200 m to 2,000 m (656 to 6,562 ft) isobath; up to 50 m (164 ft) isobath near De Soto Canyon
Sandbar Shark	Adult, juvenile, neonate	Shallow coastal waters to the 90 m (295 ft) isobath
Scalloped Hammerhead Shark	Juvenile, neonate	Shallow coastal waters, coastal bays, estuaries; 5 m (16 ft) to the 200 m (656 ft) isobath
Scamp	Adult	Hardbottom
Silky Shark	Neonate	Pelagic, 200 to 2,000 m (656 to 6,562 ft) isobath
Skipjack Tuna	Spawning adult, egg, larvae	Offshore waters from 200 m (656 ft) isobath to the U.S. EEZ
Stone Crab	Adult[sa]	Soft, hard or vegetated bottom
Spiny Lobster	Adult	Hardbottom
Spanish Mackerel	Adult, juveniles/subadults, larvae, eggs[sa]	Pelagic; inshore to 200 m (656.17 ft)
Spinner Shark	Neonate	Shallow coastal bays; 0 to 5 m (0 to 16 ft)
Swordfish	Adult, spawning adult, egg ,larvae	Pelagic; 200 to 2,000 m (656 to 6,562 ft) isobath
Tiger Shark	Adult, juvenile, neonateeonate	Shallow coastal waters to the 200 m (656 ft) isobath
Tilefish	Adult[sa]	Softbottom, steep slopes; 80 to 540 m (262.47 to 1,771.65 ft)
Vermillion Snapper	Adult, juveniles/subadults, larvae, eggs[sa]	Hardbottom; 20 to 200 m (65.6 to 656.17 ft)
White Marlin	Adult, juvenile	Pelagic; 200 to 2,000 m (656 to 6,562 ft) isobath and along 50 m (164 ft) isobath along De Soto Canyon
White Shrimp	Adult, juveniles/subadults, larvae, eggs[sa]	Softbottom; inshore to 40 m (131.23 ft)
Yellowfin Tuna	Adult, juvenile/subadult, larvae, eggs	Pelagic waters from the surface to 100 m (328 ft) deep and from 200 m (656 ft) isobath to the U.Z. EEZ
Yellowtail Snapper	Adult, juveniles/subadults, larvae, eggs[sa]	Hardbottom; 0 to 180 m (0 to 590.55 ft)

sa = spawning area

3.4.6 Birds

The GOM is populated by both resident and migratory coastal and marine birds. For discussion purposes, these species have been separated into six groups: diving birds, gulls/terns, shorebirds, passerines, wading birds, and waterfowl. Examples of birds that fall into one of these six groups are provided in Table 3-12. Many species of birds likely to occur in the GOM are pelagic (open ocean) species and therefore are rarely sighted nearshore (MMS, 2007a). In addition, the Migratory Bird Treaty Act (MBTA) protects a total of 836 migratory bird species, 58 of which are currently legally hunted as game birds. Refer to Figure 3-7 for the GOM migratory route for numerous species of birds.

Table 3-12. Birds in the GOM

Diving Birds	Gulls/Terns	Shorebirds	Passerines	Wading Birds	Waterfowl
Common loon Horned grebe Pied-billed grebe Anhinga Double-crested cormorant Ganats Boobies Petrels Shearwaters	Gulls Terns Noddies Jaegers Black skimmers	Jacanas Oystercatchers Stilts Avocets Snipes Allies Upland sandpiper White-rumped sandpiper Dunlin Semipalmated sandpiper Piping plover Snowy plover Black-bellied plover Wilson's plover Western sandpiper	Blue jay Red-winged blackbird Common grackle Northern cardinal Eastern towhee	American bittern Least bittern Great blue heron Great egret Snowy egret Little blue heron Tricolored heron Cattle egret Black-crowned night heron White ibis	Greater scaup Lesser scaup Blue-winged teal

Source: MMS, 2007a and U.S. Geological Survey, 2007

3.4.6.1 Diving Birds

Diving birds are a diverse group. There are three main groups of diving birds: cormorants and anhingas, loons, and grebes. Diving birds prefer fish and are able to actively search for and capture their prey because their eyes have been adapted to see underwater. Nesting diving birds in the GOM include cormorants (MMS, 2007a). These birds feed generally by pushing themselves underwater with their wings and/or feet. Loons and grebes closely resemble one another; however, loons are larger and have a thicker neck and longer bill. The five species of loons migrate to the GOM during the non-breeding winter season. Grebes that winter along the Gulf Coast of Florida include horned and eared grebes.

3.4.6.2 Gulls/Terns

Gulls, terns, noddies, jaegers, and black skimmers make up the gull/tern group. Most of these species eat exclusively small fish and feed by pushing themselves underwater with their wings and/or feet. Terns are streamlined and have substantial size bills relative to prey size for scooping, plunge diving, and underwater pursuit of fish. Exceptions to these feeding methods are the sooty tern (the only tropical species in the group) and gull-billed tern, which pluck food from the water's surface (MMS, 2007a).

3.4.6.3 Shorebirds

Shorebirds are generally restricted to coastline and inland water margins (beaches, mudflats, etc.). An important characteristic of almost all shorebird species is their strongly developed migratory behavior, with some shorebirds migrating from nesting places in the high Arctic tundra to the southern part of South America. Along the central Gulf Coast, 44 species of shorebirds have been recorded; only 6 nest in the area, the remaining being wintering residents and/or staging migrants (MMS, 2007a).

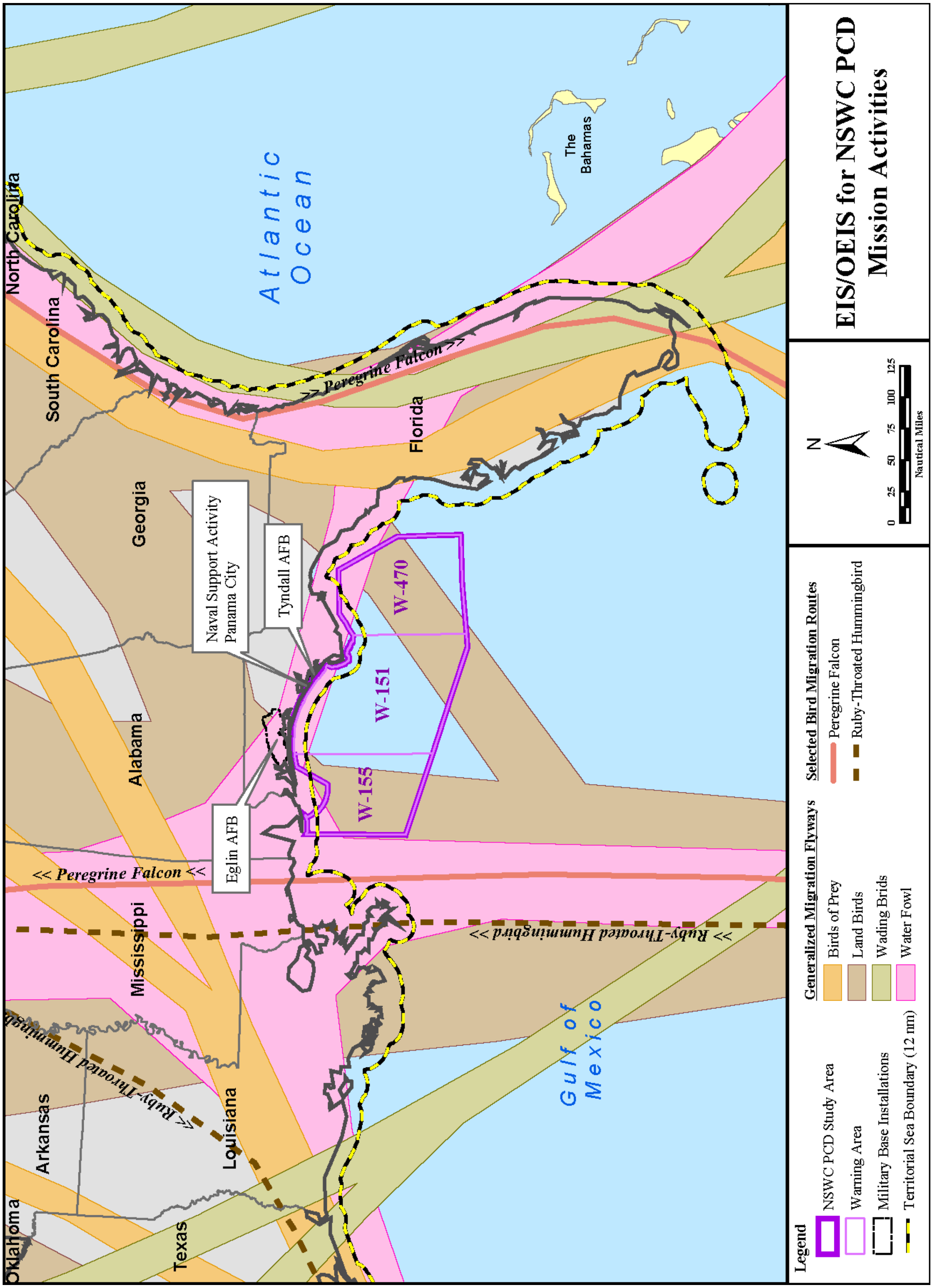

Figure 3-7. Migratory Bird Corridor

3.4.6.4 Passerine Birds

Passerine birds mostly migrate across the GOM each fall and spring and are protected along with other migrants under the MBTA. Trans-Gulf (flying straight over the GOM) migration peaks in late April and early May, coinciding with a southerly airflow (Moore et al., 1995). Fall migrations occur regularly between September and October. Some important resting areas for migratory birds include SAB, Apalachicola Bay, Tampa Bay, Gulf Islands National Seashore, St. Joseph Peninsula State Park, and St. George Island State Park (Duncan, 1994; Sprandel et al., 1997). The majority of these neotropical migrants (or birds that winter in the tropics and breed in temperate climates) fly at night, usually beginning at sunset and ending by dawn or when they find suitable habitat (Moore et al., 1995). In addition, neotropical species can be expected to be found flying at altitudes ranging from 150 m (492 ft) to 4,000 m (13,123 ft) above the surface of the water.

3.4.6.5 Wading Birds

Wading birds are those birds that have adapted to living in shallow water. They have long legs that allow them to forage by wading into shallow water, while their long bills, usually accompanied by long necks, are used to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (MMS, 2007a).

3.4.6.6 Waterfowl

Waterfowl include swans, geese, and ducks. Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the north. Waterfowl are highly social and possess a diverse array of feeding adaptations related to their habitat (MMS, 2007a). Typically waterfowl are found inland away from coastal waters; therefore, it is unlikely this group of species would be encountered in the NSWC PCD Study Area.

3.4.6.7 Seabird Foraging and Hearing

In order to adequately analyze the potential impacts to seabirds from noise associated with RDT&E activities, it is important to discuss their foraging habits and hearing abilities.

Seabird Foraging Habits

Most seabirds are visual predators and forage during the daylight hours (Shealer, 2002). Food is located primarily by visual or tactile sensory perception, and certain species may use olfactory senses (Furness and Monaghan, 1987). There are no known published reports that indicate that sea birds use hearing and/or echolocation to find prey when submerged.

Most seabirds can only feed at or near the surface (Furness and Monaghan, 1987). Some species (e.g., sulids, tropicbirds, many terns, and pelicans) feed just below the surface utilizing a method referred to as plunge diving to acquire food (Schreiber and Burger, 2002). Plunge diving is when a bird dives from the air into the water. When plunge diving, the birds penetrate the water little further than their own body length (Furness and Monaghan, 1987) and remain underwater for only a few seconds.

Another method of obtaining prey when submerged is referred to as pursuit diving. This method is used by such birds as cormorants and diving petrels and requires the bird to use its wings and/or feet to propel itself underwater (Schreiber and Burger, 2002). A few seabird species can dive to deep depths and stay submerged for several minutes. Wilson et al. (2002) indicates cormorants forage at a depth of 10 to 130 m (32.8 to 426.5 ft), gannets and boobies from 2 to 25 m (6.6 to 82.0 ft), and petrels and shearwaters from 0 to 70 m (0 to 229.7 ft). Terns are classified as pursuit divers with a foraging depth of 2 m (6.6 ft). In the GOM, cormorants are listed as being present all year. Other species of pursuit divers (e.g., terns) are listed as being in the winter and summer months.

Seabird species that forage at night predominately feed at the surface. Studies of the diet of these species indicate that the prey base is more likely to be available at or near the surface at night (such as bioluminescent myctophid fish or vertically migrating euphausiids such as krill) (Shealer, 2002).

Seabird Hearing Abilities

Seabirds' sense of hearing enables them to recognize the vocalization of a mate, offspring, or antagonist of the same species. There is no evidence that seabirds hear ultrasounds as high as those uttered by bats or mice (Hosking, 1983). There is no available data that describes a seabird's ability to hear under water. Studies of in-air hearing in birds note that behavioral measurement of absolute auditory sensitivity in a wide variety of birds show a region of maximum sensitivity between 1 and 5 kHz (NMFS, 2003a).

There have been attempts to use acoustic deterrents to alter seabird behavior, especially to reduce seabird bycatch in commercial fisheries' nets (Melvin, 1999) or predation with respect to commercial aquaculture operations (Ross et al., 2001). Ross et al. (2001) reports of a study conducted in Scotland that used underwater sound projectors in an attempt to prevent the predation of mussels by the common eider, *Somateria mollissima*. The sound projectors played recording of boat engines (boats are commonly used to chase eiders away). The study indicated that broadcasting a recording of a boat engine did alter the common eider's behavior, while unassociated noise did not appear to alter this species behavior. This study suggests that the birds associated boat engine noise with a previous visual deterrent. Other studies have found that seabirds react to loud sounds (Burger, 1981; 1983). However, even in the presence of loud sounds, seabirds respond with altered behavior to sudden unexpected sounds, and this behavior is even more enhanced when accompanied by a visual stimulus (Burger, 1981; Burger, 1983; Brown, 1990).

3.4.6.8 Protected, Threatened, and Endangered Birds

The threatened and endangered birds in the GOM are listed in Table 3-13. The brown pelican, a bird familiar to everyone in the eastern GOM, has been removed from the federal endangered species list in Florida, but remains a species of special concern (MMS, 1990; Florida Game and Freshwater Fish Commission, 1994). Such a species or subspecies is currently at a level of moderate risk of extinction in the future. The bald eagle has also been delisted, but remains protected under the Bald and Golden Eagle Protection Act (BGEPA). In addition, critical habitat has been designated for the piping plover (Figure 3-6). A description of each species is provided in Appendix F, Biological Resources.

Table 3-13. Protected Avian Species in the GOM

Species	Status[a]	Areas of Occurrence
Wood stork *Mycteria americana*	ESA: FE	Inhabits tropical, subtropical zones with distinct wet and dry seasons.
Bald eagle *Haliaeetus leucocephalus*	BGEPA: Protected	Sixty-six active nests in the Florida Panhandle, seven of which are in Bay County.
Piping plover *Charadrius melodus*	ESA: FT	Winters in eastern Florida Panhandle, Franklin to Bay County. In 2001 13% of Florida sightings of piping plover were along Gulf Coast sites. Critical habitat has been designated on Crooked Island.

Source: Florida Natural Areas Inventory (FNAI), 2004
[a] FE = Federal endangered, BGEPA = Bald and Golden Eagle Protection Act, FT = Federal threatened

3.4.7 Marine Mammals

Cetaceans (whales and dolphins) inhabiting the GOM may be grouped as odontocetes (toothed whales, including dolphins) or mysticetes (baleen whales). Most of the cetaceans occurring in the GOM belong to the odontoceti. Very few baleen whales exist in the GOM and all species except the Bryde's whale would not be expected to occur within the NSWC PCD Study Area given the preference of these species for deeper waters. Fourteen species of dolphin belonging to the family Delphinidae, and fifteen species of whale belonging to four families inhabit or migrate through the eastern GOM. Six of the fifteen whale species are considered extralimital to the NSWC PCD Study Area. The endangered Florida manatee also has the potential to occur here. However, although sightings of the Florida manatee have occurred throughout the coastal areas of the GOM all the way west to Texas, manatees are most commonly sighted in Florida and Georgia even during warm summer months (USFWS, 2008). The introduction of powerplants and papermills in northern Florida, southern Georgia, Louisiana, and Texas has increased the availability of warm water in other parts of the GOM. As a result of this, manatees have become attracted to the warm water effluents produced by these industrial processes, and have expanded their winter habitat (USACE, 2008). However, along the Gulf coast, manatees are commonly sighted from the Wakulla River, which is located in the eastern portion of the NSWC PCD Study Area, and to the south (USACE, 2008). The eastern GOM supports a variety of marine mammal species. All cetaceans are afforded some degree of federal protection under the Marine Mammal Protection Act (MMPA), and several are listed under the ESA.

3.4.7.1 Gulf Of Mexico

Table 3-14 lists those marine mammals that are common in the GOM. These species are protected under the MMPA and include the Atlantic bottlenose dolphin (*Tursiops truncatus*), pantropical spotted dolphin (*Stenella attenuata*), Atlantic spotted dolphin (*Stenella plagiodon*), and striped dolphin (*Stenella coeruleoalba*). Of all whale species in the GOM, the endangered sperm whales (*Physeter macrocepalus*) are the most abundant (Waring et al., 2007). Chapter 4 includes information on the density calculations used for impact analysis during NSWC PCD RDT&E activities. Refer to Appendix F, Biological Resources, for marine mammal descriptions.

Table 3-14. Marine Mammals in the GOM

Species	ESA Status[a]	Areas of Occurrence
North Atlantic right whale *Eubalaena glacialis*	ESA: FE	Most endangered of the large whales. Population declining. Rare visitor to the GOM. Only three sightings of North Atlantic right whales have been documented here, most recently in March 2006. Right whales are considered extralimital to the NSWC PCD Study Area. The species is dismissed from further discussion and analysis.
Humpback whale *Megaptera novaeangliae*	ESA: FE	Sightings and strandings have been recorded from fall through spring in the GOM, although low to no occurrence is expected. Individuals have been seen far inshore off western Florida. Humpback whales are considered extralimital to the NSWC PCD Study Area; therefore, the species is dismissed from further examination.
Sei whale *Balaenoptera borealis*	ESA: FE	Not expected to occur in the NSWC PCD Study Area. Only one stranding has been reported on the panhandle of Florida. Sei whales are considered extralimital to the NSWC PCD Study Area. Thus, the species is dismissed from further discussion and analysis.
Fin whale *Balaenoptera physalus*	ESA: FE	Small numbers of sightings and strandings have been documented in the GOM. May be rare visitor to this area or may be relict (persistent remnants of a formerly widespread species in certain isolated areas) resident population. Fin whales are considered extralimital to the NSWC PCD Study Area. They are dismissed from further examination.
Blue whale *Balaenoptera musculus*	ESA: FE	Largest animal on earth. Only two cases of blue whales have been documented in the GOM. Not expected to occur within NSWC PCD Study Area. Blue whales are considered extralimital to the NSWC PCD Study Area; therefore, the species is dismissed from further discussion and analysis.
Bryde's whale *Balaenoptera edeni*		Most common baleen whale in the GOM. Most sightings of the Bryde's whale have occurred during the spring and summer months along the edge of DeSoto Canyon.
Minke whale *Balaenoptera acutorostrata*		This species has only been documented as stranded individuals in the GOM. Low occurrence in the GOM, with no distribution expected in the NSWC PCD Study Area. Thus, the species is dismissed from further discussion and analysis.
Sperm whale *Physeter macrocephalus*	ESA: FE	The most abundant of the federally listed endangered whales in the GOM. Areas of relatively high abundance west of W-151 (includes Panama City Operating Area).
Pygmy sperm whale *Kogia breviceps*		Distribution in Atlantic ranges from Nova Scotia to Greater Antilles, including the northeastern and western GOM. Sightings have occurred in the northern GOM primarily along the continental shelf edge and in deeper continental shelf waters during all seasons except winter.
Dwarf sperm whale *Kogia simus*		Dwarf sperm whales generally inhabit the deeper offshore waters, feeding on squid, crustaceans, and fish.
Cuvier's beaked whale *Ziphius cavirostris*		Perhaps the most common beaked whale in the GOM, these animals have been sighted during all seasons within the eastern GOM.
Gervais' beaked whale *Mesoplodon europaeus*		Information on this species in the GOM in general indicates that they are deep-diving animals, feeding on fish, squid, and deep-water benthic invertebrates. This species has been sighted within the eastern GOM.
Sowerby's beaked whale *Mesoplodon bidens*		Occurs in cold temperate waters in North Atlantic and Indian Ocean; may occasionally occur within the NSWC PCD Study Area. Avoids vessels.

Table 3-14. Marine Mammals in the GOM (Cont'd)

Species	ESA Status[a]	Areas of Occurrence
True's beaked whale *Mesoplodon mirus*		Found in deep, temperate waters on continental slope; may be associated with the Gulf Stream. Feeds on squid and deepwater fish.
Blainville's beaked whale *Mesoplodon densirostris*		Blainville's beaked whales are difficult to distinguish from other beaked whales during surveys, but beaked whales in general were sighted in all seasons within the eastern GOM.
Killer whale *Orcinus orca*		Killer whales are found in all oceans of the world with local distribution ranging from the Atlantic pack ice to the Lesser Antilles, including the north, east, and western GOM.
False killer whale *Pseudorca crassidens*		Occurs primarily in waters greater than 200 m (656 ft) deep in the GOM. Distribution of species is expected to be consistent throughout the year.
Pygmy killer whale *Feresa attenuata*		Distribution in the Atlantic ranges from North Carolina to the Lesser Antilles, including the GOM. Sighted primarily outside the region of influence.
Short-finned pilot whale *Globicephala macrorhynchus*		Distribution in the Atlantic ranges from New Jersey to Venezuela, including GOM.
Risso's dolphin *Grampus griseus*		Sightings in the GOM and Atlantic occur along continental shelf and slope; this species is abundant within the eastern GOM.
Melon-headed whale *Peponocephala electra*		Distribution is worldwide tropical to warm-temperate waters including the Atlantic Ocean and GOM.
Rough-toothed dolphin *Steno bredanensis*		Expected to occur throughout the year in the GOM and Atlantic.
Atlantic bottlenose dolphin *Tursiops truncatus*		Bottlenose dolphins are commonly sighted in groups throughout the coastal, continental shelf, and slope waters of the NSWC PCD Study Area. A very small population is resident to St. Andrew Bay.
Atlantic spotted dolphin *Stenella frontalis*		Diet of the Atlantic spotted dolphin consists of squid and fish from the surface and epipelagic zones of the GOM.
Pantropical spotted dolphin *Stenella attenuata*		Year-round inhabitants of the GOM and Atlantic having been sighted during all seasons, primarily in waters greater than 200 m (656 ft).
Striped dolphin *Stenella coeruleoalba*		Primarily found off deeper waters of the continental shelf and have been sighted in the Atlantic and northern GOM.
Spinner dolphin *Stenella longirostris*		Distribution in the Atlantic ranges from eastern Newfoundland to the Lesser Antilles, including northern and eastern GOM waters. Sightings in the GOM occur along continental shelf and slope.
Clymene dolphin *Stenella clymene*		Distribution in Atlantic ranges from New Jersey to Lesser Antilles, including GOM. Primarily sighted outside the NSWC PCD Study Area.
Fraser's dolphin *Lagenodelphis hosei*		Species is tropically distributed; should be expected in pelagic waters of all oceans. Has been sighted in northern GOM.
West Indian manatee *Trichechus manatus*	ESA: FE	Herbivorous aquatic mammal. Diet consists mainly of water hyacinth, hydrilla, turtle grass, manatee grass, and shoal grass. Usually occurs south of Suwannee River, but has been sighted in northwest Florida.

Source: DON, 2007a [a] FE = Federal endangered

Table 3-15 provides an overview of the minimum population estimates for marine mammal stocks by region in the NSWC PCD Study Area, which are calculated by NMFS officials in their Stock Assessment Reports. Stocks and regions are provided because some species, in this case the Atlantic bottlenose dolphin, have been divided by NMFS officials into different stocks based on their anatomical, genetic, and/or behavioral characteristics.

Table 3-15. Best and Minimum Population Estimates for Marine Mammals in the GOM Calculated by NMFS

Species	Stock	Best Population Estimate	Minimum Population Estimate
Bryde's Whale	Northern GOM	40	25
Sperm Whale	Northern GOM	1,349	1,114
Dwarf and Pygmy Sperm Whale	Northern GOM	742	584
Mesoplodon sp. (Blainville's & Gervais Beaked Whales)	Northern GOM	106	76
Cuvier's Beaked Whale	Northern GOM	95	65
Sowerby's Beaked Whale	Western North Atlantic	NA	NA
Killer Whale	Northern GOM	133	90
False Killer Whale	Northern GOM	1,038	606
Pygmy Killer Whale	Northern GOM	408	256
Risso's Dolphin	Northern GOM	2,169	1,668
Rough-toothed Dolphin	Northern GOM	2,223	1,595
Atlantic Bottlenose Dolphin	Coastal, Eastern GOM	9,912	8,963
Atlantic Bottlenose Dolphin	GOM Bay Sound and Estuarine (SAB)	124	79
Atlantic Bottlenose Dolphin	Continental Shelf &Slope	25,320	20,414
Atlantic Bottlenose Dolphin	GOM Oceanic	2,239	1,607
Atlantic Bottlenose Dolphin	Northern GOM Coastal	4,191	3,518
Atlantic Spotted Dolphin	Northern GOM	30,947	24,752
Pantropical Spotted Dolphin	Northern GOM	91,321	79,879
Striped Dolphin	Northern GOM	6,505	4,599
Spinner Dolphin	Northern GOM	11,971	6,990
Clymene Dolphin	Northern GOM	17,355	10,528
Florida Manatee	Northern GOM	Unknown	1,822
Fraser's Dolphin	Northern GOM	726	427

NA Not applicable; OCS = Outer Continental Shelf
Source: Waring et al., 2007; USFWS, 2000

SAB

A resident population of bottlenose dolphins lives in SAB (Waring et al., 2002). Scientists at NMFS have conducted stock assessments of coastal bottlenose populations and have determined that the coastal form of bottlenose dolphin constitutes a separate genetic stock within the bays and estuaries in which they occur. The inshore form possesses slightly different physical characteristics than the offshore variety. The offshore animals are more robust and possess darker coloration, and larger features than their inshore counterparts (Wells and Scott, 2002). Bottlenose dolphins are the only cetacean species found in SAB.

3.4.7.2 Threatened and Endangered Marine Mammals

As shown in Table 3-14, seven endangered marine mammals occur in the GOM. These species include the blue whale, fin whale, humpback whale, North Atlantic right whale, sperm whale**,** sei whale, and the West Indian manatee. A description of these species is provided in Appendix F, Biological Resources.

3.4.7.3 Cetacean Stranding Events

This section provides discussion on strandings included in other Navy EIS/OEISs for informational purposes only. Based on geographic features of the NSWC PCD Study Area and the number, types, and intensity of NSWC PCD RDT&E activities performed, stranding events are not expected in the NSWC PCD Study Area.

When a live or dead marine mammal swims or floats onto shore and becomes “beached” or incapable of returning to sea, the event is termed a “stranding” (Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007a). The legal definition for a stranding within the United States is that “a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance” (16 USC 1421h).

The majority of animals that strand are dead or moribund (i.e., dying) (NMFS, 2007a). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival.

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (NMFS, 2007a).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell 1987; Walsh et al., 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al. 1999). All of these normally pelagic off-shore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier’s dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier’s beaked whales, California sea lions, and harbor seals (Mazzuca et al. 1999, Norman et al., 2004, Geraci and Lounsbury 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2002; Gulland, 2006; NMFS, 2007a). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include the following (Hohn et al., 2006b):

1. A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.
2. A temporal change in morbidity, mortality, or strandings is occurring.
3. A spatial change in morbidity, mortality, or strandings is occurring.
4. The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
5. Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).
6. Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.
7. Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al., 1999; Carretta et al., 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Hoelzel, 2003; Geraci and Lounsbury, 2005; NRC, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding. Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes as listed below:

- Natural Stranding Causes
    - Disease
    - Natural toxins
    - Weather and climatic influences
    - Navigation errors
    - Social cohesion
    - Predation
- Human Influenced (Anthropogenic) Stranding Causes
    - Fisheries interaction
    - Vessel strike
    - Pollution and ingestion
    - Noise

Specific beaked whale stranding events potentially associated with naval operations are as follows:

- May 1996: Greece (North Atlantic Treaty Organization [NATO]/U.S.)
- March 2000: Bahamas (U.S.)
- May 2000: Portugal, Madeira Islands (NATO/U.S.)
- September 2002: Canary Islands (NATO/U.S.)
- January 2006: Spain, Mediterranean Sea coast (NATO/U.S.)

These events represent a small overall number of animal strandings (40 animals) over an 11 year period and not all worldwide beaked whale strandings can be linked to naval activity (International Council for Exploration of the Sea [ICES], 2005a; 2005b; Podesta et al., 2006). Four (Greece, Portugal, Spain, and Canary Islands) of the five events occurred during NATO exercises or events where DON presence was limited. One (Bahamas) of the five events involved only DON ships. These five events are described briefly below. For detailed information on these events, refer to Appendix G, Marine Mammal Stranding Report.

- May 1996 Greece - Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1μPa, respectively (D'Amico and Verboom, 1998; D'Spain et al., 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.
- March 2000, Bahamas – Seventeen marine mammals comprised of Cuvier's beaked whales, Blainville's beaked whales (*Mesoplodon densirostris*), minke whale

(*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*), stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15–16, 2000 (Evans and England, 2001). The strandings occurred over a 36 hour period and coincided with DON use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined.

- May 2000, Madeira Island, Portugal – Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 – 14, 2000 (Cox et al., 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 – 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.
- September 2002, Canary Islands – On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzarote Islands in the Canary Islands (Jepson et al., 2003). At the time of the strandings, an international naval exercise called (Neo-Tapon, 2002) that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al., 2005). The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events.
- January 2006, Spain – The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26–28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 50 NM of the stranding site. According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

By comparison, potential impacts to all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals versus 10s of animals) (Culik, 2002; ICES, 2005b; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, or significant portion of the overall ocean noise budget. A constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid-frequency sonar (Bradshaw et al., 2006; ICES 2005b; Barlow and Gisiner, 2006; Cox et al., 2006).

Refer to Appendix G, Marine Mammal Stranding Report, for additional information on the history of stranding, a description of the above-listed stranding events, a review of the many different possible reasons for stranding, as well as the stranding investigation findings and conclusions.

3.4.8 Sea Turtles

An overview of sea turtles is provided below because of the extent of their management by NMFS and the U.S. Fish and Wildlife Service (USFWS). Refer to Appendix F, Biological Resources, for sea turtle species descriptions.

As shown in Table 3-16, five species of sea turtles occur along the continental shelf of the eastern GOM: greens, hawksbills, Kemp's ridleys, leatherbacks, and loggerheads. Loggerheads and leatherbacks also occur over the slope region of the eastern GOM. Cape San Blas has been documented as supporting the highest density of nesting sea turtles in northwest Florida (Lamont et al. 1997, McMichael, 2003). Of the five species protected by state and federal governments, all but the loggerhead are classified as endangered. The loggerhead is classified as threatened by both the State of Florida and the federal government (Patrick, 1996). Sea turtles spend their lives at sea and only come ashore to nest. It is theorized that young turtles, between the time they enter the sea as hatchlings and their appearance as subadults, spend their time drifting in ocean currents among seaweed and marine debris (Carr, 1986, 1986a, 1987). The number of sea turtles has decreased during the twentieth century. The illegal domestic harvesting of eggs and turtles in the United States and its territories as well as other important nesting areas around the world has continued to create this plummet in sea turtle abundance (National Research Council of the National Academies [NRC], 1990). Chapter 4 includes information on the density calculations used for effects analysis during NSWC PCD RDT&E activities.

Densities for sea turtles are provided in Section 4.3.7.2. Table 3-17 provides the nesting data for counties adjacent to the Florida portions of W-151, W-155, and W-470 (Florida Fish and Wildlife Conservation Commission [FWC] and Florida Marine Research Institute [FMRI], 2003).

Table 3-16. Sea Turtles in the NSWC PCD Study Area

Species	Status[a]	Areas of Occurrence
Atlantic green sea turtle *Chelonia mydas*	ESA: FE	Inhabits open water and hardbottoms of marine environment. Nests in the GOM from May to August. May occur within SAB.
Hawksbill sea turtle *Eretmochelys imbricata*	ESA: FE	Open water. Does not nest or regularly occur within NSWC PCD Study Area.
Kemp's ridley sea turtle *Lepidochelys kempi*	ESA: FE	Smallest and most endangered of the sea turtles. Open water. Does not nest within NSWC PCD Study Area, but does occur in NSWC PCD Study Area waters.
Leatherback sea turtle *Dermochelys coriacea*	ESA: FE	Inhabits open water and hardbottoms of marine environment. Does not nest within NSWC PCD Study Area, but does occur within NSWC PCD Study Area waters. May occur within SAB.
Atlantic loggerhead sea turtle *Caretta caretta*	ESA: FT	Inhabits open water and hardbottoms of marine environment. Hatchlings often associated with *Sargassum* rafts. Nests on northern GOM beaches from April to October. May occur within SAB.

Source: NMFS, 2004; FNAI, 2004
FE = Federal endangered, FT = Federal threatened

Table 3-17. Sea Turtle Nesting Data 2006

County	Survey Length in km (mi)	Loggerhead Sea Turtle Nests	Loggerhead Sea Turtle Non-Nesting Beach Appearances	Green Sea Turtle Nests	Green Sea Turtle Non-Nesting Beach Appearances	Leatherback Sea Turtle Nests	Leatherback Sea Turtle Non-Nesting Beach Appearances
Bay	80.2 (49.8)	80	111	0	0	0	0
Escambia	61.1 (38.0)	36	78	0	0	0	0
Franklin	98.6 (61.3)	221	185	0	2	0	0
Gulf	50.6 (31.4)	238	295	10	2	0	0
Okaloosa	38.3 (23.8)	21	17	6	5	0	0
Santa Rosa	11.2 (7.0)	11	3	10	0	0	0
Walton	47.5 (29.5)	24	18	5	6	0	0

Source: FWC and FMRI, 2003
km – kilometers; mi = miles

3.5 ANTHROPOGENIC (MAN-MADE) ENVIRONMENT

The human-related resources that have the potential to be affected by NSWC PCD RDT&E activities include components of the socioeconomic environment, airspace management, artificial reefs, safety, cultural and historical resources, and environmental justice.

3.5.1 Socioeconomics

The following resources are addressed in this subsection: tourism, recreational fishing, recreational boating, commercial fishing, and commercial shipping. The NSWC PCD Study Area encompasses the over water and in water areas within W-155 (includes Pensacola Operating Area), W-151 (includes Panama City Operating Area), and W-470 and SAB. The majority of all NSWC PCD RDT&E activities are conducted far enough offshore that they do not cause any noise or aesthetic issues to the public.

3.5.1.1 Tourism

The coastal zone of the northern GOM is one of the major tourist and recreational regions of the United States, especially for marine fishing and beach activities. Recreational resources include coastal beaches, barrier islands, coral reefs, estuarine bays and sounds, river deltas, and tidal marshes. Many of the areas used for recreational purposes are held in trust for the public under federal, state, and local jurisdiction as parks and landmarks. Commercial facilities such as resorts and marinas are also primary areas for tourist activity.

It is estimated there were 84.6 million visitors to Florida in 2006 (Visit Florida Research, 2007). In 2005, approximately 11.7 percent of these tourists visited the counties adjacent to the NSWC PCD Study Area. Therefore, it is assumed that about 10 million people visit the northwestern and north central counties in the State of Florida (Visit Florida Research, 2007). The importance of tourism and recreation can be gauged from an assessment of three related indices: (1) the number of persons employed in the leisure and hospitality sectors of the economy; (2) the number of accommodations and restaurants; and (3) tourist development tax collections (bed tax). For instance, the Northwest Florida Region employed over 61,000 or 13 percent of its population in the leisure and hospitality industry in 2005 (Enterprise Florida, 2007).

3.5.1.2 Recreational Fishing

The GOM waters are estimated to support almost 30 percent of the nation's marine recreational fishing, with 3.6 million anglers in 2006 who caught an estimated 191 million fish during more than 23 million individual fishing trips. Almost 109 million of the fish were caught from private/rental boats, nearly 8 million from charter boats, and almost 43 million from the shore (NMFS, 2007b).

In the NSWC PCD Study Area, pleasure boats comprise over 95 percent of all registered boats, and they are concentrated in the most populous counties including Bay, Escambia, Okaloosa, and Santa Rosa. Commercial fishing boats show a high concentration in Bay and Franklin Counties.

In the GOM, recreational fishing activities typically occur within 5 km (2.7 NM) of the shoreline, with anglers fishing from shore or from private or charter boats. Recreational fishing activities also include fishing from charter boats that go into deep water. Party boats fish primarily over offshore hardbottom areas, wrecks, or artificial reefs for amberjack, barracuda, groupers, snapper, grunts, porgies, and sea bass.

Fishing tournaments make a sizeable contribution to the Florida economy in general and particularly to the local economies of various communities, including those in the panhandle. Tournaments bring in direct revenue to local businesses from the participants. Panama City hosts many tournaments throughout the year. Panama City's Annual Bay Point Invitational has become one of the most prestigious billfishing tournaments in the world and is part of the World Billfish Series (World Billfish Series [WBS], 2005). It has been estimated that during the billfish tournament, the marina sells 45 kiloliters (kl) (10,000 gallons) of diesel fuel a day over the four-day period, 4989 kilograms (11,000 pounds) of ice, and $25,000 in retail sales and draws approximately 10,000 spectators (NMFS, 2005a). In addition to the direct revenues generated from these events, proceeds for charities exceeding $100,000 have been raised over the past 20 years.

3.5.1.3 Recreational Boating

Recreational boating activities in the eastern GOM are primarily associated with sport fishing, charter boat fishing, sport diving, sailing, power cruising, and other recreational boating activities. Recreational fishing boats and other recreational boats range throughout coastal waters in the northeast GOM, depending on the season and weather conditions. Most recreational fishing and boating occur within a few miles of shore, with boats generally returning to the point of departure. Fishing charters and recreational fishing boats pursuing sportfishing opportunities in deeper water can be expected to traverse the eastern GOM. Fishing parties may also enter the eastern GOM to fish at artificial reefs. Numerous artificial reefs have been established along the coast of the northeastern GOM, many of them at considerable distances from shore (See Section 3.5.3., Artificial Reefs).

The area within and adjacent to the GOM contains many sites popular with scuba divers and snorkelers. Many of the favored dive sites are wrecks and artificial reefs. There are close to 300 named dive sites off the Florida coast from the Florida Keys to Pensacola. The vast majority of these sites is located within 40 km (21.6 NM) of shore and can be explored year-round. Of the many sites frequented by divers in the eastern GOM, most are artificial reefs. A modest number of these artificial reefs are shipwrecks; many of these are quite old, with little of the structure remaining. Refer to Section 3.5.3 for additional information regarding artificial reefs.

3.5.1.4 Commercial Fishing

The GOM is one of the most important commercial fishing areas in the United States based on landings by volume and economic value (NMFS, 2007c). High concentrations of profitable fish are typically found along the eastern GOM, at the Florida Big Bend Seagrass beds, the Florida Middle Grounds, the mid-Outer Continental Shelf (OCS), and the DeSoto Canyon Protected Areas. Grouper, dolphin fish, and Spanish and king mackerels are a few open water species that spend part of their life cycle in estuaries and may occur in SAB. Red drum, spotted seatrout, gulf menhaden, and striped mullet are important commercial species. Fishermen also target species like pinfish, croakers, flounders, sea robin, lizardfish, rays, and skates that are associated with bottom habitats.

In 2006, commercial landings off the west coast of Florida amounted to almost 74 million pounds valued at over $150 million (NMFS, 2007c). The only major commercial fishing port located within the NSWC PCD Study Area is Apalachicola. The primary targeted commercial fisheries associated with this port are oysters/shrimp with 8.6 million pounds valued at $5.2 million in 2004 (NMFS, 2007b).

Almost 22 million pounds of fish were landed by commercial fishing operators in the ten counties located along the boundaries of the NSWC PCD Study Area in 2006. The largest share (over 58 percent) of the landings is composed of finfish, followed by invertebrates (25 percent), and shrimp (17 percent). Compared to the whole of Florida's landings, this shows a specialization in finfish. Gulf County contributes the largest share (31 percent) of the total landings, followed by Franklin County (26 percent) and Bay County (14 percent) (FWC, 2007a).

Many of the commercially important species in the GOM are believed to be declining from overfishing (GulfBase, 2006). Fishing methods such as trawling, gill netting, or purse seining, when practiced nonselectively, contribute to a reduction in the standing stocks of the desired species and the nontargeted fishery resources. Standing stocks of traditional fisheries like shrimp and red snapper and of recent fisheries, such as black drum, shark, and tuna have declined (MMS, 1996).

3.5.1.5 Commercial Shipping

Seven of Florida's deepwater ports are located on the GOM: Port of Pensacola, Port of Panama City, Port St. Joe, Port of St. Petersburg, Port of Tampa, Port Manatee, and Port of Key West. Three of these ports occur within the NSWC PCD Study Area. Approximately 45 percent of U.S. shipping tonnage passes through GOM ports. The GOM supports the second largest marine transport industry in the world. In 1999 more than 234,000 trips were taken upbound and downbound in the Gulf Intercoastal Waterway. In 1999, over 109.6 million tons of commodities were shipped through the GOM portion of the Intercoastal Waterway (U.S. Army Corps of Engineers [USACOE], 1999). Six of the seven deep-water ports within the GOM are active. Port St. Joe in Gulf County, which is within the NSWC PCD Study Area, is inactive. Refer to Appendix H, Supporting Information on Socioeconomics, for more information on ports in the NSWC PCD Study Area.

3.5.2 Airspace Management

Airspace management is defined as the direction, control, and handling of flight operations in the volume of air that overlies the geopolitical borders of the United States and its territories. Airspace is a resource managed by the Federal Aviation Administration (FAA), which has established policies, designations, and flight rules to protect aircraft in the airfield and en-route environment, in Special Use Areas identified for military and other governmental activities, and other military training airspace. Management of this resource considers how airspace is designated, used, and administered to best accommodate the individual and common needs of military, commercial, and general aviation. Because of these multiple and sometimes competing demands, the FAA considers all aviation airspace requirements in relation to airport operations, federal airways, jet routes, military flight training activities, and other special needs to determine how the National Airspace System can best be structured to satisfy all user requirements.

3.5.2.1 Types of Airspace

The FAA has designated four types of airspace above the United States. They are Controlled, Uncontrolled, Special Use, and Other. A description of each type of airspace is as follows:

- *Controlled airspace* is categorized into five separate classes: Class A, B, C, D, and E airspace. These classes identify airspace that is controlled, airspace supporting airport operations, and designated airways affording en-route transit from place-to-place. The classes also dictate pilot qualification requirements, rules of flight that must be followed, and the type of equipment necessary to operate within that airspace.
- *Uncontrolled* airspace is designated Class G airspace and has no specific prohibitions associated with its use. Class G airspace includes all airspace not otherwise designated as

A, B, C, D, or E. Operations within Class G airspace are governed by the principle of "see and avoid."

- *Special Use Area* (SUA) airspace is designated airspace within which flight activities are conducted that requires confinement of participating aircraft or places operating limitations on nonparticipating aircraft. Restricted areas, military operations areas, and warning areas are examples of SUA.
- *Other* airspace consists of advisory areas, areas that have specific flight limitations or designated prohibitions, areas designated for parachute jump operations, Military Training Routes (MTRs), and Aerial Refueling Tracks (ARTs). This category also includes Air Traffic Control Assigned Airspace (ATCAA). When not required for other needs, ATCAA is airspace authorized for military use by the managing Air Route Traffic Control Center (ARTCC), usually to extend the vertical boundary of SUA.

3.5.2.1 Existing Airspace Conditions

The airspace located above the NSWC PCD Study Area is considered to be SUA. Multiple use of the airspace within the NSWC PCD Study Area is permitted. However, avoidance measures are advised during times of military use. Although Warning Areas are considered "joint-use" airspace, pilots using the airspace are responsible to employ "see-and-avoid" standards of flight safety. Warning Areas are plotted on aeronautical charts so all pilots are aware of their location and the potential for military flight training in the airspace.

All of the Warning Areas used are situated over the GOM. W-151 (includes Panama City Operating Area) is composed of four elements: W-151A, B, C, and D. This airspace is located south of Panama City, Florida. W-155 (includes Pensacola Operating Area) is composed of two elements: W-155A and W-155B. This airspace is located south of Pensacola, Florida. W-470 is composed of three elements: W-470A, B, and C. This airspace is located south of Tallahassee, Florida. Table 3-18 describes these Warning Areas, and shows the controlling and scheduling agencies. The table also provides the minimum and maximum altitude and times at which the airspace may be used.

Table 3-18. Description of Warning Areas

Airspace	Minimum Altitude	Maximum Altitude	Times of Use	Controlling ARTCC	Scheduling Agency
W-151A	Surface	Unlimited	0600 – 0130 Daily, Other By NOTAM [1]	Jacksonville	Eglin AFB
W-151B	Surface	Unlimited			
W-151C	Surface	Unlimited			
W-151D	Surface	Unlimited			
W-155A	Surface	FL 600 [2]	Sunrise – 0100 Mon. – Fri. Other By NOTAM[1]	Jacksonville	Pensacola Naval Air Station
W-155B	Surface	FL 600 [2]			
W-470A	Surface	Unlimited	0600 – 0030 Daily, Other By NOTAM[1]	Jacksonville	Eglin AFB
W-470B	Surface	Unlimited			
W-470C	Surface	Unlimited			

Source: DoD, 2003
[1] NOTAM – Notice to Airmen
[2] FL – Flight Level. FL is an altitude above mean sea level (MSL), expressed in hundreds of feet. Thus, FL 600 is approximately 60,000 feet MSL.

Collectively, all of the elements of W-151 (includes Panama City Operating Area) cover approximately 35,108 km^2 (10,223 NM^2) of surface area. W-155 (includes Pensacola Operating Area) covers approximately 18,568 km^2 (5,407 NM^2), and W-470 covers approximately 24,033 km^2 (6,998 NM^2).

3.5.3 Artificial Reefs

Artificial reefs consist of materials deposited on the ocean floor, usually for the purpose of enhancing fishing or other recreational activities. Artificial reefs provide bottom relief and habitat for fish and other marine species in areas that may otherwise be featureless. The U.S. Army Corps of Engineers (USACOE) regulates artificial reef construction in U.S. waters through its Permits and Evaluation Branch. Regulatory authority has been given to the USACOE through the Rivers and Harbors Act of 1899, the Outer Continental Shelf Lands Act of 1953, NEPA, the Clean Water Act of 1972, and the Marine Protection Research and Sanctuaries Act of 1972 (Ocean Dumping Act).

In state waters off the Florida Panhandle, allowable materials are limited to clean concrete materials, rock, or steel boat hulls. An assessment of material types used in 709 publicly funded Florida artificial reef deployments from 1994–2000 revealed the secondary use of concrete materials (43 percent) composed the majority of materials followed by concrete modules (24 percent); military equipment, mainly armored combat tanks (11 percent), steel vessels, and barges (11 percent); scrap steel (6 percent); limestone (3 percent); and miscellaneous materials (2 percent) (FWC, 2007b). Materials historically used for reefs in Alabama include car bodies, culverts, bridge rubble, barges, boats, planes, and military equipment (mainly tanks), though a 1997 protocol limited the types of materials that can be used (Alabama Department of Conservation and Natural Resources [ADCNR], 2004).

3.5.3.1 Florida Artificial Reefs

The Florida artificial reef program is the only state program besides Maryland that is not exclusively run at a state agency level where the state holds all the reef area permits (FWC, 2007b). The FWC artificial reef program does not issue permits for artificial reef sites. This regulatory responsibility is carried out by the USACOE for proposed artificial reef areas in federal waters and by both USACOE and FDEP in state waters (FWC, 2007b).

The FWC currently holds a permit for two large areas in federal waters off Escambia County, named FWC West and FWC East (FDEP held the permits until 1999). Okaloosa and Bay Counties also hold permits for a total of five areas, named Site A, Site B, and Site C (Okaloosa County) and Site A and Site B (Bay County), where both public reefs and county-inspected private reefs may be deployed. These seven areas, known as Florida Large Area Artificial Reef Sites (LAARS), total approximately 1,338 km^2 (389.6 NM^2) and are shown in Figure 3-8. Many additional individual county-permitted artificial reefs exist off Florida's Gulf coast, ranging in size from 0.4 km to well over 1.6 km (0.22 NM to over 0.86 NM) in diameter (GSMFC, 1993).

Thirty-four of the 35 Florida coastal counties are or have been involved in artificial reef development (FWC, 2003a). More than 2,000 documented reefs have been placed in state and federal waters off these counties, with the majority occurring in the last 20 years. Local coastal governments hold all but two of the more than 300 active reef permits off the Florida coasts, about half of which are in federal waters (FWC, 2003a). Figure 3-8 shows locations of artificial reefs in the NSWC PCD Study Area. Table 3-19 provides the number of artificial reefs in the NSWC PCD Study Area by county.

Table 3-19. Artificial Reefs in NSWC PCD Study Area

County	Number of Artificial Reefs
Bay County, FL	198
Escambia County, FL	97
Franklin County, FL	46
Gulf County, FL	21
Okaloosa County, FL	105
Santa Rosa County, FL	13
Taylor, FL	12
Wakulla County, FL	35
Walton County, FL	4

Source: FWC, 2007b

3.5.3.2 Alabama Artificial Reefs

In Alabama, the Marine Resources Division of the ADCNR maintain five artificial reef general permit areas, which are named Don Kelley North, Don Kelley South, Hugh Swingle, Tatum-Winn North, and Tatum-Winn South (Figure 3-8). Approximately 3,100 km^2 (903 NM^2) of offshore waters are included in these permit areas, making Alabama the largest artificial reef program in the United States (ADCNR, 2004). Reefs may be constructed outside the general permit areas with an USACOE permit. The state, however, strongly encourages the use of general permit areas. Virtually all of the offshore artificial reefs in Alabama waters lie within the permit areas. The locations of reefs in waters offshore of Alabama are also provided in Figure 3-8. The state also maintains inshore fishing reefs in Mobile Bay, Bon Secour Bay, and Mississippi Sound. These inshore reefs are close to shore, inside the barrier reef system, and would not be a factor in military operations in W-155 (includes Pensacola Operating Area).

3.5.3.3 Rigs-to-Reefs

Formally adopted as federal policy by the MMS in 1985, Rigs-to-Reefs has become an important component and integral part of state artificial reef programs (GSMFC, 1993). Three permitted Rigs-to-Reefs sites exist off the west coast of Florida. An Exxon structure was placed off Franklin County in 1979. In 1982, a site off Escambia County was established by Tenneco. Most recently, a Chevron jacket was submerged southeast of Pensacola in the fall of 1993. Three Rigs-to-Reefs structures lay within the Alabama general permit areas. A fourth structure lies just outside one of these areas.

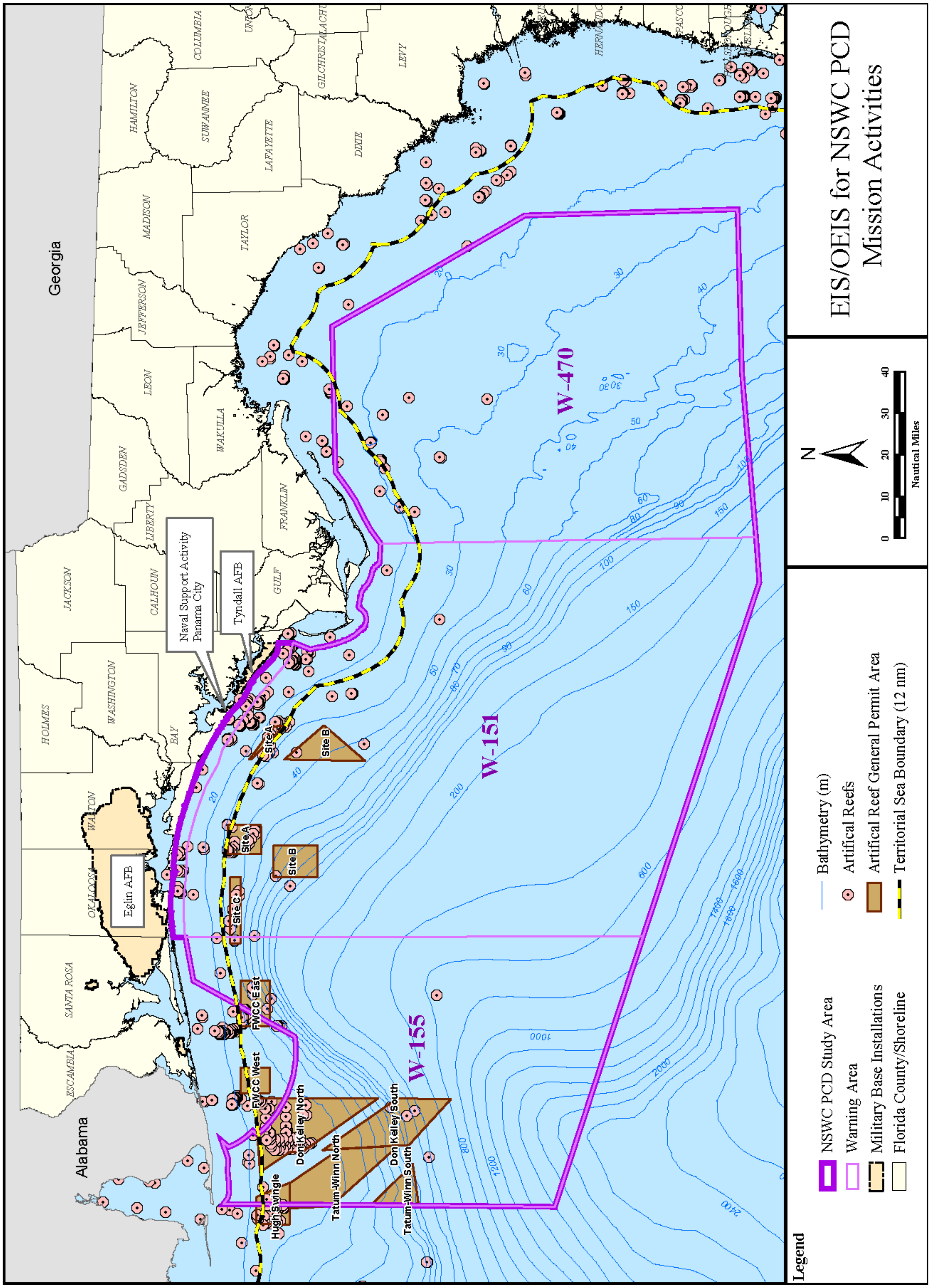

Figure 3-8. Artificial Reefs

3.5.3.4 Socioeconomic Effects of Artificial Structures

Artificial reefs benefit not only marine life but also the people who rely on marine resources. In a study sponsored by the MMS, the economic effect of oil and gas structures, including reefs created in the Rigs-to-Reefs program, from Alabama to Texas was investigated (Hiett and Milon, 2002). This social science survey revealed that 70 percent of for-hire fishing crews and 85 percent of dive shop operators thought these structures were very important for their business. Furthermore, 85 percent of the fishermen and 100 percent of the dive operators felt that removal of retired structures would hurt their industry; they asked that structures be left in the GOM even after they are no longer useful to oil removal. Table 3-20 provides an overview for the numbers and percentages of activities within a 300 ft radius of oil and gas structures in the GOM. In the study, researchers found that artificial reef structures provide approximately $324.6 million in revenue for industries in coastal counties between Alabama and Texas and employ approximately 5,600 full-time employees.

Table 3-20. Overview of Activities within 91 M (300 Ft) of Oil and Gas Structures in the GOM

Activity	Trips within 91 m (300 ft) of Artificial Structures	Total Trips	Percentage*
Private boat fishing	823,075	4,066,506	20.2%
Charter boat fishing	96,337	298,023	32.3%
Party boat fishing	60,852	119,551	50.9%
Total fishing	980,264	4,484,080	21.9%
SCUBA	83,780	89,464	93.6%

Source: Modified from Hiett and Milon, 2002
*Percentage is equal to the total trips divided by the trips within 91 m (300 ft) of artificial structures.

3.5.4 Cultural and Historical Resources

Cultural and historical resources as relevant to the NSWC PCD Study Area include any prehistoric or historic site or object considered important to a culture, subculture, or community for scientific, traditional, religious or other purposes. They include archaeological resources, historic architectural/engineering resources, and traditional resources. Significant archaeological and architectural/engineering resources are either eligible for listing, or listed on, the National Register of Historic Places (NRHP). Significant traditional resources are identified by federally recognized Indian Tribes or other groups and may also be eligible for the NRHP.

The protection of Gulf coast submerged cultural resources falls within federal and state jurisdiction. The jurisdiction covered by the state of Florida extends 16.7 km (9 NM) into the GOM. Submerged cultural resources in state waters are protected by the Florida Historical Resources Act (F.S. 18, Chapter 267). Management plans have been developed for the cultural resources within the EEZ of the OCS Region by the MMS of the United States Department of Interior. The OCS is not federally owned, and the federal government does not claim title to cultural resources on the OCS. However, if a Proposed Action has the potential to adversely affect cultural resources, the federal agencies are required (Aubry and Stright, 1999) to consult with the appropriate entities (i.e., the Advisory Council on Historic Preservation, the National Park Service, and/or the State Historic Preservation Officer). The Abandoned Shipwreck Act of 1987 gives the title to historic ships in State waters to the Federal Government, which then cedes them back to the State. The Abandoned Shipwreck Act, however, is not applicable in Federal waters.

3.5.4.1 Identified Cultural Resources

There are currently no NRHP-listed properties administered by NSWC PCD within the NSWC PCD Study Area. Archaeological resources have been identified onshore at the installation; however, the operations covered by this EIS/OEIS include only those seaward of the mean high water line. There is a range of submerged cultural resources known to exist in offshore operations areas.

Many prehistoric archaeological sites along the Gulf coast have been inundated by rising sea levels over the millennia. These sites are likely to have been deposited between the maximum low sea stand (an area of bottom in the GOM that would have been above water during glacierization prior to sea level stabilization) around 18,000 years ago and the maximum high stand from 5,000 to 3,000 years (yrs) ago (CEI, 1977). Most of the submerged sites are more than 6,000 years old and are some of the state's most significant archaeological resources. The chemical and physical characteristics of underwater environments prevent decay of organic remains, resulting in some of the best-preserved evidence of aboriginal peoples (Division of Historical Resources [DHR], 1994).

Two criteria are used to determine the potential for submerged prehistoric sites: (1) the presence of submerged geologic formations that would have a high probability of associated prehistoric sites, and (2) the known natural occurrences that would preserve a site, such as sedimentation and tidal movement. Geologic features in the eastern GOM (karst topography, relict barrier islands with back barrier bays and lagoons, and coastal dune lakes) are used as indicators of potential cultural resources and have a high-probability of containing prehistoric sites. Sites in high-probability zones may date to the Paleoindian, Archaic, and Early Gulf formational periods (U.S. Air Force, 1997b). The occurrence of submerged prehistoric cultural resources is likely for near-shore areas of the northern Gulf continental shelf, particularly from the area shoreward from the 45-m (nearly 150-ft) bathymetric contour. In the Santa Rosa Island area, submerged prehistoric cultural resources are likely to exist nearly 5 km (2.7 NM) seaward (U.S. Air Force, 1997a).

Submerged historic shipwrecks from the period of Spanish exploration through the modern era are found throughout the GOM. The properties of water (lower oxygen content) and the reduced exposure to human activities have preserved some shipwrecks, while others have deteriorated over time (DHR, 1994). In the late 1970s, the MMS began sponsoring studies to collect information on cultural resources in the GOM. Studies in 1977 (CEI, 1977) and 1989 (Garrison et al., 1989) were used to determine where remote-sensing surveys should be conducted to identify historic shipwrecks within MMS lease blocks in the GOM. By 2000, approximately 2,800 archaeological surveys had been conducted within lease blocks and along pipeline rights-of-way (Pearson et al., 2003).

A 2000 study reevaluated and refined earlier models of shipwreck occurrences and expanded the shipwreck database (Pearson et al., 2003). This study found few shipwreck losses prior to 1750, with significant increases after 1850. Losses increased in the twentieth century with fishing industry, recreational boating, and oil and gas development. A large number of the vessels in water depths greater than 10 m (33 ft) remain relatively intact and are usually only partially buried by sediment. High density areas contain shipwreck concentrations of 25 or more per 0.5-degree unit (latitude/longitude coordinates). High probability areas contain reported or discovered shipwrecks with a Reliability Factor of 1 or 2 (high reliability). High probability zones are concentrated off the central and western Gulf coasts (Pearson et al., 2003).

The northern part of W-155 (includes Pensacola Operating Area) and the northwestern part of W-151 (includes Panama City Operating Area) contain areas with a high density of shipwrecks (25 or more per 0.5-degree unit). High probability blocks are also concentrated in these areas and occur throughout the northern portions of W-151 (includes Panama City Operating Area) and W-470 (Pearson et al., 2003). Less than two percent of pre-twentieth century ships and less than 10 percent of all ships reported lost in the GOM between 1500 and 1945 have known locations (MMS, 1990). Table 3-21 lists identified shipwrecks by name and date of occurrence in W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), and W-470 of the NSWC PCD Study Area that have known ages of approximately 50 yrs or older, or whose ages are unknown. Additionally information regarding the history of the Gulf coast is provided in Appendix I, Supporting Information on Cultural Resources.

Table 3-21. Historic Shipwrecks in the NSWC PCD Study Area Waters

Operations Area	Name	Date	Operations Area	Name	Date
W-151	Terry	0	W-470 Cont'd	Gelmer	0
	Unknown	0		New Moon	0
	Unknown	0		Unknown (Gigi Iv)	0
	Moonraker	0		May	1752
	Unknown	1752		Rhode Island	1752
	Mary	1842		Atlas	1816
	Three Sisters	1877		St. Isabel	1836
	Rhoda B. Taylor	1878		Sobieski	1844
	Annie Lewis	1883		J.D. Noyes	1844
	Walter L. Plummer	1894		Ok	1862
	Crescent	1920		Rob Roy	1865
	Golden State	1922		Valley City	1882
	Thelma	1925		A.A. Rowe	1906
	Empire Mica	1942		G.L. Daboll	1906
	Anaconda	1946		Asa T. Stowell	1906
	Athens	1951		Elsie Marie	1907
W-155	Unknown	0		Addie F. Cole	1908
	Unknown	0		Mildred	1914
	Unknown	0		Priscilla	1914
	Unknown	0		Donna Christina	1915
	Obstruction	0		Maggie Todd	1918
	Gandy Dancer	0		Millie R. Bohannan	1919
	High Stepper	0		John Francis	1919
	Vila Y. Hermano	1905		Munisla	1919
	Elmer E. Randall	1906		Saverio M. Stella	1920
	Columbus	1909		Holliswood	1920

Table 3-21. Historic Shipwrecks in the NSWC PCD Study Area Waters (Cont'd)

Operations Area	Name	Date	Operations Area	Name	Date
W-155 Cont'd	James C. Clifford	1909	W-470 Cont'd	W.D. Cash	1926
	Marion N. Cobb	1925		S C Loveland	1948
	Unknown	1939		Carmen Louise	1949
	Anona	1944		C.D. Ergas	1954
W-470	Unknown	0		Uncle Lum	1956
	Bahama Mama	0		Ageos Speridon	1957
	Unknown	0		Ralph E. Havens	1957
	Unknown	0		Supertest	1958
	Unknown	0			

Source: U.S. Navy Database, 2004
*Historic shipwrecks are characterized as having an estimated construction date of greater than 50 yrs or date is unknown.

3.5.5 Environmental Justice and Risks to Children

In 1994, EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations (Environmental Justice)*, was issued to focus the attention of federal agencies on human health and environmental conditions in minority populations and low-income populations. The EO was established to ensure that disproportionately high and adverse human health or environmental effects of federal actions on these populations are identified and addressed. The environmental justice analysis addresses the characteristics of race, ethnicity, and poverty status of populations residing in areas potentially affected by the proposed federal action.

The DoD Strategy on Environmental Justice was adopted on 24 March 1995. It includes a summary report, strategy on environmental justice and implementation plan and states that DoD will use NEPA as the primary mechanism to implement the provisions of EO 12898.

OPNAVINST 5090.1C (1 November 1994) was revised to incorporate environmental justice concepts into Chapter Five, "Procedures for Implementing the National Environmental Policy Act (NEPA)." It states: "The Navy shall act with care to ensure, to the maximum extent practicable, that in conducting its mission of providing for the national defense, it does so in a manner consistent with national environmental policies, including environmental justice." OPNAVINST 5090.1C incorporates environmental justice concepts in the scoping process, public hearings, and the evaluation of environmental consequences.

For the purpose of this EIS/OEIS, minority and low-income populations are defined as follows.

- *Minority Populations*: All persons identified by the Census of Population and Housing to be of Hispanic or Latino origin, regardless of race, plus non-Hispanic persons who are Black or African American, American Indian and Alaskan Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other (i.e., non-white) Race or Two or More Races. For purposes of the EIS analysis, the minority population is calculated by subtracting the number of persons who are White but not Hispanic, from the total population.

- *Low-Income Populations*: All persons that fall within the statistical poverty thresholds published by the U.S. Census Bureau in the Current Population Survey are considered to be low-income. For the purposes of this analysis, low-income populations are defined as persons living below the poverty level ($16,895 for a family of four with two children, adjusted based on household size and number of children), as reported in the 2000 Census. The 2000 Census asked people about their income in the previous calendar year. Therefore, poverty estimates reported in the 2000 Census compare family income in 1999 with the corresponding 1999 poverty thresholds. If the total income for a family or unrelated individual falls below the relevant poverty threshold, then the family or unrelated individual is classified as being below the poverty level. The percentage of low-income persons is calculated as the percentage of all persons for whom the Census Bureau determines poverty status, which is generally a slightly lower number than the total population because it excludes institutionalized persons, persons in military group quarters and college dormitories, and unrelated individuals under 15 yrs old.

In 1997, EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (*Protection of Children*), was issued to identify and address issues that affect the protection of children. Socioeconomic data specific to the distribution of population by age (under age 18) are presented below.

3.5.5.1 Minority and Low-Income Populations and Children

Census data on minority populations, low-income populations, and children is provided below for the 11 coastal counties of the states of both Alabama and Florida that border W-155 (includes Pensacola Operating Area), W-151 (includes Panama City Operating Area), and W-470. The counties are, from west to east, Mobile and Baldwin in the state of Alabama, and Escambia, Santa Rosa, Okaloosa, Walton, Bay, Gulf, Franklin, Wakulla, and Jefferson in the state of Florida. For the environmental justice analysis, the NSWC PCD Study Area is also referred to as the Community of Comparison (COC). Information is also provided for two active deep-water ports in the NSWC PCD Study Area: Panama City in Bay County, Florida, and Pensacola in Escambia County, Florida.

The total population of the 11-county COC was 1,371,881 persons in 2000, with a minority percentage of 25.2 percent and a low-income percentage of 14.2 percent (Table 3-22) (U.S. Census Bureau, 2004). By comparison, Alabama has a minority percentage of 29.7 percent and Florida has a minority percentage of 34.6 percent, both of which exceed the minority percentage in the COC. Alabama has a low-income percentage of 16.1 percent and Florida has a low-income percentage of 12.5 percent, which are greater than and less than the COC, respectively. Children comprise 25.1 percent of the population of the COC (U.S. Census Bureau, 2004).

The counties bordering the NSWC PCD Study Area with the largest minority percentages include Jefferson County, Florida (41.7 percent), and Mobile County, Alabama (37.5 percent). The counties with the smallest minority percentages include Santa Rosa County, Florida (10.9 percent) and Walton County, Florida (12.7 percent) (U.S. Census Bureau, 2004).

Table 3-22. Minority Populations, Low-Income Populations, and Children in the NSWC PCD Study Area

Geography	Total Population	Minority Population	Percent Minority	Low-Income Population	Percent Low-Income[1]	Children Under Age 18	Percent Children
State of Alabama	**4,447,100**	**1,321,281**	**29.7%**	**698,097**	**16.1%**	**1,123,422**	**25.3%**
Baldwin County, AL	140,415	19,547	13.9%	14,018	10.1%	34,320	24.4%
Mobile County, AL	399,843	150,080	37.5%	72,549	18.5%	109,881	27.5%
State of Florida	**15,982,378**	**5,523,869**	**34.6%**	**1,952,629**	**12.5%**	**3,646,340**	**22.8%**
Bay County, FL	148,217	25,509	17.2%	18,882	13.0%	35,642	24.0%
Escambia County, FL	294,410	85,732	29.1%	41,978	15.4%	69,271	23.5%
Franklin County, FL	11,057	2,235	20.2%	1,654	17.7%	1,989	18.0%
Gulf County, FL	13,332	2,840	21.3%	1,988	16.7%	2,895	21.7%
Jefferson County, FL	12,902	5,380	41.7%	2,040	17.1%	2,930	22.7%
Okaloosa County, FL	170,498	32,439	19.0%	14,562	8.8%	42,133	24.7%
Santa Rosa County, FL	117,743	12,824	10.9%	11,282	9.8%	31,269	26.6%
Wakulla County, FL	22,863	3,470	15.2%	2,437	11.3%	5,864	25.6%
Walton County, FL	40,601	5,176	12.7%	5,577	14.4%	8,795	21.7%
11-County Area	**1,371,881**	**345,232**	**25.2%**	**186,967**	**14.2%**	**344,989**	**25.1%**

[1] The percentage of low-income persons is calculated as a percentage of all persons for whom the Bureau of the Census determines poverty status, which is generally a lower number than the total population because it excludes institutionalized persons, persons in military group quarters and college dormitories, and unrelated individuals under 15 yrs old.
Source: U.S. Census Bureau, 2004

The counties bordering the NSWC PCD Study Area with the largest low-income percentages include Mobile County, Alabama (18.5 percent), and Franklin County, Florida (17.7 percent). The counties with the smallest low-income percentages include Okaloosa County, Florida (10.9 percent), and Santa Rosa County, Florida (9.8 percent) (U.S. Census Bureau, 2004). Panama City in Bay County, Florida, and Pensacola in Escambia County, Florida, are two active deep-water ports in the NSWC PCD Study Area. Port St. Joe in Gulf County is currently inactive. The population of Panama City in 2000 was 36,417. The minority percentage of Panama City was 27.7 percent, which is more than twice the percentage in Walton County (12.7 percent). The low-income percentage in Panama City was 17.2 percent, which is also higher than Walton County (14.4 percent) (U.S. Census Bureau, 2004). The population of Pensacola in 2000 was 56,255. The minority percentage in Pensacola was 36.3 percent, which is higher than Escambia County (29.1 percent). The low-income percentage was 16.1 percent, which is also higher than Escambia County (15.4 percent). Children comprise 23 percent of the population in Panama City and 22.9 percent of the population in Pensacola (U.S. Census Bureau, 2004).

3.6 COASTAL ZONE RESOURCES

The coastal zone is rich in natural, commercial, recreational, ecological, industrial, and aesthetic resources. As such, it is protected by legislation for the effective management of its resources. The Coastal Zone Management Act (CZMA) of 1972 (16 USC 1451, et seq., as amended) provides assistance to states, in cooperation with federal and local agencies, for developing land and water use programs in the coastal zone. This includes the protection of natural resources and the management of coastal development.

The CZMA establishes national policy to protect resources in the coastal zone. CZMA policy is implemented via NOAA-approved coastal management programs. Federal lands are excluded from the jurisdiction of such approved coastal management programs. The CZMA and its implementing regulations, however, provide that federal agencies must determine if it is reasonably foreseeable that their proposed actions, whether inside or outside of a state's coastal zone, will directly or indirectly affect any land or water use or natural resource within that coastal zone. The CZMA requires that federal activities affecting any coastal use or resource of a state must be consistent to the maximum extent practicable with the enforceable policies of the state's NOAA-approved coastal management plan.

The landward boundaries of the coastal zone vary by state, reflecting both the natural and built environments. The seaward boundaries extend to the outer limits of the jurisdiction of the state; in the Florida Panhandle, state jurisdiction extends to 16.7 km (9 NM) into the GOM while in Alabama, state jurisdiction extends to 5.6 km (3 NM).

In accordance with 15 C.F.R. § 930.41, the state agencies have 60 days from receipt of this document in which to concur with or object to this Consistency Determination, or to request an extension, in writing, under 15 C.F.R. § 930.41(b). The federal agency may presume state agency concurrence if the state agency's response is not received within 60 days from receipt of the federal agency's consistency determination and supporting information.

3.6.1.1 Florida's Coastal Zone Management Program

The Florida Coastal Management Program (FCMP) was approved by NOAA in 1981. The FCMP established a cooperative program of coastal area management between local and state government agencies.

The FCMP consists of 23 Florida statutes administered by 11 state agencies and four water management districts. The statutes are designed to protect the state's water, cultural, historic, and biological resources and to minimize the state's vulnerability to coastal hazards. In addition, these statutes have been put into place to ensure compliance with the state's growth management laws and proprietary interest as the owner of sovereign submerged lands (FDEP, 2005). Additional information on Florida's Coastal Zone Management Plan (CZMP) is available in Appendix J.

3.6.1.2 Alabama's Coastal Zone Management Program

The Alabama Coastal Management Program was approved by NOAA in 1972. The program is administered by the ADEM and the ADCNR, State Lands Division, Coastal Section. ADEM is responsible for permitting, monitoring, and enforcing the Coastal Zone Management Plan. Additional information on Alabama's CZMP is available in Appendix K.

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4. ENVIRONMENTAL CONSEQUENCES

This Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) and Executive Order (EO) 12114, respectively. While NEPA and EO 12114 compliance represent two distinct, parallel processes, they are conducted as concurrent processes in the Naval Surface Warfare Center Panama City Division (NSWC PCD) EIS/OEIS. Each alternative includes operations that may occur both within and outside U.S. Territorial Waters. Analyses under the purview of NEPA are presented under the heading of "Territorial Waters," and analyses under the purview of EO 12114 are presented under "Non-Territorial Waters." Applicability of NEPA and EO 12114 compliance also focuses on the location of potential effects on the environment as well as the location of the activity. Proposed mitigation and protective measures have been developed to minimize or avoid potential effects to the natural environment and are identified in Chapter 5. In addition, an assessment of environmental consequences including estimates of potential direct, indirect, cumulative, and unavoidable effects is provided in Chapter 6.

4.1 INTRODUCTION

This chapter describes the potential environmental consequences associated with the No Action Alternative (baseline activities), Alternative 1, and Alternative 2 proposed for research, development, test, and evaluation (RDT&E) activities in the NSWC PCD Study Area. This chapter considers resource areas addressed in Chapter 3 and identified as requiring environmental analysis. Only resources associated with an environmental issue are discussed in this chapter; therefore, activities that do not have the potential for adverse environmental effects are not addressed. For example, sonar operations are not addressed under the Air Quality section because sonar operations have no potential for effects on air quality. Furthermore, resource areas that have no potential for effects to occur based on the best available science have been discounted and require no additional analysis in this chapter. Refer to Table 4-1 for a summary matrix of potential environmental issues and RDT&E operations associated with the respective environmental resource.

Potentially significant issues described in this chapter focus on historical and current operations (baseline) included in the No Action Alternative and the additional levels of activities associated with Alternatives 1 and 2. An introduction and approach to analysis section is provided before each subsection to identify and explain the method used for analysis. Some resource areas include mitigation and protective measures in the analysis. It should be noted that mitigation measures are required procedures developed during consultation whereas protective measures are additional procedures developed by NSWC PCD to further protect the marine environment. Refer to Chapter 5 for an explanation of the mitigation and protective measures discussed in this Chapter.

Table 4-1. Summary of Resources and Operations Analyzed

Resource	Operation
Geology and Sediments	Ordnance Operations (Sediment Area Affected)
	Subsurface Operations (Sediment Area Affected)
Air Quality	Air Operations and Surface Operations Combined (Pollutant Emissions)
In-Air Sound	Air and Surface Operations Combined (Sound Levels)
Water Quality	Ordnance Operations (Explosion Products, Metal Leaching, Turbidity)
	Projectile Firing (Metal Leaching)
Marine Habitats	Surface Operations (Grounding/Turbidity)
	Subsurface Operations (Sediment Area Affected)
	Ordnance Operations (Habitat Destruction)
Invertebrates	Sonar Operations (Underwater Sound)
	Laser Operations (Laser Exposure)
Fish	Air Operations (Sound)
	Sonar Operations (Underwater Sound)
	Electromagnetic Operations (EMF Exposure)
	Laser Operations (Laser Exposure)
	Ordnance Operations (Shock Wave)
Essential Fish Habitat	Subsurface and Ordnance Operations Combined (Habitat Disturbance)
Birds	Air Operations (Sound)
	Sonar Operations (Underwater Sound)
	Laser Operations (Laser Exposure)
	Ordnance Operations (Shock Wave)
Marine Mammals	Air Operations (Sound)
	Surface Operations (Vessel Collision)
	Sonar Operations (# of Exposures)
	Electromagnetic Operations (EMF Exposure)
	Laser Operations (Laser Exposure)
	Ordnance Operations (# of Exposures)
Sea Turtles	Air Operations (Sound)
	Surface Operations (Vessel Collision)
	Sonar Operations (Underwater Sound)
	Electromagnetic Operations (EMF Exposure)
	Laser Operations (Laser Exposure)
	Ordnance Operations (# of Exposures)
Airspace Management	Air Operations (# Flight Hours)
Artificial Reefs	Air Operations (# Helicopter Flight Hours)
	Surface Operations (Tow Tests)
	Subsurface Operations (Physical Strikes)
	Ordnance Operations (Shock Wave, Silting)
Environmental Justice & Special Risks to Children	All Operations Combined (Disadvantaged Groups Affected)
Cultural/Historical Resources	Air Operations (Expendables, System Jettison)
	Subsurface Operations (Resource Disturbance)
	Ordnance Operations (Resource Disturbance)

4.2 PHYSICAL RESOURCES

4.2.1 Geology and Sediments

This analysis identifies potential direct and indirect effects to geology and sediments as a result of baseline and future activities at NSWC PCD. Although air and surface operations will have no effect on sediments, operations involving detonations and subsurface activities may disturb ocean bottom sediments. Dive operations that involve routine hull maintenance procedures will only displace minimal amounts of sediments and are not addressed in further detail. Activities that result in sediment displacement are analyzed in this section. Turbidity, toxicity, and water quality are addressed in Section 4.2.4.

4.2.1.1 Ordnance Operations

4.2.1.1.1 Introduction and Approach to Analysis – Geology and Sediments (Ordnance Operations)

The majority of sediment displaced in the test areas will result from detonations of ordnance on or near the sea floor. Detonations occurring directly on the sea floor generally displace the greatest amount of sediment and result in the formation of a crater. The radius of the crater depends upon the net explosive weight (NEW) used and the depth of the explosion. All detonations on the sea floor will be associated with line charge testing. The majority of detonations, however, will not occur on the sea floor. With the exception of line charges, all other test scenarios involving detonations will require mines to be tethered and floating some distance above the bottom.

Smaller explosive devices, which will contain from 0.5 to 5 kilograms (kg) (1 to 10 pounds [lbs]) of NEW, will typically be placed by divers under controlled conditions. Medium-sized devices will contain from 5 to 34 kg (11 to 75 lbs) of NEW and may be placed by either divers or unmanned undersea systems. Larger detonations ranging from 34 to 272 kg (76 to 600 lbs) will also be conducted. These larger detonations will be associated with live mine tests.

Mine testing will occur in a minimum water depth of 30 meters (m) (100 feet [ft]). The mines will be configured to float either just below the surface or half-way between the surface and the sea floor. In relatively deep water, the radius of the explosion gas bubble may be considered a reasonable approximation of the radius of a crater if the explosion had occurred on the bottom (O'Keefe and Young, 1984). Therefore, the bubble radius of detonations in the water column is used to determine impacts to bottom sediments. If the radius were to extend to the sea floor, then impacts to the sediment will likely occur. If, however, the radius were not to reach the bottom, then no impacts to sediment will be considered.

Test scenarios for live detonations may occur from the surf zone seaward to the outer perimeter of the NSWC PCD Study Area. Detonations involving ordnance less than 34 kg (75 lbs) of NEW will be conducted in territorial waters; detonations involving ordnance greater than 34 kg (75 lbs) of NEW will be conducted in non-territorial waters. In addition, all line charges will be conducted in territorial waters.

4.2.1.1.2 Calculation Methods – Geology and Sediments (Ordnance Operations)

Equations for determining the radii of sea floor craters due to underwater explosions are provided by Young (1984). The primary variables are NEW and depth of explosion. The amount of NEW used varies with the type of activity.

Variables used in the equations are defined as follows:

R_c = affected area radius (ft)
d = depth of explosion (on bottom) (ft)
W = charge weight (lbs)
Z = hydrostatic pressure at depth of explosion (ft)
$d/W^{.33}$ = reduced explosion depth

The *reduced explosion depth* is a scaled measure that takes water pressure and NEW into account. If NEW is held constant, the value of this parameter increases with depth. Conversely, if the depth is held constant, the value decreases with increasing NEW. The value of $d/W^{.33}$ determines the specific equation to be used. For example, when $d/W^{.33}$ values are between 0.08 and 0.2, the first equation listed below is used.

For $0.08 < d/W^{.33} < 0.2$, $R_c = 3.87\ W^{.33}\ (d/W^{.33})^{.30}$
For $0.2 < d/W^{.33} \leq 1.0$, $R_c = 2.2\ W^{.33}$
For $1.0 < d/W^{.33} \leq 4.0$, $R_c = 2.2\ W^{.33}\ (d/W^{.33})^{.30}$
For $d/W^{.33} > 4.0$, $R_c = 14.5\ (W^{.33}/Z^{.33})$

The equation used when $d/W^{.33}$ values are greater than 4 provides an area rather than a radius measurement. The area, however, may be used to derive the radius.

It is generally considered that the bottom is disturbed over an area twice the distance of the crater radius (Young, 1973; O'Keefe and Young, 1984).

For mines, the largest single NEW used in any category is 272 kg (600 lbs). Mine testing will occur in minimum water depth of 30 m (nearly 100 ft), near the surface and at the point midway from the surface to the bottom. Therefore, detonations will occur at least halfway, or 15 m (50 ft), above the sea floor. Since water pressure increases as the depth increases, the gas bubble caused by an explosion will be largest in shallow water. Tests occurring in the minimum water depth of 30 m (nearly 100 ft) will result in a maximum bubble size of 8.9 m (29 ft), which will stop several meters above the bottom. Swisdak (1978) provides the equation for the maximum radius of a gas bubble as:

$A_{max} = (J)\ (W^{.33}/[H+H_o]^{.33})$, where

A_{max} = maximum bubble radius (m)
J = bubble coefficient, which for trinitrotoluene (TNT) is 3.5 $m^{4/3}/kg^{1/3}$
W = charge weight (kg)
H = depth of explosion (m)
H_o = atmospheric head, which equals 10 meters

Under conditions where the bubble radius will be nearest the bottom (272 kg/600 lbs NEW detonated at 15 m/50 ft water depth), the calculation will be as follows.

$$\text{Maximum bubble radius} = (3.5 \times 272^{.33})/(15.2 + 10)^{.33} = 8.9 \text{ m or } 29 \text{ ft}$$

Therefore, under the worst-case scenario, the radius does not extend to the sea floor. Smaller charge weights used at the same depth or 272 kg (600 lb) charges detonated in deeper water will result in smaller radii. It should be noted that no single detonations exceeding 34 kg (75 lbs) of NEW will be conducted in territorial waters.

4.2.1.1.3 Territorial Waters – Geology and Sediments (Ordnance Operations)

The analysis for ordnance operations includes three detonations per year in the 0.45 to 4.5 kg (1 to 10 lbs) NEW range and one line charge detonation for the No Action Alternative. Alternative 1 encompasses 17 detonations per year in the 0.45 to 4.5 kg (1 to 10 lbs), one in the 5.0 to 34 kg (11 to 75 lbs) NEW range, and two line charge detonations. The analysis takes into account 51 detonations in the 0.45 to 4.5 kg (1 to 10 lbs), three per year in the 5.0 to 34 kg (11 lb to 75 lbs) NEW range, and three line charge detonations for Alternative 2. The calculations reveal that there will be no craters created under any alternative.

Suspended sediments from mission activities will settle quickly within the NSWC PCD Study Area, where sediment movement is naturally facilitated during major storm and hurricane events. Given the stability of the NSWC PCD Study Area's marine geology, it will take approximately 1,000 years to accumulate enough sediment to create a noticeable change in the geological formation or bottom contour. In addition, line charge detonations will be separated in both time and location, which will disperse effects and allow sufficient time for sediments to settle between events.

Some of the detonations in the 0.45 to 4.5 kg (1 to 10 lbs) range are associated with recovery operations. These detonations will be placed by divers on predetermined targets or structures within the water column and will not affect the bottom sediments. Line charge tests tests occur in areas of wave action where suspended sediment will dissipate quickly. The analysis showed that no sediment would be affected by detonations under the three alternatives. In accordance with NEPA because detonations will occur in the water column, the time period (1,000 years) it would take to affect the geological formation or bottom contour, and the separation of events in time and space, there will be no significant impact to geology and sediment from ordnance operations in territorial waters with the No Action Alternative, Alternative 1, or Alternative 2.

4.2.1.1.4 Non-Territorial Waters – Geology and Sediments (Ordnance Operations)

No Action Alternative – Geology and Sediments (Ordnance Operations, Non-Territorial)

No ordnance operations will occur in non-territorial waters with the No Action Alternative.

Alternatives 1 & 2 – Geology and Sediments (Ordnance Operations, Non-Territorial)

There will be no line charge detonation within the non-territorial portion of the NSWC PCD Study Area. Thus, all detonations will occur within the water column. The largest single NEW used in any single detonation category is 272 kg (600 lbs). Such tests will occur in minimum water depth of 30 m (nearly 100 ft), near the surface and at the point midway from the surface to the bottom. That is, detonations will occur at least halfway, or 15 m (50 ft), above the sea floor. Since water pressure increases as the depth increases, the gas bubble caused by an explosion will be largest in shallow water. The largest explosion gas bubble will result from tests in the minimum water depth of 30 m (nearly 100 ft), where a detonation at halfway, 15 m (50 ft), above the sea floor will produce a bubble size of 8.9 m (29 ft), stopping several meters above the bottom. Refer to Section 4.2.1.1.2 for calculations.

Therefore, under the worst-case scenario, the radius does not extend to the sea floor. Smaller charge weights used at the same depth or 272 kg (600 lbs) charges detonated in deeper water will result in smaller radii. Thus, bottom sediments will not be affected by detonations occurring within the water column. Therefore, in accordance with EO 12114 there will be no significant harm to geology and sediment from ordnance operations in non-territorial waters with Alternative 1 and Alternative 2.

4.2.1.2 Subsurface Operations

4.2.1.2.1 Introduction and Approach to Analysis – Geology and Sediments (Subsurface Operations)

This analysis identifies potential effects to geology and sediment from subsurface activities (i.e., crawler, mine placement, and recovery operations) that may disturb and/or displace ocean bottom sediments. Turbidity, toxicity, and water quality are addressed in Section 4.2.4. Because unmanned underwater vehicles (UUVs) and sea-air-land delivery vehicles (SDVs) are propeller driven and do not move along the ocean floor, there are no significant impacts to geology and sediments from their operations. Therefore, UUVs and SDVs will not be discussed further in this section. Furthermore, crawler operations will not occur in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. Therefore, they will not be discussed in that respective section.

4.2.1.2.2 Calculation Methods – Geology and Sediments (Subsurface Operations)

Three particular types of operations, crawler, mine placement, and recovery operations, conducted at the NSWC PCD Study Area will be encompassed by the subsurface operations category.

Crawler operations involve 0.61 m (2 ft) wide, lithium–battery-operated, amphibious vehicles used for reconnaissance missions to classify and map underwater mines. The crawlers weigh an estimated 41 kg (90 lbs) and move along the bay/sea floor at a maximum speed of 1.5 m (5 ft) per second. To calculate the area affected by a single crawler operation (0.013 square kilometers [km^2] [0.0052 square miles (mi^2)]), the width of the crawler, 0.61 m (2 ft), is multiplied by the distance traveled per operation, 22 kilometers (km) (13.7 miles (mi), or 73,920 ft). Crawler operations will not be conducted in areas of hardbottoms, coral, wrecks, or known cultural resources. Therefore, only sediment effects are considered.

During *mine placement operations*, mine-like objects (MLOs) and/or versatile exercise mines (VEMs) will be placed on the sea floor. The MLO mooring block will likely have the greatest effect on geology and sediments upon contact with the sea floor. The surface area of each mooring block, multiplied by the number of MLOs/inert mines and VEMs placed in the water annually, gives the total area of sea floor potentially affected. As described in Section 2.1.3.5, a concrete mooring block of approximately 76.2 × 76.2 × 76.2 centimeters (cm) (30 × 30 × 30 inches [in]) weighing up to 1,225 kg (2,700 lbs) secure most moored mines deployed from surface vessels. MLOs/VEMs will be placed with little force on the surface of the sea floor. Therefore, the potential effects to sediment will only occur at shallow depths on the surface of the sea floor.

Recovery operations refer primarily to the location and recovery of MLOs and VEMs, although other miscellaneous RDT&E items may occasionally be recovered. Therefore, the area of sea floor potentially disturbed per recovery operation is considered to be the surface area of an MLO mooring device, which is 76.2 × 76.2 cm (30 × 30 in, surface area) (0.6m^2 or 6.5 ft^2). In calculating the area of sea floor affected by recovery operations, the assumption is made that all MLOs/VEMs will be recovered. This results in conservative analyses.

4.2.1.2.3 Territorial Waters – Geology and Sediments (Subsurface Operations)

No Action Alternative – Geology and Sediments (Subsurface Operations, Territorial)

It has been estimated there will be 14 crawler operations per year under the No Action Alternative. Given the infrequency of crawler operations and the light weight of the crawler (average 41 kilograms [kg] (90 pounds [lbs]), minimal amounts of sediment will be disturbed as described in the following narrative. These minor disturbances to the sea floor will be temporary (about one hour per operation) and localized as follows. Assuming that each crawler operation will disturb a new area of 0.013 km^2 (0.0052 mi^2), approximately 0.18 km^2 (0.070 mi^2) of bottom will be disturbed in territorial waters annually. This amount is extremely small when compared to the overall territorial portion of the NSWC PCD Study Area of 5,444 km^2 (2,102 mi^2). The potential disturbed sediment area equates to only 0.00033 percent of the territorial portion of the NSWC PCD Study Area. This is equivalent to a 0.018 m^2 (0.19 ft^2) patch of sod on a professional football field (i.e., 5,351 square meters (m^2) [57,600 square feet (ft^2)]). In accordance with NEPA, there will be no significant impact to geology and sediment from crawler operations in territorial waters with the No Action Alternative.

In addition, approximately 186 MLOs/VEMs will be placed in territorial waters annually with the No Action Alternative. All MLOs/VEMs will be recovered. The 1,225 kg (2,700 lb) concrete mooring block associated with moored MLOs/inert mines will be considered to have the greatest effect on geology and sediment. Placement of all 186 MLOs/VEMs will result in disturbance of approximately 108 m^2 (1,162.5 ft^2). This amount is extremely small when compared to the overall territorial portion of the NSWC PCD Study Area, which equates to 5,444 km^2 (2,102 mi^2, or 58 billion ft^2). The potential disturbed sediment area equates to only

0.0000019 percent of the territorial portion of the NSWC PCD Study Area. This is equivalent to 0.0001 m^2 (0.0011 ft^2) of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Sediments displaced during these activities will be expected to settle by completion of the test activities after mooring placement and removal. The placement and removal of MLOs/VEMs will result in disturbances not significantly different from disturbances to the sea floor such as those caused by bottom-feeding sharks and other predators, These effects will be temporary (approximately one hour per placement) and localized (0.6 m^2 [6.5 ft^2] per MLO/VEM) as previously described. In accordance with NEPA, there will be no significant impact to geology and sediments from mine placement operations in territorial waters with the No Action Alternative.

Recovery of RDT&E equipment, moored MLOs, and buried VEMs will not be expected to cause any major disturbance of the sea floor. The area of sea floor potentially disturbed per recovery operation is considered to be the surface area of a MLO/VEM mooring block. The disturbed sediments will be expected to quickly settle after the MLOs/VEMs are removed. Considering that a maximum of 186 MLOs/VEMs may be recovered annually with the No Action Alternative, recovery operations could affect up to the same amount of area as operations involving their placement or 108 m^2 (1,162.5 ft^2) of the same bottom area disturbed during placement operations. The information on the area affected is detailed above. Since the recovery operations will affect an extremely small area as described previously, it is unlikely significant effects to geology and sediments will occur. Therefore, in accordance with NEPA, there will be no significant impact to geology and sediments from mine recovery operations in territorial waters with the No Action Alternative.

Alternative 1 – Geology and Sediments (Subsurface Operations, Territorial)

It has been estimated there will be 38 crawler operations per year under the Alternative 1. Given the infrequency of crawler operations and the light weight of the crawler (average 41 kg [90 lb]), minimal amounts of sediment will be disturbed as described in the following calculation. This activity is likely to result in only minor disturbances to the sea floor, and effects will be temporary (approximately one hour) and localized as follows. Using the same methodology as in the No Action Alternative, with Alternative 1 approximately 0.49 km^2 (0.19 mi^2) of bottom may be disturbed annually during crawler operations. This amount is extremely small when compared to the overall territorial portion of the NSWC PCD Study Area, which equates to 5,444 km^2 (2,102 mi^2). The potential disturbed sediment area equates to only 0.0090 percent of the territorial portion of the NSWC PCD Study Area. This is equivalent to 0.48 m^2 (5.2 ft^2) of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). In accordance with NEPA, there will be no significant impact to geology and sediment from crawler operations in territorial waters with Alternative 1.

Mine placement operations with Alternative 1 represent approximately 225 MLOs/VEMs that will be used annually. Using the same methodology as in the No Action Alternative, a total of approximately 130.5 m^2 (1,404.69 ft^2) of bottom will be affected annually. This amount is extremely small when compared to the overall territorial portion of the NSWC PCD Study Area, which equates to 5,444 km^2 (2,102 mi^2, or 58 billion ft^2). The potential disturbed sediment area equates to only 0.0000024 percent of the territorial portion of the NSWC PCD Study Area. This is the equivalent of 0.000128 m^2 (0.00138 ft^2) patch of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Sediments displaced during these activities will be expected to settle quickly after the placement of the mooring blocks. The placement and removal of MLOs/VEMs will result in disturbances not significantly different from disturbances to the sea floor such as those caused by bottom-feeding sharks and other predators. These effects will be temporary (about one hour per placement) and localized (0.6 m^2 [6.5 ft^2] per MLO/VEM) as previously described. In accordance with NEPA, there will be no significant impact to geology and sediment from mine placement operations in territorial waters with Alternative 1.

Even though Alternative 1 operations will increase over the No Action Alternative, recovery operations will still not be expected to cause any major disturbance of the sea floor sediments. The area of sea floor potentially disturbed per recovery operation is considered to be equivalent to the amount of surface area potentially disturbed during MLO/VEM mooring or 130.5 m^2 (1,404.69 ft^2) of bottom of the same bottom area disturbed during placement operations. The information on the area affected is detailed above. Recovery will result in minor disturbance, whereby effects will be temporary (approximately one hour per recovery) and local as described previously. Therefore, in accordance with NEPA, there will be no significant impact to geology and sediments from recovery operations in territorial waters with Alternative 1.

Alternative 2 – Geology and Sediments (Subsurface Operations, Territorial)

Crawler operations will also increase with Alternative 2 activities; it has been estimated there will be 114 crawler operations per year under the Alternative 2. Given the infrequency of crawler operations and the light weight of the crawler (average 41 kg [90 lb]), minimal amounts of sediment will be disturbed as described in the following calculation. This activity is likely to result in only minor disturbances to the sea floor, and effects will be temporary (approximately one hour per event) and localized as follows. Alternative 2 crawler operations will disturb approximately 1.5 km^2 (0.58 mi^2) of bottom. This amount is extremely small when compared to the overall territorial portion of the NSWC PCD Study Area of 5,444 km^2 (2,102 mi^2). The potential disturbed sediment area equates to only 0.028 percent of the territorial portion of the NSWC PCD Study Area. This is the equivalent of 1.5 m^2 (16 ft^2) sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Therefore, in accordance with NEPA, there will be no significant impact to geology and sediment from crawler operations in territorial waters with Alternative 2.

Mine placement operations with Alternative 2 represents 677 MLOs/VEMs that will be used annually. Using the same methodology, a total of approximately 392.66 m^2 (4,226.56 ft^2) of bottom will be affected annually. This amount is extremely small when compared to the overall territorial portion of the NSWC PCD Study Area of 5,444 km^2 (2,102 mi^2). The potential disturbed sediment area equates to only 0.00000721 percent of the territorial portion of the NSWC PCD Study Area. This is equivalent to 0.00039 m^2 (0.0042 ft^2) of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Sediments displaced during these activities will be expected to settle quickly after the placement of the mooring blocks. The placement and removal of MLOs/VEMs will result in disturbances not significantly different from disturbances to the sea floor such as those caused by bottom-feeding sharks and other predators. These effects will be temporary (about one hour per placement) and localized (0.6 m^2 [6.5 ft^2] per MLO/VEM) as based on the surface area of the mooring. In accordance with NEPA, there will be no significant impact to geology and sediment from mine placement operations in territorial waters with Alternative 2.

Operations supported by Alternative 2 will increase over Alternative 1; however, recovery operations will still not be expected to cause any major disturbance of the sea floor sediments. The area of sea floor potentially disturbed per recovery operation is considered to be equivalent to the amount of surface area potentially disturbed during MLO/VEM mooring or 392.66 m^2 (4,226.56 ft^2) of the same bottom area disturbed during placement operations. The information on the area affected is detailed above. Furthermore, recovery will result in minor disturbance, whereby effects will be temporary (approximately one hour per recovery) and local as previously described. Therefore, in accordance with NEPA, there will be no significant impact to geology and sediments from recovery operations in territorial waters with Alternative 2.

4.2.1.2.4 Non-Territorial Waters – Geology and Sediments (Subsurface Operations)

As stated in Section 4.2.1.2.1, Introduction and Approach to Analysis – Geology and Sediments, crawler operations will not occur in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The following text discusses potential effects from the placement of mines.

No Action Alternative – Geology and Sediments (Subsurface Operations, Non-Territorial)

With the No Action Alternative in non-territorial waters, 80 MLOs/VEMs will be placed in the water annually during mine placement operations. Sediments displaced during these activities will be expected to settle quickly (within one hour) after the placement of the mooring blocks. The placement and removal of MLOs/VEMs will result in disturbances not significantly different from disturbances to the sea floor such as those caused by bottom-feeding sharks and other predators. These effects will be temporary (about one hour per operation) and localized (0.6 m^2 [6.5 ft^2] per MLO/VEM), as based on the surface area of the mooring and because each event is separated in time and location.

In addition, these activities will result in approximately 46.4 m^2 (499.4 ft^2) area of bottom affected annually. This amount is extremely small when compared to the overall non-territorial portion of the NSWC PCD Study Area, which equates to 72,125 km^2 (27,848 mi^2). The potential disturbed sediment area equates to only 0.000000064 percent of the non-territorial portion of the NSWC PCD Study Area. This is equivalent to 0.0000034 m^2 (0.000037 ft^2, or the size of an individual grain of sand) of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Therefore, in accordance with EO 12114, there will be no significant harm to geology and sediments from mine placement operations in non-territorial waters with the No Action Alternative.

The area of sea floor potentially disturbed per recovery operation is considered to be equivalent to the amount of surface area potentially disturbed during MLO/VEM mooring, which is detailed above. Furthermore, recovery will result in minor disturbance, whereby effects will be temporary (approximately one hour per recovery) and local as previously described. Therefore, in accordance with EO 12114, there will be no significant harm to geology and sediments from recovery operations in non-territorial waters with the No Action Alternative.

Alternative 1 – Geology and Sediments (Subsurface Operations, Non-Territorial)

The effects to geology and sediments under Alternative 1 are similar to the No Action Alternative. Mine placement operations with Alternative 1 will involve the placement of 97 MLOs/VEMs in the water annually. Sediments displaced during these activities will settle quickly after the placement of the mooring blocks. The placement and removal of MLOs/VEMs will result in disturbances not significantly different from disturbances to the sea floor such as those caused by bottom-feeding sharks and other predators. These effects will be temporary (about one hour per placement and localized (0.6 m^2 [6.5 ft^2] per MLO/VEM), as based on the surface area of the mooring and because each event is separated in time and location.

In addition, the placement of mooring blocks will result in a total of approximately 56.3 m^2 (606.01 ft^2) of bottom affected annually. This amount is extremely small when compared to the overall non-territorial portion of the NSWC PCD Study Area of 72,125 km^2 (27,848 mi^2, or 776 billion ft^2). The potential disturbed sediment area equates to only 0.000000078 percent of the non-territorial portion of the NSWC PCD Study Area. This is equivalent to 0.0000042 m^2 (0.000045 ft^2, or the size of an individual grain of sand) of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Sediments displaced during these activities will be expected to settle quickly after the placement of the mooring blocks. This activity is likely to result in only minor disturbances to the sea floor and effects will be temporary (approximately one hour per placement) and localized.

The area of sea floor potentially disturbed per recovery operation is considered to be equivalent to the amount of surface area potentially disturbed during MLO/VEM mooring, which is detailed above. Furthermore, recovery will result in minor disturbance, whereby effects will be temporary (approximately one hour per recovery) and local as previously described. Therefore, in accordance with EO 12114, there will be no significant harm to geology and sediments from recovery operations in non-territorial waters with Alternative 1.

Alternative 2 – Geology and Sediments (Subsurface Operations, Non-Territorial)

Mine placement operations with Alternative 2 will involve the placement of 289 MLOs/VEMs in the water annually. Sediments displaced during these activities will settle quickly after the placement of the mooring blocks. The placement and removal of MLOs/VEMs will result in disturbances not significantly different from disturbances to the sea floor such as those caused by bottom-feeding sharks and other predators. These effects will be temporary (about one hour per operation and localized (0.6 m^2 [6.5 ft^2] per MLO/VEM), as based on the surface area of the mooring and because each event is separated in time and location.

These operations will result in a total of approximately 167.62 m^2 (1,804.2 ft^2) of bottom affected annually. This amount is extremely small when compared to the overall non-territorial portion of the NSWC PCD Study Area of 72,125 km^2 (27,848 mi^2). The potential disturbed sediment area equates to only 0.00000023 percent of the non-territorial portion of the NSWC PCD Study Area. This is equivalent to 0.000012 m^2 (0.00013 ft^2) of sod on a professional football field (i.e., 5,351 m^2 [57,600 ft^2]). Sediments displaced during these activities will be expected to settle quickly after the placement of the mooring blocks. This activity will likely result in only minor disturbances to the sea floor, and effects will be temporary (approximately one hour per placement) and localized as previously described. Therefore, in accordance with EO 12114, there will be no significant harm to geology and sediments in non-territorial waters from implementing Alternative 2.

The area of sea floor potentially disturbed per recovery operation is considered to be equivalent to the amount of surface area potentially disturbed during MLO/VEM mooring, which is detailed above. In addition, recovery will result in minor disturbance, whereby effects will be temporary (approximately one hour per recovery) and local as previously described. Therefore, in accordance with EO 12114, there will be no significant harm to geology and sediments from recovery operations in non-territorial waters with Alternative 2.

4.2.1.3 Projectile Firing

4.2.1.3.1 Introduction and Approach to Analysis – Geology and Sediments (Projectile Firing)

NSWC PCD RDT&E activities that encompass projectile firing have the potential to affect sediments in terms of area and contamination. The following analysis focuses on a quantitative approach to investigate the amount of the NSWC PCD Study Area affected and the pollution of sediments in the Gulf of Mexico (GOM).

4.2.1.3.2 Territorial Waters – Projectile Firing (Geology and Sediments)

No projectile firing will occur in territorial waters.

4.2.1.3.3 Non-territorial Waters – Projectile Firing (Geology and Sediments)

To investigate potential effects to the seafloor, the total area covered by the rounds/projectiles was estimated. It is assumed that all the shells and casings land in the water intact (except for the five-inch explosive rounds) and sink to the bottom. Once on the bottom, they would remain on the surface of the sediment and cover a section of the seafloor given by its cross-sectional area. For the five-inch shells, the portion covered was assumed to be twice the cross-sectional area. The areas for the individual rounds were then summed to get the total area covered by all the rounds. This method gives the maximum area covered, with the following assumptions: 1) all the rounds remain intact, 2) all the rounds cover the seafloor given by their cross-sectional area, and 3) the shell casings ejected from the gun during firing also land in the sea. The probability that any area on the bottom is impacted by a round was calculated using the fraction of the total area covered by rounds (Table 4-2).

Table 4-2. Distribution and Quantities of Projectile Pieces on the Ocean Floor (Per Year)

	Total Area Encompassed By Warning Area in km^2 (mi^2)	Total Area Impacted in km^2 (mi^2)	Percent Total Coverage of Shell Debris	Total Particles*	Total Mass of Shells kg (lb)
NSWC PCD Study Area	81,032 (31,287.19)	0.000055 (0.000021)	0.0000000675	10,842	3361 (7,394)

*Does not include explosion debris

To estimate the potential for pollution from the use of projectile firing in a worst case scenario under Alternative 2, the mass of the rounds was needed (3,361 kg [7,394 lb]), along with the concentrations already present in the sediment and density of wet soil or sand (Table 4-3 and Table 4-4). The total amount of sediment required that would contain the same amount of pollutant that was being added by the operation was calculated by using these values and the following equation:

%area = 100*(Pb/(VE * MR))/TA

Where Pb = concentration of lead in sediment
VE = volume of earth that weighs 1 ton
TA = total Area of NSWC PCD Study Area
MR = total mass of rounds

Table 4-3. Average Contaminants Already in Sediment

Metal	Contaminant Level (kg / metric ton of sediment)
Aluminum	52
Copper	0.014
Iron	21
Lead	0.020

Source: USEPA, 2008

Table 4-4. Bulk Density of Sand and Soil

Substance	Density in Kg/m^3 (lb/mi^3)
Earth, dense	2002 (18,397)
Sand, wet	1922 (17,662)

Source: SImetric, 2008

From the information in Tables 4-2, 4-3 and 4-4, if the total material dropped was made from 100 percent lead (the primary contaminant of concern in the main constituents), this amount would be the same level of lead contained in 84,025 m^3 of sediment. According to the USGS (USGS, 2008) sediments in the Gulf of Mexico are hundreds to thousands of meters thick. Assuming a biologically available sediment depth of 1 m (3 ft), this amount is less than the lead contained in 300 m^2 (3,229 ft^2) of seafloor. The total NSWC PCD Study Area is approximately 81,032 km^2 (31,287 ft^2) (Table 4-5). Ignoring the burden of lead already in the water, NSWC PCD RDT&E activities would add 0.00000043 percent of the total lead already in the top meter of the sediments each year (Table 4-5). This material would continue to be buried deeper each year, reducing the possibility of buildup in a biologically accessible top layer In accordance with EO 12114, there would be no significant harm from projectile firing to sediments based on the small amount of area affected and the lack of contamination as described in this section.

Table 4-5. Maximum Percent Contribution* to Sediment Load in NSWC PCD Study Area

Metal	Percentage
Lead	0.00000043
Aluminum	0.0000000085
Copper	0.00000052
Iron	0.000000013

*Assumes that projectiles and rounds are made entirely of pure metal

4.2.2 Air Quality

4.2.2.1 Introduction and Approach to Analysis – Air Quality

Federal and state standards have been established for air pollutants, which are discussed in Section 3.2.2. This section discusses the potential effects to air quality as a result of the No Action Alternative and the proposed action alternatives. Identifying the affected area for an air quality assessment requires knowledge of air emissions sources, pollutant types, emissions rates and release parameters, proximity to other emissions sources, and local as well as regional meteorological conditions. Refer to Appendix B, Air Quality, for a review of air quality regulations and associated methodologies used for emissions calculations. Additionally, meteorological details concerning the NSWC PCD Study Area are included in Appendix B.

Emissions associated with ordnance detonation and air and surface operations will be the main contributors to effects generated by each alternative. The air quality analysis focused on emissions from these three operations. It should be noted that air quality issues associated with the NSWC PCD RDT&E activities will result from mobile sources.

4.2.2.2 Calculation Methods – Air Quality

Air pollutant emission calculations have been performed for air, surface, and ordnance operations. For air operations, total emission calculations take into account factors such as the type of pollutant, the annual amount of time emission occurs, fuel flow, engine type, and the number of engines per aircraft. Emission calculations associated with surface operations incorporate similar factors and are categorized as marine outboard engines, diesel engines, or stationary gas turbines. Ordnance and munitions emissions are calculated using the number of explosives used annually, the net weight of the explosives, and conversion and emission factors.

The General Conformity Rule only affects federal actions occurring in non-attainment areas (i.e., areas that do not meet the National Ambient Air Quality Standards [NAAQS]) and maintenance areas (areas that were classified as non-attainment that now are in attainment). Since the alternatives will be located in attainment areas, the Navy will not need to prepare a conformity determination. Specific details regarding the assumptions and calculations associated with the emissions estimates are located in Appendix B, Air Quality.

For the analysis, various references were utilized, including the U.S. Environmental Protection Agency's (USEPA's) AP-42 (published emission factors) values as well as the U.S. Air Force Inventory Guidance for Mobile Sources at Air Force Installations (from the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis [AFIERA]). In order to evaluate the air emissions and their effect to the overall NSWC PCD Study Area, the emissions associated with the NSWC PCD RDT&E activities were compared to the total emissions on a pollutant–by-pollutant basis for the NSWC PCD Study Area's 2002 National Emissions Inventory (NEI) data. Potential effects to air quality were then identified as the total emissions of any pollutant that equals 10 percent or more of the NSWC PCD Study Area's emissions for that specific pollutant.

The 10 percent criteria approach is used in the General Conformity Rule as an indicator for effect analysis for non-attainment and maintenance areas, and although the NSWC PCD Study Area is attainment for the NAAQS, the General Conformity Rule's effect analysis was utilized to provide a consistent approach to evaluating the effect of the proposed action's emissions. To provide a conservative evaluation, the effects screening in this analysis used a more restrictive criteria than required in the General Conformity Rule. Rather than comparing emissions from NSWC PCD RDT&E activities to regional inventories (as required in the General Conformity Rule), emissions were compared to the individual county potentially impacted, which is a smaller area. As stated in Section 3.2.2, a quantitative air quality analysis was completed for activities occurring over both territorial and non-territorial waters. However, since air quality standards for activities occurring over non-territorial waters do not exist, the same criterion established for territorial waters was used. Although the CAA does not apply to activities occurring outside the territorial waters, the Navy has performed a qualitative analysis for these activities to address the potential effects of emissions from non-territorial activities drifting inshore and potentially affecting the air quality of counties bordering the NSWC PCD Study Area.

4.2.2.3 Air Operations Emissions – Air Quality

Emissions from air operations associated with the RDT&E activities within the NSWC PCD Study Area will arise from airborne transportation such as airplanes or helicopters. NSWC PCD activities encompassed by this EIS/OEIS will employ various aircraft, including the 1UH-1N, SH-60B, MH-53, MH-60S, and Cessna-172.

Aircraft operations of concern are those that occur from ground level up to 914.4 m (3,000 ft) above ground level (AGL). The 3,000-foot AGL ceiling was assumed as the atmospheric mixing height above which any pollutant generated will not contribute to increased pollutant concentrations at ground level. Typically, all pollutant emissions from aircraft generated above 914.4 m (3,000 ft) AGL will be excluded from this analysis, but to ensure a conservative approach, all emissions were included in the total emissions representations. The aircraft operation of interest within the mixing zone is the landing and takeoff (LTO) cycle. The LTO is characterized by five modes of operation designated as: (1) approach, (2) taxi in, (3) taxi out, (4) takeoff, and (5) climbout.

The LTO cycle is the basis for calculating pollutant emissions. For each mode of operation during an LTO cycle, an aircraft engine operates at a specified power setting and for a specific period (time-in-mode). The pollutant emission rate is a function of the engine's operating mode, the fuel flow rate, and the engine's overall efficiency. Emissions for one complete LTO cycle for a particular aircraft are calculated by knowing the specific engine pollutant emission factors for each mode of operation.

Emission factors for most military engines were obtained from the AFIERA located at Brooks Air Force Base (AFB), Texas, and were based on aircraft engines burning JP-8 fuel (U.S. Air Force, 2002b). For those aircraft for which engine data was unavailable, the T64-GE-100 was used as a surrogate. Details regarding emissions factors can be found in Appendix B, Air Quality.

4.2.2.4 Surface Operation Emissions – Air Quality

Surface operations will produce emissions from various marine craft. Activities encompassed by this EIS/OEIS will incorporate a variety of marine craft, including Athena and Athena II, OP 1/2

(Boston Whaler), PSC 6/7 (Boston Whaler), PSC-05 (Monarch), PSC- 08/12, Mine Countermeasure (MCM) Ships, DDG (Destroyer), 11m RHIB (Nautica), and Mr. Offshore. These vessels will be powered by outboard engines, diesel engines, or gas turbines. Emissions factors for outboard engines and gas turbines were compared to the planned operational levels for each craft. Emissions factors published in USEPA AP-42 and AFIERA were used to calculate the estimated emissions. Specifics regarding emissions factors can be found in Appendix B, Air Quality.

4.2.2.4.1 Marine Outboard Engines

The USEPA has published emissions factors for air pollutants produced by several types of two-stroke and four-stroke outboard engines. The most conservative emission factors (USEPA, 1999) for two-stroke engines of various horsepowers were used for calculation purposes.

Emissions estimates for surface craft utilizing outboard engines were calculated using USEPA AP-42 factors and multiplied by the engine horsepower and hours of operation. Specifics regarding emissions calculation can be found in Appendix B.

4.2.2.4.2 Diesel Engines

Limited data were available for large marine diesel engines. Therefore, USEPA AP-42 emissions factors for industrial reciprocating engines were used to calculate diesel engine emissions. Diesel was assumed to be the primary fuel to ensure an overly conservative approach. A calculation methodology similar to the outboard engines' was employed to ascertain emissions from the diesel engines.

Diesel engine emission factors were multiplied by the engines' horsepower and annual hours of operation to ascertain the pounds of pollutant emissions per year. This value was then converted to tons per year value for comparison with the NSWC PCD Study Area's total summed emissions for the individual pollutants. Specifics regarding emissions calculation can be found in Appendix B, Air Quality.

4.2.2.4.3 Stationary Gas Turbines

AFIERA emissions factors were utilized to ascertain emissions from stationary gas turbines on the smaller marine craft that are similar to an aero derivative design, since emissions factors for marine stationary gas turbines were limited. Therefore, the T64-GE-100 emissions factors were chosen as a surrogate for the stationary gas turbines on the Landing Craft Air Cushion (LCAC), DDG, and Athena and Athena II. A calculation methodology similar to the outboard engine calculations was instituted to assess emissions from the turbines. Specifics regarding emissions calculation can be found in Appendix B, Air Quality.

4.2.2.5 Ordnance and Munitions Emissions – Air Quality

TNT was used as a surrogate for mine and explosive activities. Emissions factors (Johnson, 1992 as cited in U.S. Air Force, 1997b) for nitrogen oxides (NO_x), sulfur oxides (SO_x), and carbon monoxide (CO) were utilized. These factors were then multiplied by the net weight of the explosive and the number of times that the explosive was used during a designated time frame. This calculation provided an annual weight of emissions. Specifics regarding emissions calculation can be found in Appendix B, Air Quality.

4.2.2.5.1 Territorial Waters – Air Quality (Air/Surface/Ordnance Operations)

No Action Alternative – Air Quality (Air/Surface/Ordnance Operations, Territorial)

The No Action Alternative RDT&E activities' emissions were evaluated and compared to the 10 percent criterion for individual pollutants for each of the counties bordering the NSWC PCD Study Area as described in Section 3.2.2. Table 4-6 presents the individual pollutant emissions from the No Action Alternative activities and compares that data to the USEPA NEI for 2002. Nitrogen oxide, at 19.37 tons per year, is the criteria pollutant with the highest total emissions level for the baseline. All pollutants were less than 1 percent of the total counties' emissions for their respective pollutant totals. In accordance with NEPA, there will be no significant impact to air quality from surface, air, and ordnance operations in territorial waters with the No Action Alternative.

Table 4-6. No Action Alternative: Individual Pollutant Emissions for Territorial Waters

	Tons (Metric Tons)/yr				
	NO_x	**CO**	**VOC**	**PM_{10}**	**SO_x**
NSWC PCD Cumulative Emissions	64.22 (58.26)	15.04 (13.64)	3.41 (3.09)	8.24 (7.48)	0.06 (0.05)
Total NSWC PCD Study Area Emissions[1]	137,060 (124,339)	601,522 (545,692)	118,816 (107,789)	145,871 (132,334)	150,674 (136,690)
Percentage of NSWC PCD Study Area[2]	0.0469%	0.0025%	0.0029%	0.0057%	0.0000%

Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area
NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter equal to or less than 10 microns in diameter; SO_x = sulfur oxides
[1]Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area
[2]Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Cumulative Emissions Value.

Alternative 1 – Air Quality (Air/Surface/Ordnance Operations, Territorial)

The Alternative 1 RDT&E activities were evaluated and compared to the 10 percent criterion for individual criteria pollutants for each of the counties bordering the NSWC PCD Study Area as described in Section 3.2.2. Table 4-7 presents the individual pollutant emissions from the Alternative 1 activities and compares that data to the USEPA NEI for 2002. Nitrogen Oxides represent the highest percentage of emissions for a criteria pollutant with respect to NSWC PCD activities. All pollutants were less than 1 percent of the total counties' emissions for their respective pollutant totals. In accordance with NEPA, there will be no significant impact to air quality from surface, air, and ordnance operations in territorial waters with Alternative 1.

Table 4-7. Alternative 1: Individual Pollutant Emissions for Territorial Waters

	Tons (Metric Tons)/Yr				
	NO_x	CO	VOC	PM_{10}	SO_x
NSWC PCD Cumulative Emissions	67.90 (61.60)	16.28 (14.77)	3.61 (3.27)	8.71 (7.90)	0.06 (0.05)
Total NSWC PCD Study Area Emissions[1]	137,060 (124,339)	601,522 (545,692)	118,816 (107,789)	145,871 (132,334)	150,674 (136,690)
Percentage of NSWC PCD Study Area[2]	0.05%	0.00%	0.00%	0.01%	0.00%

NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter equal to or less than 10 microns in diameter; SO_x = sulfur oxides
[1]Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area
[2]Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Cumulative Emissions Value.

Alternative 2 – Air Quality (Air/Surface/Ordnance Operations, Territorial)

An assessment was performed to determine the upper limits of mission activities in comparison to air quality criterion established using the previously identified mission effect sources (i.e., aircraft, surface craft, and ordnances). This evaluation indicated that air and surface craft could operate 7,227 hours per year total either inside or outside the territorial line and ordnance as well as munitions activities could increase threefold without surpassing the established criterion. Table 4-8 represents this evaluation. The highest pollutant percentage increase is NO_x, which is approximately 0.08 percent of the NSWC PCD Study Area total NO_x emissions based on the USEPA 2002 NEI. All pollutants were less than 1 percent of the total counties' emissions for their respective pollutant totals. In accordance with NEPA, there will be no significant impact to air quality from surface, air, and ordnance operations in territorial waters with Alternative 2.

Table 4-8. Alternative 2: Individual Pollutant Emissions for Territorial Waters

	Tons (Metric Tons)/Yr				
	NO_x	CO	VOC	PM_{10}	SO_x
NSWC PCD Cumulative Emissions	203.69 (184.78)	48.14 (43.67)	10.83 (9.82)	26.12 (23.70)	0.19 (0.17)
Total NSWC PCD Study Area Emissions[1]	137,060 (124,339)	601,522 (545,692)	118,816 (107,789)	145,871 (132,334)	150,674 (136,690)
Percentage of NSWC PCD Study Area[2]	0.149%	0.0080%	0.0091%	0.0179%	0.0001%

NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter equal to or less than 10 microns in diameter; SO_x = sulfur oxides
[1]Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area
[2]Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Cumulative Emissions Value.

4.2.2.5.2 Non-Territorial Waters – Air Quality (Air/Surface/Ordnance Operations)

Since the naval activities occur in waters near the U.S. mainland, an evaluation utilizing the same criterion established for territorial waters was completed and is explained below. Details are represented in Appendix B, Air Quality.

No Action Alternative

No Action Alternative activities were evaluated and compared to the 10 percent criterion for the counties bordering the NSWC PCD Study Area. Table 4-9 presents the individual pollutant emissions from the No Action Alternative activities and compares that data to the USEPA NEI for 2002. NO_x represents the highest percentage of emissions for a criteria pollutant with respect to baseline NSWC PCD activities at a level of 68 percent per year. All pollutants were less than 1 percent of the total emissions for counties bordering the NSWC PCD Study Area. In accordance with EO 12114, there will be no significant harm to air quality within non-territorial waters under the No Action Alternative.

Table 4-9. No Action Alternative: Individual Pollutant Emissions for Non-Territorial Waters

	Tons (Metric Tons)/Yr				
	NO_x	CO	VOC	PM_{10}	SO_x
NSWC PCD Cumulative Emissions	21.68 (19.67)	5.13 (4.65)	1.15 (1.04)	2.80 (2.54)	0.03 (0.03)
Total NSWC PCD Study Area Emissions[1]	137,060 (124,339)	601,523 (545,692)	118,817 (107,789)	145,873 (132,334)	150,675 (136,690)
Percentage of NSWC PCD Study Area[2]	0.016%	0.001%	0.001%	0.002%	0.000%

NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides

[1]Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area

[2]Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Cumulative Emissions Value.

Alternative 1 – Air Quality (Air/Surface/Ordnance Ops, Non-Territorial)

The increased activities associated with Alternative 1 were evaluated and compared to the 10 percent criterion for the counties bordering the NSWC PCD Study Area and will not exceed this criterion for each corresponding pollutant. Table 4-10 presents the individual pollutant emissions from Alternative 1. All pollutants were less than 1 percent of the total counties' emissions for their respective pollutant totals. In accordance with EO 12114, there will be no significant harm to air quality in non-territorial waters from under Alternative 1.

Table 4-10. Alternative 1: Individual Pollutant Emissions for Non-Territorial Waters

	Tons (Metric Tons)/Yr				
	NO_x	CO	VOC	PM_{10}	SO_x
NSWC PCD Cumulative Emissions	22.93 (20.80)	5.79 (5.25)	1.22 (1.11)	2.95 (2.68)	0.03 (0.03)
Total NSWC PCD Study Area Emissions[1]	137,060 (124,339)	601,523 (545,692)	118,817 (107,789)	145,873 (132,334)	150,675 (136,690)
	Tons (Metric Tons)/Yr				
	NO_x	CO	VOC	PM_{10}	SO_x
Percentage of NSWC PCD Study Area[2]	0.01673%	0.00096%	0.10202%	0.00202%	0.00002%

NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter equal to or less than 10 microns in diameter; SO_x = sulfur oxides

[1]Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area

[2]Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Cumulative Emissions Value.

Alternative 2 – Air Quality (Air/Surface/Ordnance Ops, Non-Territorial)

An evaluation of Alternative 2 activities determined the upper limits of mission activities in comparison to air quality criterion established using the previously identified mission effectors (aircraft, surface craft, and ordnances). This evaluation indicated that air and surface craft could operate 7,227 hours per year total, and ordnance as well as munitions activities could increase threefold without exceeding the established criterion. Table 4-11 represents this evaluation. The highest pollutant percentage increase is NO_x, which is approximately 0.08 percent of the NSWC PCD Study Area's total NO_x emissions based on the USEPA 2002 NEI. All pollutants were less than 1 percent of the total counties' emissions for their respective pollutant totals. In accordance with EO 12114, there will be no significant harm to air quality in non-territorial waters under Alternative 2.

Table 4-11. Alternative 2: Individual Pollutant Emissions for Non-Territorial Waters

	Tons (Metric Tons)/Yr				
	NO_x	CO	VOC	PM_{10}	SO_x
NSWC PCD Cumulative Emissions	68.68 (62.31)	16.65 (15.10)	3.65 (3.31)	8.84 (8.02)	0.08 (0.07)
Total NSWC PCD Study Area Emissions[1]	137,060 (124,339)	601,523 (545,692)	118,817 (107,789)	145,873 (132,334)	150,675 (136,690)
Percentage of NSWC PCD Study Area[2]	0.0501%	0.0028%	0.0031%	0.0061%	0.0001%

NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter equal to or less than 10 microns in diameter; SO_x = sulfur oxides
[1]Total NSWC PCD Study Area Emissions = total counties' emissions bordering the NSWC PCD Study Area
[2]Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Cumulative Emissions Value.

4.2.3 In-Air Sound

4.2.3.1 Introduction and Approach to Analysis – In-Air Sound

Sound, often defined as unwanted sound, is one of the most common environmental issues associated with human activities, especially military testing. Concerns regarding sound relate to certain potential effects such as hearing loss, non-auditory health effects, annoyance, speech interference, sleep interference, and effects on domestic animals, wildlife, structures, terrain, and historic and archaeological sites. This section focuses on in-air sound, as underwater sound only has the potential to affect biological resources. Therefore, refer to Section 4.3, Biological Resources, for analyses of underwater sound.

The physical characteristics of sound, or sound, include its intensity, frequency, and duration. Sound is created by acoustic energy, which produces pressure waves that travel through a medium, like air, and are sensed by the eardrum. This may be likened to the ripples in water produced by a stone being dropped into it. As the acoustic energy increases, the intensity or amplitude of the pressure waves increase, and the ear senses louder sound.

Sound intensity varies widely (from a soft whisper to a jet plane) and is measured on a logarithmic scale to accommodate this wide range. The logarithm, and its use, is nothing more than a mathematical tool that simplifies dealing with very large and very small numbers. For example, the logarithm of the number 1,000,000 is 6, and the logarithm of the number 0.000001 is -6 (minus 6). Obviously, as more zeros are added before or after the decimal point, converting these numbers to their logarithms greatly simplifies calculations that use these numbers.

The frequency of sound is measured in cycles per second, or hertz (Hz). This measurement reflects the number of times per second the air vibrates from the acoustic energy. Low frequency sounds are heard as rumbles or roars, and high frequency sounds are heard as screeches.

Sound measurement is further refined through the use of "weighting." The normal human ear can detect sounds that range in frequency from about 20 to 15,000 Hz. However, all sounds throughout this range are not heard equally well. Therefore, through internal electronic circuitry, some sound meters are calibrated to emphasize frequencies in the 1,000 to 4,000 Hz range. The human ear is most sensitive to frequencies in this range. When measuring these sounds that continue over some time period (such as an aircraft overflight) with these instruments, the levels are termed "A-weighted" and are shown in terms of A-weighted decibels (dBA).

The duration of sound events and the number of times sound events occur are also important considerations in assessing sound effects. The word "metric" is used to describe a standard of measurement. As used in environmental sound analysis, there are many different types of sound metrics. Each metric has a different physical meaning or interpretation, and each was developed by researchers attempting to represent the effects of environmental sound.

The metrics supporting the assessment of sound that will result from the conduct of air operations that support NSWC PCD RDT&E activities in and over the GOM in the three Warning Areas (W-151 [Panama City Operating Area], W-155 [Pensacola Operating Area], and W-470) and St. Andrew Bay (SAB) include both single event and time-averaged cumulative metrics. Each metric represents a "tier" for quantifying the sound environment and is briefly discussed below.

4.2.3.1.1 Maximum Sound Level – In-Air Sound

The highest sound level measured during a single sound event (e.g., an aircraft overflight), or the L_{max} metric, defines peak sound levels and is the sound actually heard by a person on the ground. For an observer, the sound level starts at the ambient (or background) sound level, rises up to the maximum level as the aircraft flies closest to the observer, and returns to the ambient level as the aircraft recedes into the distance. Maximum sound level is important in judging a sound event's interference with conversation, sleep, or other common activities.

Table 4-12 shows L_{max} values (peak sound level that is actually heard) at various altitudes (above water) associated with representative fixed- and rotary-wing aircraft operating in the Warning Areas. Aircraft speeds and power settings associated with these acoustic values are typical of the expected operations in the airspace.

Table 4-12. Representative Maximum Sound Levels

Aircraft and Power	L_{max} Values (in dBA) at Altitude (in Meters [Feet])				
	152 (500)	305 (1,000)	762 (2,500)	1,524 (5,000)	3,048 (10,000)
F-18 Intermediate Power	98.5	91.1	80.1	70.5	59.3
MH-53 Flight at 100 knots	83.6	76.8	67.0	58.8	49.5
MH-60 Flight at 140 knots	86.0	79.4	69.7	61.4	51.8

Source: OMEGA108R, 2004

4.2.3.1.2 Sound Exposure Level – In-Air Sound

The sound exposure level (SEL) metric combines the intensity (maximum sound level) and duration of a sound event into a single measure. It is important to note, however, that unlike the L_{max} metric, SEL does not directly represent the sound level heard at any given time, but rather provides a measure of the total exposure of the entire event. Its value represents all of the acoustic energy associated with the event as though it were present for one second. For sound events that last longer than one second, the SEL value will be greater than the maximum sound level created by the event. For sound events that last less than one second, the SEL value will be less. The SEL metric is important because it is the value used to calculate other time-averaged sound metrics. Table 4-13 shows SEL values corresponding to the aircraft and power settings reflected in Table 4-12.

Table 4-13. Representative Sound Exposure Levels

Aircraft and Power	SEL Values (in dBA) At Altitude (in Meters [Feet])				
	152 (500)	305 (1,000)	762 (2,500)	1,524 (5,000)	3,048 (10,000)
F-18 Intermediate Power	100.7	95.2	86.6	78.8	69.4
MH-53 Flight At 100 knots	95.2	90.2	82.8	76.4	68.8
MH-60 Flight At 140 knots	91.8	87.0	79.7	73.3	65.4

Source: OMEGA108R, 2004
SEL = sound exposure level

4.2.3.1.3 Time-Averaged Cumulative Day-Night Average Sound Metrics – In-Air Sound

The equivalent sound level (L_{eq}) is a metric reflecting average continuous sound. The metric considers variations in sound magnitude over periods of time, sums them and reflects, in a single value, the acoustic energy present during the time period considered. Common time periods for averaging are 1, 8, and 24 hour periods.

The Day-Night Average Sound Level (L_{dn}) also sums the individual sound events and averages the resulting level over a specified length of time. Normally, this is a 24-hour period. Thus, like L_{eq}, it is a composite metric representing the maximum sound levels, the duration of the events, and the number of events that occur. However, this metric also considers the time of day during which sound events occur. This metric adds 10 decibels (dB) to those events that occur between 10:00 P.M. and 7:00 A.M. to account for the increased intrusiveness of sound events that occur at night when ambient sound levels are normally lower than during the daytime. It should be noted that if no sound events occur between 10:00 P.M. and 7:00 A.M., the value calculated for L_{dn} will be identical to that calculated for a 24 hour equivalent sound level ($L_{eq(24)}$). This cumulative metric does not represent the variations in the sound level heard. Nevertheless, it does provide an excellent measure for comparing environmental sound exposures when there are multiple sound events to be considered.

In this document, some sound levels associated with proposed military activities are considered as 24 hour equivalent sound levels (i.e., $L_{eq(24)}$). If applicable, the L_{dn} metric will be used in place of the $L_{eq(24)}$ metric. Average Sound Level metrics are the preferred sound metrics of the Department of Housing and Urban Development (HUD), the Department of Transportation (DOT), the Federal Aviation Administration (FAA), the USEPA, and the Veterans Administration (VA). Scientific studies and social surveys have found that Average Sound Level metrics are the best measure to assess levels of community annoyance associated with all types of environmental sound. Therefore, their use is endorsed by the scientific community and governmental agencies (American National Standards Institute [ANSI], 1980; USEPA, 1974; Federal Interagency Committee on Urban Noise [FICUN], 1980; Federal Interagency Committee on Noise [FICON], 1992, Department of Navy (DON) Office of the Chief of Naval Operations Instruction [OPNAVINST], 2002).

To account for the random and often sporadic nature of military flight activities in special use areas, some of the computer programs developed to calculate sound levels created by these activities base their calculations on a monthly, rather than a daily, period. Additionally, to consider some of the unique aspects of sound created by low altitude, high-speed flight of military aircraft, up to 11 dBA may be added to the calculated sound levels to account for the rapid onset rate of the sound. However, no low-level high-speed flights are associated with NSWC PCD testing.

Assumptions are made when the sound model, which may include high-speed flights, is applied. This sound measurement metric is termed the Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}). Disregarding the onset-rate adjustment for a moment, it should be noted that arithmetically, calculations of L_{dnmr} will yield the same result as calculations of L_{dn}, as long as the numbers of sound events, or aircraft operations considered, are normalized to monthly as opposed to daily rates. Additionally, the L_{dnmr} metric reflects the uniformly distributed sound throughout the airspace. Therefore, for the same number of operations by a specific aircraft, the greater the extent of the airspace area, the lower the distributed sound level will be.

The source levels of airborne sources such as aircraft are conveniently characterized by measurements made at a standard flyover altitude of 305 m (1,000 ft). The sound associated with aircraft operations and operations involving the LCAC associated with the alternatives will be considered and compared with current conditions to assess both direct and indirect effects. Data developed during this process will also support analyses in other resource areas.

4.2.3.2 Calculation Methods – In-Air Sound

Based on numerous sociological surveys and recommendations of federal interagency councils, the most common benchmark reference is a Day-Night Average Sound Level of 65 decibels for dBA. These thresholds are often used to determine residential land use compatibility and risk of human annoyance. Several other sound levels are also useful in assessing environmental effects. The two most common sound levels used are as follows:

- A Day-Night Average Sound Level of 55 dBA was identified by the USEPA as a level "required to protect the public health and welfare with an adequate margin of safety" (USEPA, 1974). Sound may be heard, but there is no risk to public health or welfare.
- A Day-Night Average Sound Level of 75 dBA is a threshold above which effects other than annoyance may occur. It is 10 to 15 dBA below levels at which hearing damage is a known risk (Occupational Safety and Health Administration [OSHA], 1983). However, it is also a level above which some adverse health effects cannot be categorically discounted.

Public annoyance is often the most common effect associated with exposure to elevated sound levels. When subjected to the benchmark Day-Night Average Sound Levels of 65 dBA, approximately 12 percent of persons exposed will be "highly annoyed" (Wyle, 2003) by the sound. At levels below 55 dBA, the percentage of annoyance is correspondingly lower (less than 3 percent), although the percentage of people annoyed by sound never drops to zero (some people are always annoyed) (Wyle, 2003). Levels below 55 dBA are considered low enough to be essentially negligible (Wyle, 2003).

4.2.3.3 Specific Information on LCAC Sound

Sound resulting from LCAC operations was considered under a transit mode of operation. The LCAC uses rotary air screw technology to power the craft over the water. In doing so, the LCAC remains decoupled from the water surface (has no physical contact with the water's surface) during transit and operations. Thus, the sound emitted from the LCAC engines must first pass through the air prior to entering the water. Therefore, the NSWC PCD RDT&E activities associated with the LCAC were analyzed for potential environmental effects associated with in-air sound. Classified NSWC PCD acoustic in-water sound characterization studies show the sound emitted from the LCAC into the water is very similar to that of the MH-53 helicopter operating at low altitudes during tow missions.

The only non-classified LCAC sound data available was the information presented in the Air Forces Programmatic Environmental Assessment for Cape San Blas. The Air Force's "model" is really more of a computerized sound meter, which integrates all produced sound throughout the frequency spectra, applies adjustments to A-weight the sound levels, and presents a single value for the sound. Based on the Air Force's Acoustic Effects Branch (AL/OBEN) Excess Sound Attenuation Model for the LCAC's engines under ground runup conditions, data estimate that the maximum sound level (98 dBA) results at a point 45 degrees from the bow of the craft at a distance of 61 m (200 ft). Maximum sound levels fall below 90 dBA at a point less than 122 m (400 ft) from the craft (U.S. Air Force, 1999). It should be noted that the LCAC is typically operated in major shipping channels offshore, and in territorial waters. A non-territorial waters analysis for in-air sound effects from LCAC operations is not included in this EIS/OEIS. If an NSWC PCD RDT&E requirement for a test requires shallow water testing, then the LCAC operation is conducted on or near a military facility.

To estimate sound exposure from the LCAC in transit, it was considered as a sound source moving laterally in front of a receptor positioned from 91 to 762 m (299 to 2,500 ft) perpendicular to the track of the craft. The craft was estimated to be traveling at a speed of 40 knots along this track. Considering available sound level data, SEL at the receptor was calculated for the total sound event, which was estimated to last approximately 16 seconds. Using this value, a 24-hour equivalent sound level ($L_{eq(24)}$) was calculated at the receptor. In order to place this into context, it was assumed that the ambient sound for the remainder of the 24 hour period was 45 dB. Table 4-14 reflects these metrics for a range of altitudes.

Table 4-14. LCAC Sound Levels

Distance in Meters (Feet)	SEL	$L_{eq\ (24)}$	Change from Ambient Level of 45 dB
91.4 (300)	104	54.8	55.2
305 (1,000)	96	46.5	48.8
457 (1,500)	92	43.2	47.2
610 (2,000)	90	40.8	46.4
762 (2,500)	88	38.9	45.9

Source: U.S. Air Force, 1999; SAIC, 2002
SEL = sound exposure level

4.2.3.4 Territorial Waters – In-Air Sound

4.2.3.4.1 No Action Alternative – In-Air Sound (Territorial)

Aircraft Sound, No Action Alternative – In-Air Sound (Territorial)

The No Action Alternative includes helicopter and fixed-wing operations conducted within the NSWC PCD Study Area that will continue at current levels. Under current conditions, 70 percent of all helicopter operations and 20 percent of all fixed-wing operations will occur above the GOM during daylight hours. Aircraft operations over territorial waters will total 239 hours per year under the No Action Alternative. However, takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land, since the majority of aircraft operations will occur over the open ocean. The contribution of NSWC PCD aviation operations to sound levels in these areas is shown in Table 4-15.

Table 4-15. No Action Alternative: Aviation Sound Contribution in Territorial Waters

Airspace	Current Sound Levels (in L_{dnmr}) from All Users [1]	Arithmetic Level	NSWC PCD Contribution (in L_{dnmr})	Arithmetic Level	NSWC PCD Percentage Contribution
W-470	41 – 44	12,589.25	13.4	21.88	0.17%
W-151	40 – 41	10,000	11.8	15.14	0.15%
W-155	30	1,000	14.6	28.84	2.88%

1. Where L_{dnmr} is the onset-rate adjusted monthly day-night average sound level
Source: Lucas and Calamia, 1996

Sound levels created by NSWC PCD aviation operations in these airspace elements will only make up 0.28 percent of the overall sound level generated within the NSWC PCD Study Area. Since all levels are less than 65 L_{dnmr}, all locations will be in Sound Zone 1 (less than 15 percent of the population annoyed).

The majority of all NSWC PCD flight activities occur above the waters of the GOM during daylight hours. Takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land. Based on the location of NSWC PCD and the fact that the majority of flight operation will be occurring over the open ocean, in accordance with NEPA, there will be no significant impact to in-air sound levels from air operations over territorial waters with the No Action Alternative.

LCAC Sound, No Action Alternative – In-Air Sound (Territorial)

The No Action Alternative LCAC operations would continue as under current conditions. LCACs will operate 75 percent of the time in territorial waters, totaling 54 hours per year. Aside from the immediate area along the craft's track, sound resulting from LCAC operations is minimal. Tracks will be somewhat random through these bodies of water, and the probability of successive exposures at short ranges will be low. Based on the low probability of successive exposures at short ranges and the lack of a change to the acoustic environment, in accordance with NEPA, there will be no significant in-air sound impact from LCAC operations over territorial waters with the No Action Alternative.

4.2.3.4.2 Alternative 1 – In-Air Sound (Territorial)

Aircraft Sound, Alternative 1 – In-Air Sound (Territorial)

Under this alternative, 70 percent of all helicopter operations and 20 percent of all fixed-wing operations will occur above the GOM during daylight hours. Aircraft operations in territorial waters will total 252 hours per year under this alternative. However, takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land, since the majority of aircraft operations will occur over the open ocean. Alternative 1 air operations represent an increase of 13 annual operations (approximately 5.4 percent above the No Action Alternative). All air operations occurring within the territorial boundary of the NSWC PCD Study Area will include both transient and operational flight hours. Since uniformly distributed sound levels are spatially dependent, the portion of the total airspace within 22 km (12 nautical miles [NM]) of the coast was estimated, and overall sound was apportioned based on these ratios. For W-470, W-151, and W-155, approximately 4.5, 8.4, and 10.6 percent, respectively, were over territorial waters. Sound levels associated with these slightly increased operations were compared with the No Action Alternative (baseline levels) in Table 4-16.

Table 4-16. Alternative 1: Aviation Sound Contribution in Territorial Waters

Airspace	Current Sound Levels (in L_{dnmr}) from All Users [1]	Arithmetic Level	NSWC PCD Contribution (in L_{dnmr})	Arithmetic Level	NSWC PCD Percentage Contribution
W-470	41 – 44	12,589.25	16.1	39.80	0.32%
W-151	40 – 41	10,000	15.6	36.10	0.36%
W-155	30	1,000	22.2	166.00	16.60%

1.Where L_{dnmr} is the onset-rate adjusted monthly day-night average sound level
Source: Lucas and Calamia, 1996

Although operations increase slightly with Alternative 1, sound levels created by NSWC PCD aviation operations in these airspace elements will make up 1.03 percent of the total sound level present within the NSWC PCD Study Area. Since all levels are less than 65 L_{dnmr}, all locations will be in Sound Zone 1 (less than 15 percent of the population annoyed).

The majority of all NSWC PCD flight activities occur above the waters of the GOM during daylight hours. Takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land. Based on the location of NSWC PCD and the fact that, besides takeoffs and landing approaches, the majority of flight operation will be occurring over the open ocean, in accordance with NEPA, there will be no significant in-air sound impact from air operations over territorial waters with Alternative 1.

LCAC Sound, Alternative 1 – In-Air Sound (Territorial)

Under Alternative 1, LCAC operations would operate 75 percent of the time in territorial waters, totaling 55 hours per year. Aside from the immediate area along the craft's track, sound resulting from LCAC operations is minimal. Tracks will be somewhat random through these bodies of water, and the probability of successive exposures at short ranges will be low. This one-hour increase over the course of a year will not change the acoustic environment of the region. Based on the low probability of successive exposures at short ranges and the lack of a change to the acoustic environment, in accordance with NEPA, there will be no significant in-air sound impact from LCAC operations over territorial waters with Alternative 1.

4.2.3.4.3 Alternative 2 – In-Air Sound (Territorial)

Aircraft Sound, Alternative 2 – In-Air Sound (Territorial)

Under this alternative, 70 percent of all helicopter operations and 20 percent of all fixed-wing operations would occur above the GOM during daylight hours. Aircraft operations in territorial waters will total 774 hours per year under this alternative. However, takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land, since the majority of aircraft operations will occur over the open ocean. Alternative 2 NSWC PCD aviation operations in the three Warning Areas will increase by 522 annual operations over Alternative 1. Since uniformly distributed sound levels are spatially dependent, the portion of the total airspace within 22 km (12 NM) of the coast was estimated, and overall sound was apportioned based on these ratios. For W-470, W-151, and W-155, approximately 4.5, 8.4, and 10.6 percent, respectively, were over territorial waters. Sound levels associated with these increased operations were compared with the No Action Alternative (baseline levels) in Table 4-13 (only aircraft operations are projected; LCAC sound is not included in Table 4-17).

Table 4-17. Alternative 2: Aviation Sound Contribution in Territorial Waters

Airspace	Current Sound Levels (in L_{dnmr}) from All Users [1]	Arithmetic Level	NSWC PCD Contribution (in L_{dnmr})	Arithmetic Level	NSWC PCD Percentage Contribution
W-470	41 – 44	12,589.25	20.9	123.03	0.98%
W-151	40 – 41	10,000	20.4	109.65	1.10%
W-155	30	1,000	27.0	501.19	50.1%

1.Where L_{dnmr} is the onset-rate adjusted monthly day-night average sound level
Source: Lucas and Calamia, 1996

Although operations increase with Alternative 2, sound levels created by NSWC PCD aviation operations in these airspace elements make up 3.1 percent of the total sound level present within the NSWC PCD Study Area. Since all levels are less than 65 L_{dnmr}, all locations will be in Sound Zone 1 (less than 15 percent of the population annoyed).

The majority of all NSWC PCD flight activities occur above the waters of the Gulf of Mexico during daylight hours. Takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land. Based on the location of NSWC PCD and the fact that, besides takeoffs and landing approaches, the majority of flight operation will be occurring over the open ocean, in accordance with NEPA, there will be no significant in-air sound impact from air operations over territorial waters with Alternative 2.

LCAC Sound, Alternative 2 – In-Air Sound (Territorial)

Under Alternative 2, LCAC operations would operate 75 percent of the time in territorial waters, totaling 164 hours per year. As stated in Section 2.3.3, RDT&E activities cannot increase more than threefold because activities above this increase may not be accommodated at NSWC PCD without associated increases in facility support equipment and test personnel. Aside from the immediate area along the craft's track, sound resulting from LCAC operations is minimal. Tracks will be somewhat random through these bodies of water, and the probability of successive exposures at short ranges will be low. This increase in annual operating hours over the course of a year will not alter the acoustic environment of the region. Based on the low probability of successive exposures at short ranges and the lack of a change to the acoustic environment, in accordance with NEPA, there will be no significant impact to in-air sound levels from LCAC operations over territorial waters with Alternative 2.

4.2.3.5 Non-Territorial Waters – In-Air Sound

Public annoyance is often the most common effect associated with exposure to elevated sound levels; thus, the Navy has adopted criteria that integrate land use guidelines with predictions of percentages of the population that will be "highly annoyed" when exposed to given L_{dn}. As stated in Section 4.2.3.4.1, No Action Alternative – In-Air Sound (Territorial), takeoffs and landing approaches are the only portions of flight activities that may require routes that pass over populated strips of land. These hours have been captured in calculations for activities occurring in territorial waters. No significant impacts to in-air sound levels from aircraft operations or LCAC operations would occur over territorial waters with the No Action Alternative, Alternative 1, or Alternative 2; therefore, in accordance with EO 12114, no significant harm is expected related to in-air sound from aircraft operations or LCAC operations over non-territorial waters. Refer to Section 4.3., Biological Resources, for information regarding potential effects to marine animals from in-air sound.

4.2.4 Water Quality

This section discusses potential effects, both direct and indirect, to water resources within the NSWC PCD Study Area. The primary issues considered were possible changes in water quality due to explosion products, turbidity, metal leaching, and projectile firing (naval ammunition). Analyses focus on assessing the potential for effects to water resources from ordnance operations and subsurface operations; identifying potential issues associated with increased levels of turbidity, heavy metals, and explosion products; and identifying methods to reduce the potential for negative effects to water resources from these activities.

The steel foam-filled inert mines, MLOs, and VEMs are constructed of inert materials that are resistant to corrosion; therefore, leaching is not anticipated to affect water quality. Dive, recovery, crawler, and mine operations have activities that may cause temporary, localized turbidity clouds, but these will be expected to settle by the completion of the operations. Those operations were addressed previously in Section 4.2.1 and are not addressed in the following water quality section. In addition, there currently are no water quality standards for activities occurring in the non-territorial portion of the NSWC PCD Study Area; therefore, activities occurring in this area will be discussed qualitatively.

4.2.4.1 Ordnance Operations – Water Quality

4.2.4.1.1 Introduction and Approach to Analysis – Water Quality (Ordnance Operations)

Analyses first identified the water bodies located within the areas proposed for each operation type. Next, analyses were done to estimate the potential amounts of: various explosion products that could be released; turbidity that could be produced; and leaching that could occur during each operation at each site and how these changes will affect water quality.

Potential water quality effects of ordnance operations conducted can be categorized as explosion products, metal leaching, and turbidity. Similar effects to turbidity were found with all alternatives and will be discussed as a combined subsection for both Territorial and Non-Territorial Waters.

4.2.4.1.2 Calculation Methods – Water Quality (Ordnance Operations)

Calculations were made to determine the size of the surface pool (volume of affected water) at stabilization at depths of 0.3, 3, 12, and 183 m (1, 10, 40, and 600 ft) for the 0.45 to 4.5 kg, 5 to 34 kg, and 34 to 272 kg (1 to 10 lb, 11 to 75 lb, and 76 to 600 lb) NEW ranges and at 6 m (20 ft) for the 794 kg (1,750 lb) line charge, at 0.91 m (3 ft) for the 60 kg (132 lb) Distributed Explosive Technology (DET), and at 0.6 and 4.6 m (2 and 15 ft) for the 105 kg (232 lb) line charges. Stabilization occurs when the radial expansion of the pool becomes steady and the surface of the pool gradually becomes smooth. The pool growth is fed by upwelling water at the center. The motion of water within the pool is turbulent, then the turbulence subsides, and the products in the pool are assumed to be thoroughly mixed and uniformly distributed. At the end of "Stage II," the energy of the explosion has been dissipated, and the pool becomes subject to natural forces. The pool is no longer visible, unless a dye tracer has been used.

Formulas to calculate surface pool volume vary based on the type of explosive, the weight of explosive, and the depth of detonation, and are presented below. TNT was used as explosive material for all detonations.

For TNT:

$A1 = 13.1 (W^{.33}/Z^{.33})$
A1 = maximum radius of explosion bubble during first pulse (ft)
W = weight of explosive material (lbs)
Z = d + 33 ft
d = depth of explosion (ft)

d/ A1 = reduced depth

For $0.01 < d/A_1 < 1.0$, then $R_{stab} = 106 (d/A_1)^{0.168} W^{0.293}$
For $1.0 < d/A_1 < 7.0$, then $R_{stab} = 106 (d/A_1)^{-0.335} W^{0.293}$

For $7 < d/A_1 < 40$, then $R_{stab} = 202 (d/A_1)^{-0.66} W^{0.293}$

R_{stab} = radius of pool at stabilization (end of stage II), (ft)

$h = 1.6W^{.33}$
h = depth of pool (ft)

$V_{stab} = \pi h R_{stab}^2$

V_{stab} = volume of stabilized pool (ft^3)

The following text is taken directly from *Handbook on the Environmental Effects of Underwater Explosions* (O'Keefe and Young, 1984) for reduced depths of greater than $d/A_1=40$.

> If an explosion is at a reduced depth of greater than $d/A_1=40$, the assumption may be made that the products are uniformly mixed in a cone-shaped volume with a half-angle of 11^0. The vertex may be taken at the depth of explosion and the uppermost portion may be assumed to lie at a depth equal to the difference between the actual depth and the depth of the same explosive charge if detonated at a reduced depth of 40.
>
> For example, if a 454 kg (1,000 lb) explosion occurs at d/A_1=15m (50 ft), the depth, d, is equal to 228m (748 ft). The same explosion at d/A_1= 12m (40 ft) would be at a depth of 191m (625 ft). It may be assumed here that the explosion products are deposited in a cone with the vertex at a 228m (748-ft) depth and the base of the cone 37 m (123 ft) beneath the surface. The volume of this cone would be about 0.27m x 0.28^6 cubic meters (9.6 x 10^6 cubic feet).

The surface pool volume was then used to determine the concentration of the explosion products, assuming that all of the products were entirely contained in the pool. In reality, the gases are continuously dissolving into the surrounding water or escaping to the atmosphere, so these concentrations actually represent a conservative estimate. Additionally, the values presented are from the combination of NEW and depth that produced the highest concentration of explosion products, representing a very conservative approach.

Concentrations of explosion products in the surface pool at stabilization were calculated by dividing the weight of explosive product per unit of NEW by the volume of the surface pool at stabilization. Values for the grams of detonation product per kilogram of explosive were obtained from *Chemical Products of Underwater Explosions* (Renner and Short, 1980). The volume of the surface pool at stabilization for each depth and NEW was calculated using formulas from the *Handbook on the Environmental Effects of Underwater Explosions* (O'Keefe and Young, 1984).

4.2.4.1.3 Territorial Waters – Water Quality (Ordnance Operations)

The following subsections will discuss the potential effects that explosion products, metal leaching, and turbidity may have on water quality in territorial waters with the No Action Alternative, Alternative 1, and Alternative 2. As mentioned above, analysis found similar turbidity conclusions for all of the alternatives and will be discussed at the end of this section.

No Action Alternative – Water Quality (Ordnance Operations, Territorial)

The locations of the live detonation tests and the type and weight of the explosives used vary depending on the testing scenario. This means that the location may be at various depths anywhere from the surf zone to 22 km (12 NM) in the GOM, and the weight of the explosive material may range from 0.45 to 4.5 kg (1 to 10 lbs) plus one line charge. The primary explosive used in these live detonations will be TNT; however, a small number of tests will use minimal amounts of other explosive materials including a plastic explosive, C4, and a polymer-bonded explosive, PBXN-9. There is a possibility of affecting water quality through the release of explosion products, leaching of metals, and increased turbidity.

Explosion Products, No Action Alternative – Water Quality (Ordnance Operations, Territorial)

Live ordnance detonations will release explosion products, primarily gases, to the water column. These explosion products will be initially confined within a surface pool that eventually will rise to the ocean surface. After the turbulence of the explosion subsided, the surface pool will stabilize and the explosion products will become uniformly distributed.

The major products of detonating TNT underwater will be carbon dioxide, carbon monoxide, nitrogen, water, and carbon. Carbon dioxide (CO_2) is extremely soluble and dissolves in water to form carbonic acid (H_2CO_3). This H_2CO_3 then dissociates (separates) to hydrogen, bicarbonate, and carbonate ions, which are natural constituents of seawater. The CO_2 that does not react with the water will ultimately be released to the atmosphere. The remaining major gases released by detonations will not be very soluble in water, and most will eventually escape to the atmosphere. None of the constituents violate water quality standards, even before the breakdown will occur; furthermore, most of them are natural to seawater. Table 4-18 lists the predicted maximum concentrations of explosion products of TNT in the surface pool at stabilization. The concentrations are conservatively derived from the combination of NEW and water depth that yielded the greatest value. These concentrations will be produced in three locations for 0.45 to 4.5 kg (1 to 10 lbs) NEW and in one location for the line charge.

Table 4-18. No Action Alternative: Maximum Concentrations of Explosion Products for Various NEWs in Territorial Waters

	Maximum Concentration of Explosion Product (mg/L)	
	0–4.5 kg (1–10 lbs) NEW	**Line Charge**
Carbon dioxide (CO_2)	0.78	0.24
Carbon monoxide (CO)	0.47	0.15
Nitrogen (N_2)	0.42	0.13
Water (H_2O)	0.16	0.05
Ethane (C_2H_6)	0.11	0.03
Propane (C_3H_8)	0.04	0.01
Ammonia (NH_3)	0.009	0.003
Methane (CH_4)	0.004	0.001
Hydrogen (H_2)	0.003	0.0008
Hydrogen cyanide (HCN)	0.0001	0.00003
Methyl alcohol (CH_3OH)	0.00004	0.00001
Formaldehyde (CH_2O)	0.00001	0
Nitrogen oxide (NO)	0	0
Carbon solid (C)	0.32	0.10

mg/L = milligrams per liter

The percentage of explosion gases released to the atmosphere varies based on the reduced depth, which is a function of the depth of the explosion and the type and weight of explosive (
Table 4-19). Due to mixing and continued dilution, explosion products will be reduced to undetectable levels. The gaseous products will not affect water quality beyond an extremely short time period in the close vicinity of the test.

Table 4-19. Estimated Amounts of Explosive Gases that Escape to the Atmosphere

Reduced Depth (ft)	Estimated Amount of Product Gases that Escape to Atmosphere (%)
0.2 to 1	Almost all
1 to 4	90%
4 to 7	>80%
7 to 25	>50%
25 to 40	<50%
Greater than 40	Negligible amount

Source: O'Keefe and Young, 1984

The only explosion products for which the USEPA has established water quality criteria are cyanide and ammonia. Both hydrogen cyanide and ammonia will be released during detonations of TNT, but in extremely small amounts. No Action Alternative detonations result in a maximum amount of hydrogen cyanide per detonation of 0.1 microgram per liter (µg/L) (Table 4-15), which does not exceed the acute limit in seawater for cyanide of 1 µg/L (USEPA, 2004). A maximum of 0.009 milligrams per liter (mg/L) (Table 4-15) ammonia will be produced by a detonation, which does not exceed the permissible concentration of 0.233 mg/L (USEPA, 1989). These amounts will be diluted within hours to even lower concentrations by the vast volume of the Study Area waters.

Solid carbon also results from underwater detonations (Table 4-15). TNT, cyclotrimethylene trinitramine (RDX), and PBXN materials exploded underwater can produce carbon residue in the form of soot. However, this soot will be dispersed in the water within hours of the operation, and carbon has been proven to be physiologically inert and nontoxic to living organisms (U.S. Air Force, 1997b).

Research has shown that if munitions function properly, full combustion of explosive materials will introduce one-billionth to one-millionth the total weight of raw explosive, in this case TNT, used during an open air test (above water) into the environment (U.S. Air Force, 1997b). The amount of TNT introduced into the water from fully combusted explosions of No Action Alternative detonations is effectively zero. Any of the live ordnance that did not explode will be detonated in place by Explosive Ordnance Disposal (EOD) personnel; therefore, unexploded ordnance will not be a source of TNT to the water.

Explosion products either will dissipate rapidly into surrounding waters (within hours) or are physiologically inert, and no water quality criteria will be exceeded as a result of the level of detonations with the No Action Alterative. Based on these findings, in accordance with NEPA, there will be no significant impact to water quality from the explosion products of live detonations in territorial waters with the No Action Alternative.

Metal Leaching, No Action Alternative – Water Quality (Ordnance Operations, Territorial)

An extremely small number of steel and aluminum fragments from the detonation of live ordnance may be left on the sea floor. Most of the pieces will be recovered in order to evaluate the success of the test. However, if the detonation took place in water deeper than 31 m (102 ft), the pieces will most likely not be recovered. Metal pieces that may remain on the sea floor will likely settle into the oxygen-poor bottom sediments where they may slowly corrode. Both iron and aluminum are present in low concentrations in ocean water already. The level for iron is 0.002 mg/kg; aluminum, 0.5 mg/kg (University of Washington, 2008). As described in Section 4.2.1.2.3, the surface area is 5,444 km^2 (2,102 mi^2). Table 3-5 shows that the territorial portion of the study area lies between 30 m (98 ft) and zero meters (the shore). Therefore 15 meters (49 ft) would be a reasonable approximation of the average depth.

Table 4-20 shows the values and method to calculate the total mass of iron and aluminum already present in the study area waters. To raise the concentration in the NSWC PCD Study Area by even 1 percent would require 1.67 metric tons (1.84 tons) of iron and 418.5 metric tons (460.4 tons) of aluminum to be left on the ocean floor and it would have to dissolve instantly. As the Navy intends to recover any fragments that are deposited in less than 30 m (98 ft) of water and only 3 detonations will occur in a year under the No Action Alternative, it is unlikely that such large amounts of material will be left behind. Given the concentrations present naturally in seawater, no toxic effects would be expected. No US EPA water quality standard could be found for iron or aluminum toxicity in seawater. In accordance with NEPA, there will be no significant impact to water quality from metal leaching associated with metal fragments in territorial waters with the No Action Alternative.

Table 4-20. Values and Method used to Calculate Total Mass of Iron and Aluminum

Concentration (mg/kg) ppm (University of Washington, 2008)	Constituent	Volume of Study Area (m^3 (yd^3))	Density of Seawater at 70 F (kg/m^3 (lbs/ft^3) (*US Coast Guard, 2008*)	Total Mass of Constituents in Study Area Water (metric tons / tons)	1 % of Total Mass (metric tons / tons)
0.002	Iron	8.2E+10 (1.1E+11)	1025 (64.02)	167.4 (184.1)	1.67 (1.84)
0.5	Aluminum			41,850.8 (46,035.8)	418.5 (460.4)

Total Mass = Concentration x Volume x Density / 1,000,000,000 (to convert mg to metric tons.)

Alternative 1 – Water Quality (Ordnance Operations, Territorial)

The use of live detonations up to 34 kg (75 lbs) NEW with Alternative 1 creates the potential for water quality to be affected through the release of explosion products and leaching of metals. Alternative 1 includes the following types of live detonations: live mines, line charges, and live ordnance.

Explosion Products, Alternative 1 – Water Quality (Ordnance Operations, Territorial)

The types of explosion products released with Alternative 1 activities would be the same as those identified for the No Action Alternative, but the number of detonations would increase. Table 4-21 lists the predicted maximum concentrations of explosion products of TNT in the surface pool at stabilization for each range of NEW and line charge. The concentrations are conservatively derived from the combination of NEW and water depth that yields the greatest value. Although an increased number of detonations will increase the number of locations where the explosion products will occur, it is not appropriate to multiply the concentrations in Table 4-21 by the number of detonations. Doing so will assume that all of the detonations occurred within the volume of one surface pool, which will result in artificially high concentrations that will never occur. Instead, it can be said that these concentrations will be seen at an increased number of locations, specifically, 17 locations for 0.45 to 4.5 kg (1 to 10 lbs) NEW, one location for 5 to 34 kg (11 to 75 lbs) NEW, and two locations for the line charges. Calculations are detailed in Appendix C, Water Quality.

The only explosion products for which the USEPA has established water quality criteria are cyanide and ammonia. Both hydrogen cyanide and ammonia will be released during detonations of TNT, but in extremely small amounts. Alternative 1 results in a maximum amount of hydrogen cyanide per detonation of 0.5 µg/L (Table 4-21), which does not exceed the acute limit in seawater for cyanide of 1 µg/L (USEPA, 2004). A maximum of 0.004 mg/L (Table 4-21) ammonia may be produced by a detonation, which does not exceed the permissible concentration of 0.233 mg/L (USEPA, 1989). These amounts will be diluted within hours to even lower concentrations by the vast volume of Study Area waters.

Explosion products either will dissipate rapidly (within hours) into surrounding waters or are physiologically inert, and no water quality criteria will be exceeded as a result of the level of detonations associated with Alternative 1. Based on these findings, in accordance with NEPA, there will be no significant impact to water quality due to the explosion products resulting from live detonations in territorial waters with Alternative 1.

Metal Leaching, Alternative 1 – Water Quality (Ordnance Operations, Territorial)

After detonation, the majority of fragments from steel mine casings will be recovered in order to evaluate the success of the test; however, a small number of metal fragments (steel and aluminum) from the detonation of live mines and ordnance may be left on the sea floor. The few pieces that may remain on the sea floor will likely settle into the oxygen-poor bottom sediments where they may slowly corrode. However, if the detonation took place in water deeper than 31 m (102 ft), the pieces will most likely not be recovered. Both of these metals are present in low concentrations in ocean water already. The level for iron is 0.002 mg / kg ; aluminum, 0.5 mg/kg (University of Washington, 2008). As described in Section 4.2.1.2.3, the surface area is 5,444 km^2 (2,102 mi^2). Table 3-5 shows that the territorial portion of the study area lies between 30 m (98 ft) and zero meters (shore). Therefore 15 meters (49 ft) would be a reasonable approximation of the average depth. Table 4-21 shows the values and method to calculate the total mass of iron and aluminum already present in the study area waters. To raise the concentration in the NSWC PCD Study Area by even 1 percent would require 1.67 metric tons (1.84 tons) of iron and 418.5 metric tons (460.4 tons) of aluminum to be left on the ocean floor and it would have to dissolve immediately. As the Navy intends to recover any fragments that are deposited in less than 30 m (98 ft) of water and only 18 detonations will occur in a year under Alternative 1, it is unlikely that such large amounts of material will be left behind. Given the concentrations present naturally in seawater, no toxic effects would be expected. No US EPA water quality standard could be found for iron or aluminum toxicity in seawater. In accordance with NEPA, there will be no significant impact to water quality associated with metal leaching in territorial waters with Alternative 1.

Table 4-21. Alternative 1: Maximum Concentrations of Explosion Products for Various NEWs in Territorial Waters

	Maximum Concentration of Explosion Product (mg/L)		
	0–4.5 kg (0–10 lbs) NEW	5–34 kg (11–75 lbs) NEW	Line Charge
Carbon dioxide (CO_2)	0.78	0.37	0.27
Carbon monoxide (CO)	0.47	0.23	0.16
Nitrogen (N_2)	0.42	0.20	0.14
Water (H_2O)	0.16	0.08	0.05
Ethane (C_2H_6)	0.11	0.05	0.04
Propane (C_3H_8)	0.04	0.02	0.01
Ammonia (NH_3)	0.009	0.004	0.003
Methane (CH_4)	0.004	0.002	0.001
Hydrogen (H_2)	0.003	0.001	0.0009
Hydrogen cyanide (HCN)	0.0001	0.0005	0.00004
Methyl alcohol (CH_3OH)	0.00004	0.00002	0.00001
Formaldehyde (CH_2O)	0.00001	0.00001	0
Nitrogen oxide (NO)	0	0	0
Carbon solid (C)	0.32	0.15	0.11

Alternative 2 – Water Quality (Ordnance Operations, Territorial)

Explosion Products, Alternative 2 – Water Quality (Ordnance Operations, Territorial)

The types of explosion products released with Alternative 2 activities would be the same as those identified for the No Action Alternative, but the number of detonations would increase. Table 4-22 lists the maximum concentration of explosion products within the surface pool at stabilization for a given detonation. The concentrations are conservatively derived from the combination of NEW and water depth that yields the greatest value. Calculations are detailed in Appendix C, Water Quality.

The increased number of detonations will increase the number of locations where the explosion products will occur. However, it is not appropriate to multiply the concentrations in Table 4-22 by the number of detonations. Doing so assumes that all of the detonations occurred within the volume of one surface pool, which results in artificially high concentrations that will never occur. Instead, it can be said that these concentrations will be seen at an increased number of locations, specifically, 51 locations for 0.45 to 4.5 kg (1 to 10 lbs) NEW, three locations for 5 to 34 kg (11 to 75 lbs) NEW, and three locations for the line charges.

Table 4-22. Alternative 2: Maximum Concentrations of Explosion Products for Various NEWs in Territorial Waters

	Maximum Concentration of Explosion Product (mg/L)		
	0–4.5 kg (0–10 lbs) NEW	5–34 kg (11–75 lbs) NEW	Line Charge
Carbon dioxide (CO_2)	0.78	0.37	0.27
Carbon monoxide (CO)	0.47	0.23	0.16
Nitrogen (N_2)	0.42	0.20	0.14
Water (H_2O)	0.16	0.08	0.05
Ethane (C_2H_6)	0.11	0.05	0.04
Propane (C_3H_8)	0.04	0.02	0.01
Ammonia (NH_3)	0.009	0.004	0.003
Methane (CH_4)	0.004	0.002	0.001
Hydrogen (H_2)	0.003	0.001	0.0009
Hydrogen cyanide (HCN)	0.0001	0.0005	0.00004
Methyl alcohol (CH_3OH)	0.00004	0.00002	0.00001
Formaldehyde (CH_2O)	0.00001	0.00001	0
Nitrogen oxide (NO)	0	0	0
Carbon solid (C)	0.32	0.15	0.11

The only explosion products for which the USEPA has established water quality criteria are cyanide and ammonia. Both hydrogen cyanide and ammonia will be released during detonations of TNT, but in extremely small amounts. The acute limit in seawater for cyanide is 1 µg/L (USEPA, 2004), and the maximum permissible concentration of ammonia is 0.233 mg/L (USEPA, 1989). No single detonation will exceed either of these standards.

Explosion products either will dissipate rapidly (within hours) into surrounding waters or are physiologically inert, and no water quality criteria will be exceeded as a result of the level of detonations with Alternative 2. Based on these findings, in accordance with NEPA, there will be no significant impact to water quality due to the explosion products resulting from live detonations in territorial waters with Alternative 2.

Metal Leaching, Alternative 2– Water Quality (Ordnance Operations, Territorial)

The potential for water quality effects from metal leaching will increase slightly with Alternative 2 activities compared to Alternative 1. However, the few pieces that may remain on the sea floor will likely settle into the oxygen-poor bottom sediments where they may slowly corrode. Both of these metals are present in low concentrations in ocean water already. The level for iron is 0.002 mg / kg; aluminum, 0.5 mg/kg (University of Washington, 2008). As described in Section 4.2.1.2.3, the surface area is 5,444 km^2 (2,102 mi^2). Table 3-5 shows that the territorial portion of the study area lies between 30 m (98 ft). Therefore 15 meters (49 ft) would be a reasonable approximation of the average depth. Table 4-20 shows the values and method to calculate the total mass of iron and aluminum already present in the study area waters. To raise the concentration in the NSWC PCD Study Area by even 1 percent would require 1.67 metric tons (1.84 tons) of iron and 418.5 metric tons (460.4 tons) of aluminum to be left on the ocean floor and it would have to dissolve instantly. As the Navy intends to recover any fragments that are deposited in less than 30 m (98 ft) of water and 54 detonations will occur in a year under Alternative 2, it is unlikely that such large amounts of material will be left behind. Given the concentrations present naturally in seawater, no toxic effects would be expected. No USEPA water quality standard could be found for iron or aluminum toxicity in seawater. In accordance with NEPA, there will be no significant impact to water quality from metal leaching in territorial waters with Alternative 2.

No Action Alternative, Alternative 1, and Alternative 2 – Turbidity, Water Quality (Ordnance Operations, Territorial)

The majority of sediment displaced by an explosion will originate from the affected area created on the sea floor. It can be assumed that the amount of bottom sediment that is suspended in the water column will be approximately equal to the volume of the affected area.

Detonations will occur within the water column, not on the sea floor. The largest NEW used in any category is 272 kg (600 lbs). Such tests will occur in minimum water depth of 30 m (nearly 100 ft), near the surface and at the point midway from the surface to the bottom. Therefore, detonations will occur at least halfway, or 15 m (50 ft), above the sea floor. Since water pressure increases as the depth increases, the gas bubble caused by an explosion will be largest in shallow water. The largest explosion gas bubble will result from tests in the minimum water depth of 30 m (nearly 100 ft), where a detonation at halfway, 15 m (50 ft), above the sea floor will produce a bubble size of 8.9 m (29 ft), stopping several meters above the bottom.

Therefore, under the worst-case scenario, the radius does not extend to the sea floor. Smaller charge weights used at the same depth or 272 kg (600 lbs) charges detonated in deeper water will result in smaller radii. Thus, bottom sediments will not be affected by detonations occurring within the water column.

For small explosions, sediments will be expected to settle out quickly, but for line charges, sediments may stay suspended for hours. The No Action Alternative activities test only one line charge annually, which makes up 100 percent of the area affected by live ordnance. Line charges will only occur in the surf zone, which already is characterized by significant turbidity. Alternative 1 includes one detonation in the 5 to 34 kg (11 to 75 lbs) range, and only two line charge tests will take place annually. Alternative 2 contains a threefold increase, approximately three or fewer detonations in the 5 to 34 kg (11 to 75 lbs) range will take place annually, and only three line charge tests will occur annually. These detonations will be separated both in time and location, dispersing effects and allowing sufficient time for sediments to settle between events. Compared to the total NSWC PCD Study Area, the area affected by line charges will be very small and effects will be localized and temporary. Furthermore, locations of line charges occur in areas of wave action; therefore, turbid waters will dissipate within hours of the operation. In accordance with NEPA, there will be no significant impact to water quality from turbidity due to live detonations in territorial waters with the No Action Alternative, Alternative 1, and Alternative 2.

4.2.4.1.4 Non-Territorial Waters – Water Quality (Ordnance Operations)

The following subsections will discuss the potential effects that explosion products, metal leaching, and turbidity may have on water quality in non-territorial waters with the No Action Alternative, Alternative 1, and Alternative 2. As mentioned above, analysis found similar turbidity conclusions for all of the alternatives and will be discussed at the end of this section.

No Action Alternative – Water Quality (Ordnance Operations, Non-Territorial)

There will be no ordnance operations in non-territorial waters under the No Action Alternative.

Alternative 1 – Water Quality (Ordnance Operations, Non-Territorial)

Explosion Products, Alternative 1 – Water Quality (Ordnance Operations, Non-Territorial)

Under Alternative 1, up to five detonations will occur in non-territorial waters. The detonations will have a NEW of 34 to 272 kg (76 to 600 lbs). However, currently there are no water quality criteria for each constituent in non-territorial waters. Therefore, a qualitative analysis was used to determine the potential effects to water quality for non-territorial waters. Table 4-23 shows the predicted maximum concentrations of explosion products of TNT in the surface pool at stabilization for the specified range of NEW. The concentrations are conservatively derived from the combination of NEW and water depth that yields the greatest value.

Table 4-23. Alternative 1: Maximum Concentrations of Explosion Products for 34 to 272 kg (76 to 600 lbs) NEW in Non-Territorial Waters

	Maximum Concentration of Explosion Product (mg/L) 34 to 272 kg (76 to 600 lbs) NEW
Carbon dioxide (CO_2)	4.44
Carbon monoxide (CO)	2.69
Nitrogen (N_2)	2.39
Water (H_2O)	0.90
Ethane (C_2H_6)	0.62
Propane (C_3H_8)	0.21
Ammonia (NH_3)	0.05
Methane (CH_4)	0.02
Hydrogen (H_2)	0.01
Hydrogen cyanide (HCN)	0.0006
Methyl alcohol (CH_3OH)	0.0002
Formaldehyde (CH_2O)	0.00008
Nitrogen oxide (NO)	0
Carbon solid (C)	1.83

Both hydrogen cyanide and ammonia will be released during detonations of TNT, but in extremely small amounts. Alternative 1 results in a maximum amount of hydrogen cyanide by a detonation of 0.6 µg/L (Table 4-18) (USEPA, 2004). A maximum of 0.05 mg/L (Table 4-18) ammonia may be produced by a detonation (USEPA, 1989). These amounts will be diluted within hours to even lower concentrations by the vast volume of NSWC PCD Study Area waters.

Explosion products either will dissipate rapidly (within hours) into surrounding waters or are physiologically inert. Therefore, based on these findings and in accordance with EO 12114, there will be no significant harm to water quality from ordnance operations in non-territorial waters with Alternative 1.

Metal Leaching, Alternative 1 – Water Quality (Ordnance Operations, Non-Territorial)

After detonation, steel mine casings will be recovered when possible to evaluate the success of the test. The small pieces of metal fragments that may remain on the sea floor will likely settle into the oxygen-poor bottom sediments where they may slowly corrode. Aluminum and steel are both present in low concentrations in ocean water already. The level for iron is 0.002 mg / kg ; aluminum, 0.5 mg/kg (University of Washington, 2008). As described in Sections 3.3.1 and 4.2.1.2.4 the average depth of the study area is more than a kilometer (0.62 mi)and the surface area is 72,125 km^2 (27,848 mi^2). Table 4-20 shows the values and calculations to calculate the total mass of iron and aluminum already present in the study area waters. To raise the concentration in the NSWC PCD Study Area by even 0.1 percent would require 14.8 metric tons (16.3 tons) of iron and 4,066 metric tons (4,066 tons) of aluminum to be left on the ocean floor. Given the concentrations present naturally in seawater, and that there will be only 4 detonations per year under Alternative 1, no toxic effects would be expected. Therefore, in accordance with EO 12114, there will be no significant harm to water quality from ordnance operations in non-territorial waters with Alternative 1.

Alternative 2 – Water Quality (Ordnance Operations, Non-Territorial)

Explosion Products, Alternative 2 – Water Quality (Ordnance Operations, Non-Territorial)

The types of explosion products released with Alternative 2 activities will be the same as Alternative 1, but the number of detonations will increase threefold. Table 4-24 lists the predicted maximum concentrations of explosion products of TNT in the surface pool at stabilization for the 34 to 272 kg (76 to 600 lb) range of NEW. The concentrations are conservatively derived from the combination of NEW and water depth that yields the greatest value. The increased number of detonations will increase the number of locations where the explosion products will be present. However, it is not appropriate to multiply the concentrations in Table 4-24 by the number of detonations. Doing so assumes that all of the detonations occurred within the volume of one surface pool, which will lead to artificially high concentrations that will never occur. Instead, it can be said that these concentrations will be seen at an increased number of locations, specifically 15 locations for 34 to 272 kg (76 to 600 lbs) NEW. However, currently there are no water quality criteria for each constituent in non-territorial waters. Therefore, a qualitative analysis was used to determine the potential effects to water quality for non-territorial waters.

Table 4-24. Alternative 2: Maximum Concentrations of Explosion Products for 34 to 272 kg (76 to 600 lbs) NEW in Non-Territorial Waters

	Maximum Concentration of Explosion Product (mg/L) 34 to 272 kg (76 to 600 lbs) NEW
Carbon dioxide (CO_2)	4.44
Carbon monoxide (CO)	2.69
Nitrogen (N_2)	2.39
Water (H_2O)	0.90
Ethane (C_2H_6)	0.62
Propane (C_3H_8)	0.21
Ammonia (NH_3)	0.05
Methane (CH_4)	0.02
Hydrogen (H_2)	0.01
Hydrogen cyanide (HCN)	0.0006
Methyl alcohol (CH_3OH)	0.0002
Formaldehyde (CH_2O)	0.00008
Nitrogen oxide (NO)	0
Carbon solid (C)	1.83

Both hydrogen cyanide and ammonia will be released during detonations of TNT, but in extremely small amounts. Alternative 2 results in a maximum amount of hydrogen cyanide per detonation of 0.6 µg/L (Table 4-24). A maximum of 0.05 mg/L (Table 4-24) ammonia may be produced by a detonation (USEPA, 1989). These amounts will be diluted within hours to even lower concentrations by the vast volume of NSWC PCD Study Area waters.

Explosion products either will dissipate rapidly (within hours) into surrounding waters or are physiologically inert, and no water quality criteria will be exceeded as a result of the level of detonations with Alternative 2. Therefore, based on these findings and in accordance with EO 12114, there will be no significant harm to water quality from ordnance operations in non-territorial waters with Alternative 2.

Metal Leaching, Alternative 2 – Water Quality (Ordnance Operations, Non-Territorial)

After detonation, the majority of fragments from steel mine casings will be recovered in order to evaluate the success of the test; however, a small number of metal fragments (steel and aluminum) from the detonation of live mines and ordnance may be left on the sea floor. The few pieces that may remain on the sea floor will likely settle into the oxygen-poor bottom sediments where they may slowly corrode. Both of these metals are present in low concentrations in ocean water already. The level for iron is 0.002 mg / kg; aluminum, 0.5 mg/kg (University of Washington, 2008). The level for iron is 0.002 mg/kg; aluminum, 0.5 mg/kg (University of Washington, 2008). As described in Sections 3.3.1 and 3.4.1.1 the average depth of the study area is more than a kilometer (0.62 mi) and the surface area is 81,032 km^2 (31287 mi^2). Table 4-25 shows the values and calculations to calculate the total mass of iron and aluminum already present in the study area waters. To raise the concentration in the NSWC PCD Study Area by even 0.1 percent would require 14.8 metric tons (16.3 tons) of iron and 4,066 metric tons (4,066 tons) of aluminum to be left on the ocean floor. Given the concentrations present naturally in seawater, and that there will be only 16 detonations per year under Alternative 2, no toxic effects would be expected. Therefore, in accordance with EO 12114, there will be no significant harm to water quality from ordnance operations in non-territorial waters with Alternative 2.

Table 4-25. Values and Calculations Used to Determine Total Mass of Iron and Aluminum

Constituent	Concentration (mg/kg) ppm	Volume of Study Area (m^3 (yd^3))	Density of Seawater at 70 F (kg/m^3 (lbs/ft^3)	Total Mass of Constituents in NSWC PCD Study Area Water (metric tons / tons)	0.1 Percent of Total Mass (metric tons / tons)
Iron	0.002	7.21E+12 9.43E+12	1025 (64.02)	14,786 (16,264)	14.8 (16.3)
Aluminum	0.5			3696406 (4,066,047)	3,696 (4066)

Total Mass = Concentration x Volume x Density / 1,000,000,000 (to convert mg to metric tons.)
Source: University of Washington, 2008; US Coast Guard, 2008

Alternative 1 and Alternative 2 – Water Quality/Turbidity (Ordnance Operations, Non-Territorial)

There will be no line charge detonation within the non-territorial portion of the NSWC PCD Study Area. Alternative 1 includes five total detonations in the range of 34 to 272 kg (76 to 600 lbs) NEW annually. Alternative 2 includes 15 total detonations in the range of 34 to 272 kg (76 to 600 lbs) NEW annually.

All detonations associated with Alternative 1 and Alternative 2 will occur within the water column. The largest NEW used in any category is 272 kg (600 lbs). Such tests will occur in minimum water depth of 30 m (nearly 100 ft), near the surface and at the point midway from the surface to the bottom. Therefore, detonations will occur at least halfway, or 15 m (50 ft), above the sea floor. Since water pressure increases as the depth increases, the gas bubble caused by an explosion will be largest in shallow water. The largest explosion gas bubble will result from tests in the minimum water depth of 30 m (nearly 100 ft), where a detonation at halfway, 15 m

(50 ft), above the sea floor will produce a bubble size of 8.9 m (29 ft), stopping several meters above the bottom.

Therefore, under the worst-case scenario, the radius does not extend to the sea floor. Smaller charge weights used at the same depth or 272 kg (600 lbs) charges detonated in deeper water will result in smaller radii. Thus, bottom sediments will not be affected by detonations occurring within the water column. As a result, there will be little to no sediment suspended in the water column. Therefore, based on these findings and in accordance with EO 12114, there will be no significant harm to water quality from ordnance operations in non-territorial waters with Alternative 1 and Alternative 2.

4.2.4.2 Projectile Firing – Water Quality

Projectile firing will take place during NSWC PCD RDT&E activities. Most of the activities, including all activities in territorial waters, involve inert firing. Inert projectile firing consists of the use of a solid round that will introduce lead or tungsten into the water. The analysis considers the introduction of these constituents into the water column. In non-territorial waters, NSWC PCD RDT&E activities will include live projectile firing (naval ammunition). Therefore, the live rounds are also included in the water quality analysis because constituents in the projectiles (for example, tungsten, lead, and aluminum powder) will be immediately available in the environment.

Studies on the effects of lead released into the marine environment indicate that lead corrodes in seawater at a rate of 0.0008 mils (0.0008 in) per year and can take more than a decade for the lead to fully disperse into the marine environment (Kennish, 1989, as cited in DON, 1996). Sedimentation and marine growth, as well as the oxide coating of rounds influence the amount of lead released into the seawater and the disposal rate. Eventually, the ammunition would most likely be buried in the sediment, due to the velocity of the impact with the bottom. Sediment contains low or zero levels of oxygen, which prohibits lead from converting into ions. The coating on rounds also reduces the chance that seawater will directly affect the lead in the rounds. Also, each projectile contains small amounts of lead that, upon accidental release, are expected to rapidly diffuse in the water column minimizing the affect on the marine environment. Therefore, due to the low amounts of lead released to the marine environment, the lead contained in expenditures would pose no environmental threat to the marine environment.

4.2.4.2.1 Territorial Waters – Water Quality (Projectile Firing)

No projectile firing will occur in territorial waters.

4.2.4.2.2 Non-Territorial Waters – Water Quality (Projectile Firing)

There are no water quality criteria for each constituent in non-territorial waters. Therefore, a qualitative analysis was used to determine the potential effects to water quality for non-territorial waters from live projectile firing.

Corrosion and leaching of metals varies significantly and is dependent on water depth, dissolved oxygen, biological activity, temperature, water currents, salinity, and pH (Schumacher, 1979).

Each metal will corrode at various rates depending upon the level of oxidation. The metals in ammunition, starting with the most easily oxidized, are aluminum, zinc, iron, lead, and copper. The lower the amount of oxygen present, the slower the corrosion process to the metals in seawater (Schumacher, 1979). The major constituents in the tungsten rounds are aluminum, plastic, iron, and tungsten. These materials will likely become lodged in the oxygen-poor sediments of the sea floor, exhibiting a high degree of corrosion resistance for the metals contained within the tungsten rounds.

It is highly unlikely that all constituents in the ammunition will be immediately available for aquatic species to transfer, ingest, or absorb. Therefore, based on the corrosion resistance and the oxygen-poor sediments of the sea floor, in accordance with EO 12114, there will be no significant harm to water quality from projectile firing in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.2.5 Underwater Sound

The potential effects from underwater sound will be associated only with sonar and ordnance operations with respect to invertebrates, fish, birds, marine mammals, and sea turtles, as well as recreational divers. Refer to Section 4.3 for discussion of the potential effects associated with underwater sound sources to marine species in the NSWC PCD Study Area. In addition, refer to Section 4.4.3 *Artificial Reefs* for a discussion regarding potential effects associated with underwater sound sources to human divers.

4.3 BIOLOGICAL RESOURCES

This section discusses potential direct and indirect effects to biological resources as a result of NSWC PCD RDT&E mission activities. The biological resources of concern include marine habitats, fish, essential fish habitat (EFH), birds (sea birds and diving birds), marine mammals, and sea turtles. The primary issues considered are possible effects to species and habitats from sound, direct impacts, and habitat disturbance. Analyses focus on assessing the potential for effects to biological resources from air, surface, subsurface, sonar, electromagnetic, laser, and ordnance operations. The regulatory drivers that govern these resources are presented in Appendix F, Biological Resources.

4.3.1 Marine Habitats

The term marine habitats as used in this document refers to unique regions of the marine environment that provide conditions suitable for supporting some portion of the life cycle of a species or suite of species. Habitats may be composed of abiotic (nonliving) structure or living organisms. The habitats evaluated are limited to those that are potentially susceptible to damage or degradation during NSWC PCD RDT&E activities and include coral/hardbottom areas, estuarine environments, and seagrasses (also referred to as submerged aquatic vegetation). These habitats are shown in Figure 3-5 in Chapter 3 of this EIS/OEIS.

Special biological resource areas are also included in this category. These locations are defined as areas of the marine environment that have been reserved by federal, state, or local laws or regulations to protect the natural and cultural resources therein. Such areas may include national marine sanctuaries, fishery management zones, national parks, state reserves, and many other types of areas. Federal agencies whose actions affect these resources must identify the actions and, to the maximum extent practicable, avoid harming the resources. Marine Managed Areas present in the Study Area include the DeSoto Canyon Closed Area, the Florida Middle Grounds (which is also classified as a habitat area of particular concern [HAPC]), the Madison-Swanson Spawning Site, the Steamboat Lumps Spawning Site, and the Reef Fish Stressed Area (Figure 3-8). Refer to Section 3.4.1.4 for a description of these areas, including the purposes of their special designations, which include protection of fish stocks and coral reefs from fishing activities. The restrictions associated with these areas are primarily targeted at fishing activities; thus, many are not applicable to military operations.

Potential effects to marine habitats were analyzed for each of the applicable operational categories identified in Chapter 2.

4.3.1.1 Surface Operations

4.3.1.1.1 Introduction and Approach to Analysis – Marine Habitats (Surface Operations)

Surface vessels utilized during NSWC PCD activities have the potential to damage or degrade marine habitats. Physical contact with seagrass can cause "prop scarring," where a boat's propeller cuts a swath through plants, killing them via root cutting or complete uprooting. Seagrasses are not present in non-territorial waters, so the discussion of territorial waters encompasses effects on seagrasses. In addition, physical contact with coral and hardbottom areas can cause structural damage to the substrate as well as mortality to encrusting organisms. However, no documented locations of coral or hardbottom areas exist within territorial waters of the NSWC PCD Study Area; therefore, coral and hardbottom areas are covered in the discussion of non-territorial waters.

In estuarine and nearshore environments, surface vessel operations can increase wave action, causing increased erosion of shorelines. While approximately 80 percent of NSWC PCD surface operations typically occur beyond St. Andrews Bay and the inshore surf zone, during some RDT&E activities, surface vessels may enter estuarine and nearshore waters.

Operation of a vessel in shallow water may also cause turbidity by stirring up bottom sediments. Turbidity can lead to seagrass mortality by silting or by reducing water clarity, both of which inhibit photosynthesis. Turbidity can also affect corals and hardbottom areas. Hermatypic (reef-building) corals are sensitive to water clarity because of their symbiotic algae. Encrusting organisms residing on hardbottoms can be affected by persistent silting as well.

Neither regulations nor scientific literature provide criteria for determining the significance of the potential effects of the NSWC PCD activities. In an effort to reduce the likelihood of affecting marine habitats, the protective measures described in Chapter 5 will be implemented.

4.3.1.1.2 Territorial Waters – Marine Habitats (Surface Operations)

Although NSWC PCD RDT&E activities conducted in the nearshore environment may temporarily increase minor wave action in estuarine areas, these activities will not be expected to result in any negative effects. Only designated areas will be used for vessels to come ashore, and missions will not intentionally occur in water too shallow for a vessel's draft. The operation of surface platforms under typical test conditions will occur in water depths that exceed the platform's draft requirement. Turbidity will be temporary and localized in the unlikely event that a boat enters shallow water where the propeller is close enough to touch or disturb bottom sediments.

To best quantify the terms "temporarily" and "localized", it is necessary to look at the sediment types in the NSWC PCD Study Area and the possible disturbances from NSWC PCD RDT&E activities. Sediments within north Florida estuaries like SAB are primarily unconsolidated, that is, composed of mud, quartz sand, and fine silt (Wolfe et al., 1988). A review of the scientific literature (Science Applications International Corporation [SAIC], 1997) found that most researchers documented fine quartz sands approximately 0.3 m (1 ft) thick in SAB. The researchers also recorded the occurrence of coarser grained sediments, particularly with shell fragments. Although the majority of SAB contains soft, sandy sediment on the floor, hardbottom substrates may occur in association with or near rock jetties or other artificial structures (Northwest Florida Water Management District [NWFWMD], 2000). Sand is defined as particles from one-sixteenth of a millimeter (mm) to two mm in diameter. Sand can be broken down into four subcategories: very fine, fine, medium, coarse and very coarse.

The largest surface craft encompassed by the Proposed Action include research vessels, which have drafts of approximately 3 m. Therefore, in the extreme case for possible vessel interactions with the bottom the Navy will use 3 m (9.8 ft). The research vessels will be operated in such a way that they will not ground. Furthermore, they are not used for landings. In the nearshore environment, which is primarily sand, using the values given in the Table 4-26 below yields Stokes fall velocities for different size particles of sand in seawater at 70°C (AJ Design Software, 2008; United States Coast Guard [USCG], 2008; Knauss, 1978). Assuming, an equal number of sand particles of each size, and with particles evenly distributed throughout the water column, two-thirds of the particles would reach the bottom in under three minutes. Particles of very fine sand would reach the bottom in still water in about 15 minutes. According to Knauss (1978) riptides up to 3 knots have been measured. Using that as a reasonable velocity for both rip tides and associated longshore currents, the resuspended sand could move approximately 500 meters or less in the time it takes to sink to the bottom. Therefore, the disturbance could be expected to last as long as the activity is stirring up the sand, plus 15 minutes for the very fine sand to settle. The effects can be complicated when the environment does not match the model parameters exactly. For example, smaller particles would sink more slowly. All particles will sink more rapidly in warmer water, if the sediment disturbance is entrained by the propeller vortices, some trace of the disturbance may persist for hours. Given that the heavier particles will still precipitate fairly rapidly, the small amount of sediment disturbed, and the likely action of wind, waves and currents, the effects would be minimal at any significant distance from the immediate impact area.

Table 4-26. Stokes Fall Velocity Calculations

Particle Diameter (m)		Particle Density (g/m^3)	Distance traveled at 3 knots (m)	
0.00025	fine sand	2600000	91.54	45.77
0.000125	fine sand		366.16	183.08
0.00009375	very fine sand		650.95	325.47
0.0000625	very fine sand		1464.63	732.32
Water Parameters				
Temperature (F)	Density (g/m^3)	Viscosity (g/m-sec)	Depth (m)	Depth (m)
70	1025502.025	1.06	3	1.5

Source: USCG, 2008

The LCACs have a draft of zero. Therefore, the only possible bottom interaction is when they hit the surf zone and the air cushion crosses the boundary between water and sand. The same sinking rates would apply to any resuspended sand, but as this is the surf zone, any effect would be insignificant. An online search revealed no specific data about the size of the waves generated by an LCAC. This would be hard to predict as the size of the wake from a moving ship is dependent on the displacement, design, and speed of the vessel and the water depth. However, a hovercraft's wake is minimal, and, consequently, wave damage to the shore is "virtually nil" (4 Wings Hovercraft, 2008). A "study in the United Kingdom concluded that the passage of hovercraft over inter-tidal areas caused no damage to sea grasses or invertebrates" (4 Wings Hovercraft, 2008).

The Proposed Action will not affect fishing effort or fishery resources and therefore no effects will occur to the protected resources in the Reef Fish Stressed Area in territorial waters of the NSWC PCD Study Area. Refer to Sections 4.3.3, 4.3.4, and 4.4.1 for more information on effects to fish, EFH, and fishing. Furthermore, NSWC PCD will implement the proposed protective measures detailed in Chapter 5. Based on the maximum time frame for a disturbance (maximum of one day), the best available data on effects from the hovercraft, and the implementation of protective measures, in accordance with NEPA, there will be no significant impact to marine habitats from surface operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.1.1.3 Non-Territorial Waters – Marine Habitats (Surface Operations)

Surface operations in non-territorial waters will not occur near any estuary systems or seagrass beds, and the water depth of operations conducted in this portion of the NSWC PCD Study Area will be greater than any vessel's draft, avoiding contact with coral and hardbottom areas. Operations will avoid the majority of the marine managed areas in non-territorial waters including the Florida Middle Grounds, Madison-Swanson Spawning Site, and Steamboat Lumps Spawning Site. Furthermore, the Proposed Action will not affect fishing effort or fishery resources and therefore no effects will occur to the protected resources in the various Marine Managed Areas. Refer to Sections 4.3.3, 4.3.4, and 4.4.1 for more information on effects to fish, EFH, and fishing. Based on the water depth of operations in non-territorial waters, the lack of effects to fisheries and EFH, and the implementation of protective measures, in accordance with EO 12114, there will be no significant harm to marine habitats in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.1.2 Subsurface Operations – Marine Habitats

4.3.1.2.1 Introduction and Approach to Analysis – Marine Habitats

Subsurface activities that involve the use of equipment on or near the sea or estuary bottom have the potential to impact marine habitats. Robotic crawlers move along the sea floor and may therefore increase water turbidity and cause structural damage to coral reefs, hardbottom areas, and seagrasses. The placement, mooring, and removal of inert mines, VEMs, and MLOs may also affect turbidity and cause structural damage. UUVs do not operate in benthic (sea floor) regions, and their propeller units are encased, thus eliminating any potential for damaging marine habitats. UUVs will not be discussed further.

4.3.1.2.2 Territorial Waters – Marine Habitats (Subsurface Operations)

As discussed previously in Section 4.2.1.2.3, sediment suspension will be temporary and local (covering an area no greater than 0.16 km^2 [0.060 mi^2- crawlers] and 392.66 m^2 [4,226.56 ft^2– mine placement]). Furthermore, there will be no effects to coral or hardbottom areas because they have not been documented in territorial waters of the NSWC PCD Study Area. Direct effects to seagrasses will be avoided through implementation of the proposed protective measures detailed in Chapter 5. Operations that disturb the sea floor (i.e., mine placement, detonations, crawler operations) will not be conducted within areas where artificial reefs or known shipwrecks are present in accordance with the protective measures described in Chapter 5. The Proposed Action will not affect fishing effort or fishery resources and therefore no effects will occur to the protected resources in the Reef Fish Stressed Area in territorial waters of the NSWC PCD Study Area. Refer to Sections 4.3.3, 4.3.4, and 4.4.1 for more information on effects to fish, EFH, and fishing. Additionally, no operations will be conducted in the St. Joseph Bay Aquatic Preserve, Apalachicola Aquatic Preserve, and St. Vincent Bay National Wildlife Refuge. Taking into consideration the short and confined nature of the potential effects as described previously and the effectiveness of avoidance, in accordance with NEPA, there will be no significant impact to marine habitats from subsurface operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.1.2.3 Non-Territorial Waters – Marine Habitats (Subsurface Operations)

As stated in Section 4.2.1.2.1, crawler operations will not occur in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. Therefore, they will not be discussed in this section. Additionally, the SAB ecosystem and seagrass habitats do not occur in non-territorial waters; thus, they are not discussed further. However, some scattered areas of hardbottom and coral do occur within the non-territorial waters of the NSWC PCD Study Area and are therefore included in this section.

As previously described in Section 4.2.1.2.4, sediment suspension will be temporary and local; covering an area no greater than 167.62 m^2 (1,804.2 ft^2) which would not be one large contiguous area. Direct effects to hardbottom and corals will be avoided through implementation of the proposed protective measures detailed in Chapter 5. Operations will avoid the majority of the marine managed areas in non-territorial waters including the Florida Middle Grounds, Madison-Swanson Spawning Site, and Steamboat Lumps Spawning Site. Furthermore, the Proposed Action will not affect fishing effort or fishery resources and therefore no effects will occur to the protected resources in the various Marine Managed Areas. Refer to Sections 4.3.3, 4.3.4, and 4.4.1 for more information on effects to fish, EFH, and fishing. Taking into consideration the short-term and confined nature of the effects as described previously and the effectiveness of avoidance, in accordance with EO 12114, there will be no significant harm to marine habitats from Subsurface Operations under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.1.3 Ordnance Operations – Marine Habitats

4.3.1.3.1 Introduction and Approach to Analysis – Marine Habitats

Live explosions have the potential to impact marine habitats both structurally and through increases in turbidity. In an effort to reduce the likelihood of affecting marine habitat, the protective measures described in Chapter 5 will be implemented.

4.3.1.3.2 Territorial Waters – Marine Habitats (Ordnance Operations)

The size and weight of the explosives used will vary from 0.91 to 272 kg (2 to 600 lbs) TNT equivalent NEW depending on the test requirements. However, no single detonations over 34 kg (75 lbs) NEW will be conducted within the territorial waters of the NSWC PCD Study Area. RDT&E activities involving live explosives include mine detonations, individual C4 charges, and surf zone line charge detonations.

Depending on the test scenario, live ordnance testing may occur from the surf zone out to the outer perimeter of the NSWC PCD Study Area. However, there are no identified areas within the territorial waters of the NSWC PCD Study Area containing coral reefs or hardbottom areas. The primary habitats of concern in territorial waters are estuarine environments, seagrass beds, and artificial reefs. There will be no ordnance operations in the St. Andrew Bay due to the high occurrence of seagrasses. The Proposed Action will not affect fishing effort or fishery resources and therefore no effects will occur to the protected resources in the Reef Fish Stressed Area in territorial waters of the NSWC PCD Study Area. Refer to Sections 4.3.3, 4.3.4, and 4.4.1 for more information on effects to fish, EFH, and fishing. Through implementation of the proposed protective measures described in Chapter 5, the likelihood of affecting marine habitat is minimal. Thus, based on the avoidance of particular marine habitats including estuaries and seagrass beds and the lack of effect to fisheries and EFH, in accordance with NEPA, there will be no significant impact to marine habitats from ordnance operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.1.3.3 Non-Territorial Waters – Marine Habitats (Ordnance Operations)

The primary habitats in non-territorial waters that will potentially be affected by structural damage of the substrate and turbidity from ordnance operations are coral reefs and hardbottom areas.

There will be no line charges conducted within non-territorial waters and all other detonations will be within the water column. Therefore, ordnance operations in non-territorial waters will not affect the sea floor. Thus, little to no increase in turbidity is expected. Coral, hardbottom, and artificial reefs will be avoided by implementing the proposed mitigation measures identified detailed in Chapter 5. Operations will avoid the majority of the marine managed areas in non-territorial waters including the Florida Middle Grounds, Madison-Swanson Spawning Site, and Steamboat Lumps Spawning Site. Furthermore, the Proposed Action will not affect fishing effort or fishery resources and therefore no effects will occur to the protected resources in the various Marine Managed Areas. Refer to Sections 4.3.3, 4.3.4, and 4.4.1 for more information on effects to fish, EFH, and fishing. Based on the implementation of the protective measures and the lack of effects to fisheries and EFH, in accordance with EO 12114, there will be no significant harm to marine habitats in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.1.4 Projectile Firing – Marine Habitats

4.3.1.4.1 Introduction and Approach to Analysis – Marine Habitats

NSWC PCD RDT&E activities that involve projectile firing have the potential to impact marine habitats structurally through direct effects. In an effort to reduce the likelihood of affecting marine habitat, the protective measures described in Chapter 5 will be implemented.

4.3.1.4.2 Territorial Waters – Marine Habitats (Projectile Firing)

Live projectile firing operations will not occur in territorial waters.

4.3.1.4.3 Non-Territorial Waters – Marine Habitats (Projectile Firing)

The primary habitats in non-territorial waters that will potentially be affected by direct impact from projectile firing are coral reefs and hardbottom areas. Coral, hardbottom, and artificial reefs will be avoided by implementing the proposed mitigation measures identified detailed in Chapter 5. Other important marine habitats identified such as seagrass and estuarine environments do not occur in non-territorial waters. Furthermore, operations will avoid the majority of the marine managed areas in non-territorial waters including the Florida Middle Grounds, Madison-Swanson Spawning Site, and Steamboat Lumps Spawning Site. Furthermore, the Proposed Action will not affect fishery resources and therefore no effects will occur to the protected resources in the various Marine Managed Areas. Refer to Section 4.3.3 for more information on effects to fish. Based on the implementation of the protective measures and the lack of effects to fish, in accordance with EO 12114, there will be no significant harm to marine habitats in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.2 Invertebrates

4.3.2.1 Sonar Operations – Invertebrates

4.3.2.1.1 Territorial Waters – Invertebrates (Sonar Operations)

According to the National Research Council of the National Academies (NRC, 2003), there is very little information available regarding the hearing capability of marine invertebrates. A study by Wilson et al. (2007) revealed that squid did not respond or change behavior when exposed to sound pressure levels ranging from 179 to 193 dB re 1 m Pa^2-s. In addition, McCauley et al. (2000) noted that one species of squid exhibited behavioral reactions to sounds from seismic airguns at received levels exceeding 156 to 161 dB re 1 μPa mean square pressure (rms). It is important to note that airguns emit a high intensity, low-frequency impulsive sound at relatively short (i.e., 6 to 20 sec [Simmonds, 2004]) intervals for long periods of time; active sonar is not operated in this manner. Since little information is available on marine invertebrates and their hearing, the results of Wilson et al., (2007) are assumed to be indicative of various marine invertebrates. Based on this limited study, marine invertebrates may not react to mid- and high-frequency sonar. If they do react, the reaction would most likely be brief since sonar is a transitory and intermittent sound. Therefore, based on the best available data for acoustic impacts to invertebrates and the short duration of sonar transmissions, in accordance with NEPA, there will be no significant impact to marine invertebrates as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.2.1.2 Non-Territorial Waters – Invertebrates (Sonar Operations)

As previously mentioned, very little information exists regarding the hearing capability of marine invertebrates (NRC, 2003). A study by Wilson et al. (2007) revealed that squid did not respond or change behavior when exposed to sound pressure levels ranging from 179 to 193 dB re 1 m Pa^2-s. In addition, McCauley et al. (2000) noted that one species of squid exhibited behavioral reactions to sounds from seismic airguns at received levels exceeding 156 to 161 dB re 1 μPa mean square pressure (rms). It is important to note that airguns emit a high intensity, low-frequency impulsive sound at relatively short (i.e., 6 to 20 sec [Simmonds, 2004]) intervals for long periods of time; active sonar is not operated in this manner. Since little information is available on marine invertebrates and their hearing, the results of Wilson et al., (2007) are assumed to be indicative of various marine invertebrates. Based on this limited study, marine invertebrates may not react to mid- and high-frequency sonar. If they do react, the reaction would most likely be brief since sonar is a transitory and intermittent sound. Therefore, based on the best available data for acoustic impacts to invertebrates and the short duration of sonar transmissions, in accordance with EO 12114, there will be no significant harm to marine invertebrates as a result of active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.2.2 Ordnance Operations – Invertebrates

4.3.2.2.1 Territorial Waters – Invertebrates (Ordnance Operations)

As described in Section 4.2.1.1.2, only line charge explosions will occur close enough to the seafloor to impact the benthic invertebrate fauna. NSWC PCD RDT&E activities encompass up to three tests of a 107-m (350-ft) line charge with a total NEW of 795 kg (1,750 lb). These tests will occur over an area defined by the size of the line charge and its blast crater. The line charge is composed of 350 2-kg (5-lb) NEW charges distributed evenly along the line. According to the Committee for Mine Warfare Assessment (2001), the diameter of the crater created by an explosion in shallow water can be calculated using the following equation:

> $Rc = 4.4W^{1/3}$, where
> Rc is the radius of the crater in feet,
> W is the charge weight in pounds, assuming that the explosive charge is located at the optimum depth under the sand, and
> $W^{1/3}$ is the optimum depth.

For the 5 lb charges that make up the line charge, the optimum burial depth would be 0.52 m (1.7 ft) with a crater radius of 2.3 m (7.5 ft). As the line itself is 107 m (350 ft), this should yield a trench 4.6 m (15 ft) wide and 111 m (365 ft) long in a water depth of 3 m (10 ft). The line charges are designed for use in the surf zone. However, the crater sizes are smaller in dry sand than in wet sand and smaller in wet sand than in sand underwater; therefore, the value given should be the largest possible size of the trench. Also, the line charge at any other depth will yield a narrower trench. Overall the affected volume comprises a maximum of 263 cubic meters (344 cubic yards) of sand. As previously noted in Section 4.2.1.1.2, in general the bottom is disturbed over an area twice the distance of the crater radius (Young, 1973; O'Keefe and Young, 1984), which would increase the affected area to 0.12 hectares (0.029 acres). As the line charges are detonated in the surf zone, wave action would fill in the sand and help redistribute infaunal and epifaunal invertebrate communities.

Lewis (1996) reviewed several studies on the impact of underwater explosions on invertebrates. Almost all the invertebrates studied were in cages suspended in the water, which does not provide an accurate measure of what happens to animals in their natural environment. The only exception was a report on the use of a detonator cord laid on the surface of a marsh. The researchers in this study found that the blast only injured animals in the "direct path" of the cord, although others nearby were ejected from their holes. The other studies held the test subjects at distances too great to be directly relevant to the fate of animals ejected directly from the sand by a blast within a few inches to a few feet of the animal. However, all the studies noted that invertebrates are quite resistant to the effects of underwater explosions (Lewis, 1996).

Marine invertebrates vary significantly in number, species, and size with respect to the location of potential effects from detonations during NSWC PCD RDT&E activities. Most invertebrates experience a large number of natural mortalities because they are important food items for fish, reptiles, birds, and mammals (Georgia Museum of Natural History, 2007). Any small level of mortality additionally caused by the NSWC PCD RDT&E activities involving detonations will most likely not be significant to the population as a whole given the localized effects, as described above, of the small amount of NEW (less than 34 kg [75 lbs]) used in territorial waters. Section 4.2.1, Geology and Sediments, presents the calculations of area affected, which further support the minimal nature of the potential effects from detonations. The majority of detonations will take place in the water column. NSWC PCD will only detonate line charges on the sea floor. Based on the calculations presented in Section 4.2.1, Geology and Sediments, the greatest area affected by line charges will range from 507 m^2 (5,460 ft^2) under the No Action Alternative to 3,882 m^2 (41,786 ft^2) under Alternative 2. The effects to invertebrates will be confined to this area.

Based on the small NEW of the explosives used in the territorial waters, it is not likely that the pressure wave associated with the detonation will reach the bottom where the majority of invertebrates live. As discussed in Section 4.2.1, Geology and Sediments, mine testing will occur at least 15 m (50 ft), above the sea floor. Tests occurring in the minimum water depth will result in a maximum bubble size of 8.8 m (29 ft), which will stop several meters above the bottom. The impacts from pressure waves are also dependent on the location of the invertebrates in relation to the explosion. Yelverton (1981) concluded that invertebrate species such as crab and shrimp found within the range of effects at 50 to 200 pounds per square inch millisecond (psi-ms) are susceptible to injuries or mortality. The area encompassed by this threshold does not extend far from the source. Additional information on the safe and 50-percent-lethal thresholds can be found in Table 4-29. In accordance with NEPA, there will be no significant impact to invertebrates from ordnance operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.2.2.2 Non-Territorial Waters – Invertebrates (Ordnance Operations)

As previously discussed, the natural mortality of invertebrates is high because they comprise the diet of many fish, reptiles, birds, and mammals (Georgia Museum of Natural History, 2007). Ordnance operations in non-territorial waters will only take place in the water column. The maximum bubble size of 8.8 m (29 ft) will stop several meters above the bottom, where the majority of invertebrates live. Thus, in accordance with EO 12114, there will be no significant harm to marine invertebrates from ordnance operations during NSWC PCD RDT&E events in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.2.3 Laser Operations – Invertebrates

4.3.2.3.1 Introduction and Approach to Analysis – Invertebrates (Laser Operations)

Laser test operations include both underwater and air-to-water mine identification operations. When using lasers, the potential for eye damage is generally the greatest concern. Operation of the laser at eye safe levels ensures that damage from laser wavelengths within the visible spectrum (400–700 nanometers [nm]) will not occur to the surface of the invertebrate. No research has been conducted on marine organisms such as corals, polychaetes, and sponges. However, light and associated laser energy rapidly attenuates through the water column. Approximately 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Due to this scattering, the greatest potential for laser effects by NSWC PCD RDT&E activities is at the surface of the ocean.

4.3.2.3.2 Territorial Waters – Invertebrates (Laser Operations)

Laser test events will be separated by both time and geography. Approximately 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Thus, the potential for effects will be greatest at the surface. The duration that any given area will be illuminated will be extremely short considering the majority of the platforms will be continuously moving within the test area. In addition, the potential for damage due to exposure to a laser beam below the surface of the water decreases as depth increases (Churnside, 2004). The majority of invertebrates live on the sea floor or in the sediment where the energy from a laser beam will be unlikely to reach due to absorption and scattering. The Navy concludes in accordance with NEPA that there will be no significant impact to invertebrates from laser operations because of the habitat preferences for invertebrates and the characteristics of laser beams in the marine environment.

4.3.2.3.3 Non-Territorial Waters – Invertebrates (Laser Operations)

No Action Alternative – Invertebrates (Laser Operations, Non-Territorial)

Laser test events will be separated by both time and geography. Approximately 96 percent of a laser beam projected into the ocean surface is absorbed, scattered, or otherwise lost within the water column (Ulrich, 2004). Thus, the potential for effects will be greatest at the surface. The duration that any given area will be illuminated will be extremely short considering the majority of the platforms will be continuously moving within the test area. In addition, the potential for damage due to exposure to a laser beam below the surface of the water decreases as depth increases (Churnside, 2004). The majority of invertebrates live on the sea floor or in the sediment where the energy from a laser beam will be unlikely to spread due to absorption and scattering. The Navy concludes in accordance with EO 12114 that there will be no significant harm to invertebrates from laser operations because of the habitat preferences for invertebrates and the characteristics of laser beams in the marine environment. .

4.3.2.4 Projectile Firing – Invertebrates

4.3.2.4.1 Introduction and Approach to Analysis

NSWC PCD RDT&E activities encompass projectile firing from surface vessels and aircraft. The use of these projectiles has the potential to directly affect invertebrates and their habitat.

4.3.2.4.2 Territorial Waters – Invertebrates (Projectile Firing)

No projectile firing operations will occur in territorial waters.

4.3.2.4.3 Non-Territorial Waters – Invertebrates (Projectile Firing)

As described in Section 4.3.1 *Marine Habitat*, more than 99 percent of the various projectiles will fall on soft bottom where they will likely bury themselves. Except for the 5-in and 30 mm rounds, which are fired from a helicopter, all of the projectiles will be aimed at near-surface targets. These targets will absorb most of the projectiles' energy before they sink. This factor will limit the possibility of high velocity impacts from rounds entering the water. Once on the bottom, most of the items would be too big to be consumed by small benthic organisms. The small amount of material will be spread over a relatively large area. This expended material will settle to the ocean bottom and will be covered by sediments over time. The potential of the release of lead into the ocean bottom environment immediately surrounding the expended projectiles having adverse effects on pelagic and benthic organisms was analyzed. Benthic marine organisms that are near the projectile may be exposed to low concentrations of lead slowly released over time from the projectile. In marine biota, lead residues are generally highest near sources (e.g., disposal sites, dredging sites, mining areas), but no significant biomagnification of lead occurs in aquatic food chains (Eisler, 1988a). Although elevated concentrations of lead were observed in the livers of marine mammals in an apparent "hot spot" for lead concentrations in the Irish Sea (Law et al., 1991), lead does not biomagnify in the food chain, as the highest concentrations are found in invertebrates that are eaten by fish, seabirds, and marine mammals (Johansen, 1997). In a study of the relationships between metals and marine food-web constituents in the Gulf of the Farallones National Marine Sanctuary in central California, Sydeman and Jarman (1998) found a significant decline in lead levels between krill and Steller sea lions, indicating biodepletion of lead rather than its biomagnification.

Bioaccomulation also has been studied extensively in higher trophic levels with respect to ingestion. For example, condors have been found to inadvertently ingest lead from ammunition left in the carcass or gut of a dead animal (Arizona Game and Fish Department, 2009). Unlike the lead shot which poisoned condors, the projectiles will not be embedded in prey items. Therefore, items will only be ingested by larger animals if the animal deliberately selects it as a food item. The fragments from rounds will lose their attractiveness quickly because they will likely become buried on impact with the sediment and be subject to corrosion and encrustment with benthic organisms.

The general bottom conditions of slightly basic and low oxygen content (i.e., a reducing environment) would prohibit the lead from ionizing. In addition, only a small percentage of lead is soluble in seawater. In soft-bottom areas, the lead would be buried due to the velocity of their impact with the bottom. Sediments are generally anoxic and thus no lead would be ionized. Studies at other ranges have shown the effect of lead ballasts to be minimal, as they are buried deep in sediments where they are not biologically available (Environmental Sciences Group, 2005).

Corrosion studies conducted on lead in seawater have shown that lead corrodes at a rate of 0.8 mils (0.0008 in) per year (Kennish, 1989). However, as only 13 percent of lead is estimated to be soluble in seawater the actual corrosion rate is likely to be much lower.

In accordance with EO 12114, there will be no significant harm to invertebrates from projectile firing in non-territorial waters under No Action Alternative, Alternative 1 or Alternative 2 based on the likelihood for burying, corrosion, and encrustment of the metal fragments.

4.3.3 Fish

4.3.3.1 Air Operations – Fish

4.3.3.1.1 Introduction and Approach to Analysis– Fish (Air Operations)

Sound originating in air can be transmitted through the air-sea boundary and be perceived underwater. The use of helicopters during some missions could potentially expose fish to air-generated sound.

4.3.3.1.2 Territorial Waters – Fish (Air Operations)

Sound level criteria do not exist for fish including the smalltooth sawfish or Gulf sturgeon. Fish have been noted to respond to sound within their environment such as underwater explosions and the sound of fishing vessels; however, aircraft sound is very rarely a part of that environment (FAA, 1985). This is most likely due to the fact that most airborne sound is reflected off the water's surface, with only a small fraction actually penetrating the air-water boundary (FAA, 1985).

Based on the best available data, there are no data documenting any long-term negative effects to species of fish from underwater sound (Hastings and Popper, 2005). Effects to fish are not expected because the sensitivity of hearing in fish is in a lower frequency range than that produced during air operations. Data suggests that the predominance of fish hearing (thresholds) occur below 1 kHz, with no long-term (greater than 48 hours) behavioral effects detected. Therefore, because most airborne sound is reflected off the water's surface and because fish hear in a lower frequency range than air operations, in accordance with NEPA, there will be no significant impact to fish from air operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy finds that air operations in territorial waters under the No Action Alternative, Alternative 1 and Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon.

4.3.3.1.3 Non-Territorial Waters – Fish (Air Operations)

Source levels of helicopter sound, and resulting received sound for fish in non-territorial waters will not differ from operations in territorial waters. As previously stated, no threshold criteria exist for fish including the smalltooth sawfish or Gulf sturgeon. Data suggests that the predominance of fish hearing (thresholds) occur below 1 kHz, with no long-term (greater than 48 hours) behavioral effects detected. In addition, most airborne sound is likely reflected off the water's surface, with only a small fraction actually penetrating the air-water boundary (FAA, 1985). Therefore, because most airborne sound is reflected off the water's surface and because fish hear in a lower frequency range than air operations, in accordance with EO 12114, there will be no significant harm to fish in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy finds that air operations in non-territorial waters under the No Action Alternative, Alternative 1 and Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon populations because both species are extralimital beyond 22.2 km (12 NM) in the NSWC PCD Study Area.

4.3.3.2 Sonar Operations – Fish

4.3.3.2.1 Introduction and Approach to Analysis Fish (Sonar Operations)

Data collected to date suggests that the predominance of fish hearing generally occurs from 0.05 to 1.0 kHz (NRC, 2003). More specifically, studies indicate that the majority of marine fish studied to date are hearing generalists and have their best hearing sensitivity at or below 0.3 kHz (Popper et al., 2003; Hasting and Popper, 2005). This can be based on the theory that certain species (hearing specialists) may have developed greater hearing sensitivities by evolving in shallow, relatively quiet underwater environments, such as freshwater environments. These species would have gained fitness advantages by enhancing their sensitivity based on the limits imposed by ambient noise levels in a quieter environment and by stretching their hearing bandwidth toward higher frequencies that propagate more effectively in shallow water. (Popper et al., 2003). While hearing generalists have their best hearing sensitivity at low frequencies, it is not known whether they can detect sounds at mid-frequencies as well. It has also been demonstrated that at least five marine hearing specialist species can detect sounds up to 4.0 kHz, while members of the clupeid family Alosinae can detect sounds above 100 kHz (Enger, 1967; Mann et al., 2001; Mann et al., 2005); however, a gap in the sensitivity exists from 3.2 kHz to 12.5 kHz for at least one of these species, the American shad (Dunning et al., 1992; Mann et al., 1998; Mann et al., 2001; Nestler et al., 2002; Popper and Carlson 1998; Ross et al., 1996). Based on these studies, it is likely that hearing specialists will be able to detect sounds at mid-frequencies and possibly even high-frequencies as well.

According to Table 3-10, of all the fish species present in the NSWC PCD Study Area for which hearing capability data exists, approximately 74 percent are classified as hearing generalists, while approximately 26 percent are classified as hearing specialists. Known hearing specialist species whose distributions overlap the NSWC PCD Study Area are the gulf menhaden (*Brevoortia patronus*), bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), Spanish sardine (*Sardinella aurita*), and silver perch (*Bairdiella chrysoura*). Refer to Table 3-10 for hearing capability data for marine fish species available to date including species potentially present in the Study Area. Based on data currently available, it is difficult to take the conclusions of limited studies and extend them to all fish in general terms. To be conservative, however, this analysis assumed that marine hearing generalists, similar to marine hearing specialists, could potentially detect mid- and high-frequency sonar, even though their best hearing sensitivities were observed at low frequencies.

Very few peer-reviewed studies have been published on the effects that human-generated sound may have on fish. Most of the studies conducted are non peer-reviewed, meaning that they are not scientifically adequate because they may lack appropriate controls, statistical rigor, and/or expert analysis of the results (Popper, 2008). However, these reports do provide some insight into the possible impacts of sound on fish. The range of potential effects includes no effect, behavioral effects, temporary loss of hearing, physical damage to auditory and non-auditory tissues, and mortality (Popper, 2008). For instance, studies have shown that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, but hearing specialists may be affected by sound exposure. Exposure to loud sound can result in significant threshold shifts in hearing specialists (Scholik and Yan, 2001; Smith et al., 2004a; Smith et al., 2004b). The following subsections provide summaries of studies investigating the range of potential effects on fish from being exposed to a variety of sound sources.

Fish studies – Ultrasound and low-frequency sounds

Experiments on marine fish have obtained responses to frequencies up to the range of ultrasound; that is, sounds between 40 to 180 kHz (University of South Florida, 2007). These responses were from several species of the Clupeidae (i.e., herrings, shads, and menhadens) (Astrup, 1999); however, not all clupeid species tested have responded to ultrasound. Astrup (1999) and Mann et al. (1998) hypothesized that these ultrasound detecting species may have developed such high sensitivities to avoid predation by odontocetes. Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al., 1992; Ross et al., 1996), blueback herring (*A. aestivalis*) (Nestler et al., 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al., 2001) and American shad (*A. sapidissima*) (Popper and Carlson, 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn, 2003; Higgs et al., 2004). The *Alosa* species have relatively low thresholds (about 145 dB re 1 μPa), which should enable the fish to detect odontocete clicks at distances up to about 200 m (656 ft) (Mann et al., 1997). For example, echolocation clicks ranging from 200 to 220 dB could be detected by shad with a hearing threshold of 170 dB at distances from 25 to 180 m (82 to 591 ft) (University of South

Florida, 2007). In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*), all of which can be found in the NSWC PCD Study Area, did not respond to frequencies over 4 kHz (Gregory and Clabburn, 2003; Mann et al., 2001).

Wilson and Dill (2002) demonstrated that there was a behavioral response seen in Pacific herring (*Clupea pallasii*) to energy levels associated with frequencies from 1.3 to 140 kHz, although it was not clear whether the herring were responding to the lower-frequency components of the experiment or to the ultrasound. However, Mann et al. (2005) advised that acoustic signals used in the Wilson and Dill (2002) study were broadband and contained energy of less than 4 kHz to ultrasonic frequencies. Contrary to the Wilson and Dill (2002) conclusions, Mann et al. (2005) found that Pacific herring could not detect ultrasonic signals at received levels up to 185 dB re 1 µPa. Pacific herring had hearing thresholds (0.1 to 5 kHz) that are typical of Clupeidae that do not detect ultrasound signals.

Species that can detect ultrasound do not perceive sound equally well at all detectable frequencies. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 to 150 kHz. The poorest sensitivity was found from 3.2 to 12.5 kHz.

Although few non-clupeid species have been tested for ultrasound (Mann et al., 2001), the only other non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Mohl, 1993). However, in Astrup and Mohl's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup, 1999; Ladich and Popper, 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 µPa, which likely only allows for detection of odontocete's clicks at distances no greater than 10 to 30 m (33 to 98 ft) (Astrup, 1999).

In another experiment exposing fish to sonar, Popper et al. (2007) studied the effects of SURTASS LFA sonar on hearing, ear structure, and non-auditory systems in rainbow trout (*Onchorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*). The fish were exposed to high intensity low-frequency sonar (215 dB re 1 μPa^2 170-320 Hz) with received levels for two experimental groups estimated at 193 dB for 324 or 648 seconds. Fish exhibited a slight behavioral reaction, and one group exhibited a 20 dB auditory threshold shift at one frequency. No direct mortality, morphological changes, or physical trauma was noted as a result of these exposures. The NSWC PCD RDT&E activities would be much shorter in duration and much lower in sound level than the system employed during this study; therefore, the Navy anticipates that effects would be insignificant. The authors point out, however, that the experimental conditions represented an extreme worst-case example with longer than typical exposures for low-frequency sonar, use of a stationary source, and confined animals. These results, therefore, may not be reflective of expected real-world exposures from low-frequency sonar operations. However, these results of low-frequency sonar effects on low-frequency sensitive rainbow trout are encouraging in that similar results may be found with mid-frequency sonar use when applied to mid-frequency sensitive fish. Still, extrapolating results should always be done with caution, especially considering that in Popper et al.'s (2007) experiment rainbow trout of different groups had markedly different reactions to test conditions.

As mentioned above, studies have shown that low-frequency sound and ultrasound will alter the behavior of fish and can be used to deter fish away from potentially dangerous situations, such as turbine inlets of hydroelectric power plants (Knudsen et al., 1994). Stronger avoidance responses are exhibited from sounds in the infrasound range (0.005 to 0.010 kHz) rather than from 0.050 and 0.15 kHz sounds (Knudsen et al., 1992). In test pools, wild salmon will swim to a deeper section of the test pool, even if that deep section was near the sound source, when exposed to low-frequency sound. Ultrasound has been shown to cause some clupeid species to exhibit strong movement away from the sound source (Dunning et al., 1992; Mann et al., 1998; Ross et al., 1993), and it has also been observed to cause some clupeids to form tight schools (Mann et al., 1998; Nestler et al., 1992), which is a common defensive behavior (Astrup, 1999).

Fish studies – Mid-frequency sounds

Culik et al. (2001) and Gearin et al. (2000) studied how sound may affect fish behavior by looking at the effects of mid-frequency sound produced from acoustic devices designed to deter marine mammals from gillnet fisheries. These devices generally produce sound in similar frequencies of mid-frequency active sonar devices. Gearin et al. (2000), studied adult sockeye salmon (*Oncorhynchus nerka*) and found that they exhibited an initial startle response, likely due to the placement of an inactive acoustic alarm (designed to deter harbor porpoises) in the test tank. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not exhibit any reaction or behavior change except for the initial startle response (Gearin et al., 2000). This demonstrated that the alarm was either inaudible to the salmon, or the salmon were not disturbed by the mid-frequency sound (Gearin et al., 2000).

Studies on juveniles

The only experiments having shown mortality in fish have been investigations on juvenile herring (*Clupea harengus*) when in close proximity to an intense mid-frequency active sonar source (1 to 6.5 kHz [Jørgensen et al., 2005] and 1 to 8 kHz [Kvadsheim and Sevaldsen, 2005]). Even with the few studies available, it is becoming more established that those species tested at a greater distance from the sound source, where the sound level is below source level, show no mortality and possibly no long-term effects (Popper, 2008).

This is not to say, however, that any fish species, no matter what their hearing sensitivity, are not prone to injury as a result of exposure to mid-frequency active sonar. Individual juvenile fish with a swim bladder resonance in the frequency range of the operational sonars, and especially hearing specialists such as some clupeid species, may experience injury or mortality. The resonance frequency will depend on fish species, size and depth (McCartney and Stubbs, 1971; Løvik and Hovem, 1979). The swim bladder is a vital part of a system that amplifies vibrations that reach the fish's hearing organs, and at resonance the swim bladders may absorb much of the acoustic energy in the impinging sound wave (Sevaldsen and Kvadsheim, 2004). The resulting oscillations may cause mortality or harm the swim bladder itself or the auditory organs

(Jørgensen et al., 2005). The physiological effect of sonars on adult fish is expected to be less than for juvenile fish because adult fish are in a more robust stage of development, the swim bladder frequencies will be outside the range of the frequency of mid-frequency active sonar, and adult fish have more ability to move from an unpleasant stimulus (Kvadsheim and Sevaldsen, 2005). In a follow-on study to their earlier work (2005) that showed mortality in herring due to mid-frequency active (MFA) sonar, Kvadsheim et al. (2007) showed no reaction of herring to MFA sonar. The age class of herring in this more recent study was not described. Interestingly, herring did react to playbacks of killer whale feeding sounds covering the same frequency band.

Kvadsheim and Sevaldsen (2005) determined the effects to the Atlantic herring population are likely to be minor considering the natural mortality rate of juvenile fish and the limited exposure of the fish to the sound source (Jørgensen et al., 2005). The investigators point out that continuous wave (CW) transmissions at the frequency band corresponding to the swim bladder resonance escalate the effect to juvenile herring significantly and suggested frequencies, depending on fish length, for which Atlantic herring will most likely be affected by CW signals Table 4-27). Still, in the area of investigation, the effect of CW transmission at 225 dB on the juvenile herring population was determined to be small (0.1 percent) compared to daily natural mortality (5 percent). While CW signals will be used in the Proposed Action, the most commonly used signals will be frequency modulated (FM), the significant threshold for mortality for which was determined to be 180–190 dB (re 1 μPa) for juvenile herring (Kvadsheim and Sevaldsen, 2005).

Table 4-27. Frequency Bands Most Likely to Affect Juvenile Herring

Atlantic Herring Length	Effective Frequency Band
2.5-3 cm (0.98 – 1.18 in)	3-6 kHz
3-4 cm (1.18 – 1.57 in)	2-5 kHz
5-6 cm (1.97 – 2.36 in)	1.5-3 kHz
6-10 cm (2.36 – 3.94 in)	1-3 kHz

cm = centimeter; kHz = kilohertz

Table 4-27 shows the frequency bands for which a juvenile herring are likely to be affected during the use of CW-sonar signals. The effective frequency band is defined based on the expected resonance frequencies of the swim bladder of the juvenile Atlantic herring, as estimated from the length of the fish using the empirical model of Lovik and Hoven (1979) +/- 1 kHz bandwidth (McCartney and Stubbs, 1971) (based on Kvadsheim and Sevaldsen, 2005).

In a study of the response of fish to active sonar ranging from 1.6 to 4.0 kHz, Jørgensen et al. (2005) observed the behavior of four unrelated marine species, (saithe [*Pollachius virens*], spotted wolffish [*Anarhichas minor*], cod [*Gadus morhua*], and Atlantic herring [*Clupea harengus*]). Jørgensen et al. (2005) concluded that, of the species studied, herring might be the only species of concern due to its increased hearing ability. Juvenile herring responded with startle behaviors from sonar signals around 170 dB re 1 μPa, but resumed normal activity after the first few pulses. However, in tests with received levels around 180 to 189 dB re 1 μPa, juvenile herring exhibited startle behaviors followed by abnormal swimming. In addition, strong distress was evident during presentation of a series of 100 FM sonar pulses at around 180 dB re 1 μPa.

The other species of juvenile fish did not exhibit startle responses, or any other behavioral evidence, from the mid-frequency sonar pulses as expected for fish with no known auditory specializations for reception of frequencies above 1.0 kHz. Investigators suggested limiting the use of sonar in the range of 1.0 to 2.0 kHz at maximal operational source levels (greater than 200 dB) in areas of known juvenile herring abundance, because juvenile herring have swim bladder resonance frequencies in this frequency band. Ultrasound detecting clupeids (such as shad and menhaden) with distributions overlapping the NSWC PCD Study Area may have similar reactions to mid-frequency active sonar (as found by Jørgensen et al., 2005 and Kvadsheim and Sevaldsen, 2005) because of their similarities in hearing sensitivity. However, because members of the Clupeidae family, including herring, are hearing specialists and based on the Section 3.4.4 explanation that hearing generalists are more prevalent than hearing specialists in the NSWC PCD Study Area, impacts to juvenile herring from mid-frequency sounds are not likely representative of all other fish species here.

Masking

The inability to hear ecologically important sounds due to the interference of other sounds ("masking") has implications for reduced fitness; potentially leaving fish vulnerable to predators, unable to locate prey, sense their acoustic environment, or unable to communicate acoustically (McCauley et al., 2003). Pressure to detect predators is likely a significant driving force in the development of hearing abilities. Gannon et al. (2005) showed that bottlenose dolphins (*Tursiops truncates*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Thus, dolphin prey, such as Gulf toadfish, could be under selective pressure to detect dolphin acoustic signals and use this information to adjust mate advertisement calling (Remage-Healey et al., 2006). Bottlenose dolphins employ a variety of vocalizations during social communication and foraging, including high-frequency whistles (5 to 20 kHz), echolocation clicks (20 to 100 kHz) and low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their auditory frequency encoding is most robust below 1.0 kHz, and they have shown reduced levels of calling when bottlenose dolphins approach (Remage-Healey et al., 2006). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich et al., 2000). Results of the Luczkovich et al. (2000) study, however, must be viewed with caution because of the lack of clarity of which sound elicited the silver perch response (Ramcharitar et al., 2006a).

Communication signals, which loud sounds have the potential to mask, are a necessary aspect of some species' ecology. The Sciaenids, which are primarily inshore fish, are probably the most active sound producers among fish (Ramcharitar et al., 2001; Ramcharitar et al., 2006a). The frequency range of sciaenid sounds may span several kHz but the dominant frequency is generally between 0.1 and 1.0 kHz. Although there may be energy to higher frequencies in some species, the functional importance of these higher frequencies is unknown, and they may only be present as extraneous harmonics on the major frequency components in the sound (Ramcharitar et al., 2006b).

The ability to hear reproductive sound signals is necessary for population survival of some vocal fish. For example, female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season. Interestingly, female midshipman fish go through a shift in hearing sensitivity depending on their reproductive status. Reproductive females showed temporal encoding up to 0.34 kHz, while nonreproductive females showed comparable encoding only up to 0.1 kHz (Sisneros and Bass, 2003). The distance over which sound can be useful is often limited by the physics of sound travel underwater and therefore makes most reproductive sounds of limited use as an ecological cue over larger distances. Reproductive calls are often thought to be undetectable to fish within 20 m (66 ft) or less from the source, due to interactions with the surface and substrate (Mann and Lobel, 1997), although the detection distance will increase as water depth increases. Loud anthropogenic sounds may mask reproductive signals and therefore be detrimental to some fish populations.

Also vulnerable to masking is navigation by larval fish. There is indication that larvae of some species navigate to juvenile and adult habitat by listening for fish choruses (the sound signature emitted from reefs and actively produced by adult fish and invertebrates [Higgs, 2005]) and other sounds indicative of a particular habitat. In a study of an Australian reef system, it was determined the sound signature emitted from fish choruses was between 0.8 and 1.6 kHz (Cato, 1978) and could be detected 5.6 to 7.4 km (3 to 4 NM) from the reef (McCauley and Cato, 2000). This bandwidth is well within the detectable bandwidth of adults and larvae of many species of reef fish (Fay, 1988; Kenyon, 1996; Myrberg, 1980).

Amoser and Ladich (2005) hypothesized that, within a family of fish, different species can live under different ambient noise conditions, which requires them to adapt their hearing abilities. Under this scenario, a species' probability of survival would be greater if there was an increase in the range of detection of the surrounding acoustic environment, which consists of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources (Amoser and Ladich, 2005). In the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae as a possible example of such environmentally-derived specialization. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper, 1979). However, as these two species live in close proximity on the same reefs, it is not certain that differing environmental conditions cause the hearing variations (Popper, 2008). Generally, a clear correlation between hearing capability and the environment cannot be asserted or refuted due to limited knowledge of ambient noise levels in marine habitats and a lack of comparative studies.

Wysocki and Ladich (2005) investigated the influence of sound exposure on the auditory sensitivity of two freshwater hearing specialists (goldfish [*Carassius auratus*] and lined Raphael catfish [*Platydoras costatus*]) and a freshwater hearing generalist (sunfish [*Lepomis gibbosus*]). Baseline thresholds showed greatest hearing sensitivity around 0.5 kHz in the goldfish and catfish and at 0.1 kHz in the sunfish. For the hearing specialists (goldfish and catfish), continuous white sound of 130 dB resulted in a significant threshold shift of 23 to 44 dB. In contrast, the auditory thresholds in the hearing generalist (sunfish) declined by 7 to 11 dB. It was concluded that acoustic communication and orientation of fish, in particular of hearing specialists, may be limited by sound regimes in their environment. Studies have also found that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, but that hearing specialists may be affected by sound exposure (e.g., acoustic communication might be restricted in noisy habitats) (Amoser and Ladich, 2003; Smith, et al., 2004a and 2004b).

Thus, studies have indicated that acoustic communication and orientation of fish may be restricted by sound regimes in their environment. However, most marine fish species are not expected to be able to detect sounds in the mid-frequency range of the operational sonars used in the Proposed Action, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the sonars. Additionally, vocal marine fish largely communicate below the range of mid-frequency levels used during NSWC PCD RDT&E activities.

4.3.3.2.2 Territorial Waters – Fish (Sonar Operations)

Various sonar systems are tested at NSWC PCD in order to demonstrate the ability to detect, locate, and characterize inert mines, MLOs, and VEMs under various environmental conditions. Sonar frequencies for this EIS/OEIS range from mid-frequency (1 to 10 kHz) to high-frequency (greater than 10 kHz). The loudness of the systems is generally concentrated in the range between 186 dB and 235 dB. The proposed use of mid-frequency sonar systems is significantly less than the proposed use of high-frequency sonar systems for all alternatives. Even with the potential increase in hours of sonar operation per year for Alternative 2, these events are still considered to be rare events when compared to other anthropogenic sound sources in the Eastern GOM (MMS, 2007c), as described in Section 3.3.5.3. As discussed in Section 4.3.3.2.1, studies have shown that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, but hearing specialists may be affected by sound exposure. Specific to the hearing specialists present in the NSWC PCD Study Area, bay anchovy, scaled sardine, Spanish sardine and silver perch have not shown any response to sounds above 4 kHz, while gulf menhaden have only demonstrated avoidance behaviors to sounds over 100 kHz. While, exposure to loud sound can result in significant threshold shifts in hearing specialists, studies thus far have shown these threshold shifts are temporary and it is not evident that they lead to any long-term behavioral disruptions in fish that are biologically significant (Scholik and Yan, 2001; Smith et al., 2004a; Smith et al., 2004b).

There is no information available that suggests that exposure to non-impulsive acoustic sources results in significant fish mortality on a population level. Mortality has been shown to occur in one species, a hearing specialist, however, the level of mortality was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and it is not evident that they lead to any long-term behavioral disruptions. Considering the best available data, no data exist that demonstrate any long-term negative effects on marine fish from underwater sound associated with sonar activities. Further, while fish may respond behaviorally to mid-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

Hearing generalists within the NSWC PCD Study Area will be able to detect mid- and high-frequency sounds; however, studies have shown that these frequencies are not within their typical ranges of hearing sensitivity. It is estimated that approximately 74 percent of fish species potentially present in the NSWC PCD Study Area are classified as hearing generalists. Therefore the majority of fish species within the NSWC PCD Study Area may be affected less than is discussed in this analysis. Additionally, given that hearing specialists may only comprise approximately 26 percent of fish species within the NSWC PCD Study Area further demonstrates that the effects mentioned above are minor in comparison to all fish populations in the northern GOM as a whole.

Therefore, in accordance with NEPA, there will be no significant impact to fish populations from sonar operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In addition, in accordance with the ESA, the Navy finds that sonar operations in territorial waters under the No Action Alternative, Alternative 1, and Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon populations based on the analysis for fish hearing.

4.3.3.2.3 Non-Territorial Waters – Fish (Sonar Operations)

Potential effects to fish in non-territorial waters will be the same as those with the No Action Alternative in territorial waters. The sonar frequencies proposed in this EIS/OEIS range from 1 kHz to 5,000 kHz, and fish hearing predominantly occurs below 1 kHz. Additionally, the use of sonar systems in non-territorial waters is less than the use of sonar systems in territorial waters, further reducing the potential for harm. A review of the available literature presented in the discussion of the alternatives for territorial waters further supports that the use of active sonar will have no effect on fish. Therefore, there will be no significant harm to fish populations under No Action Alternative, Alternative 1, and Alternative 2 in non-territorial waters. Additionally, in accordance with the ESA, the Navy finds that sonar operations in non-territorial waters under the No Action Alternative, Alternative 1, and Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon populations because they are extralimital beyond 22.2 km (12 NM) in the NSWC PCD Study Area.

4.3.3.3 Electromagnetic Operations – Fish

4.3.3.3.1 Introduction and Approach to Analysis – Fish (Electromagnetic Operations)

The NSWC PCD test events that generate an electromagnetic field (EMF) typically encompass a towed body. The body includes a magnetic sweep system that uses electrodes (materials that contain moveable electrical charges that are used to make contact with a nonmetallic part of a circuit) and the saltwater (as a return path for the magnetic field) to generate an open-loop system to simulate a ship's EMF signature. An open loop system is one that has boundaries across which energy, in this case, magnetic fields can cross. A loop sweep generates a magnetic field in all directions on each portion of the bottom under the sweep. The magnetic output is generated down a cable, which will be deployed from the towed body and transmitted through the saltwater media from the electrode at the end of the cable. The electrode at the end of the tow cable acts as the cathode, and the electrode on the sweep cable acts as the anode (DON, 2005a).

Generally, the voltage at the forward electrode (cathode) is around 30 volts relative to seawater ground. This amount of voltage is comparable to two automobile batteries. Since saltwater is an excellent conductor, only very moderate voltages of 35 volts (capped at 55 volts) are required to generate the current. These small levels represent no danger of electrocution in a current distributed sea environment (i.e., the electric potential gradient is very low in the saltwater). It is unlikely that electrocution from systems employing EMF will be a source of lethality for biological resources (i.e., fish) near the electrode. Typically, the maximum magnetic field level traveling down the towed cable will be 110,000 nanotesla (nT) (approximately 23 gauss [G]). The electromagnetic field generated at a diameter of only 4 m (13.12 ft) from the cable is comparable to the earth's magnetic field. The strength of the field at just under 8 m (26.25 ft) is 40 percent of the earth's field; at 24 m (78.74 ft), 10 percent (DON, 2005a).

The EMF emitted by the electrode will encompass an area approximately 400 m (1,312 ft) in diameter. Across an average sweep area with 10 runs, this will generate an area of electromagnetic influence that is similar to a curved rectangle or approximately oval in shape with dimensions of approximately 2,400 m (7,874 ft) long and 580 m (1,903 ft) wide.

Researchers have examined a variety of fish species and have found only a few groups that definitely possess electrosensory capabilities. Table 4-28 shows a partial list of species studied that have potential electromagnetic detection capabilities. Those studied include Chondrichthyes (sharks, skates, rays and Chimaeridae), Acipenseriformes (sturgeon and paddlefish), Silurians (catfish), Dipnoi (lungfish) and weakly electric teleosts such as the gymnotids and mormyrids. It is also known that salmonids, tuna and rainbow trout have magnetite in their lateral lines which may be used for navigation. Of the known electrosensing fish, the Chondrichthyes, the Acipenseriformes and Anguilla (eels) occur in the Gulf of Mexico. The rest are primarily freshwater species. However, one report, Jury et al, 2005, suggests that electrosensing may be a more general characteristic of the teleost lateral line system. For that reason, some further discussion of teleost electrosensing is necessary. Fish with magnetite in their lateral lines may also occur in the test area. Many of the electrosensing fish and possibly the fish with magnetite are capable of detecting magnetic fields (Gill et al., 2005).

Table 4-28. GOM Fish Species With Electromagnetic Capabilities

Common Name	Scientific Name	Electromagnetic Detection Method	Present in NSWC PCD Study Area
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	Ampullae	X
Paddlefish	*Polyodontidae* *(Polyodon spathula)*	Ampullae	
Salmon	*Salmonidae*	Magnetite	
Scalloped hammerhead	*Sphyrna lewini*	Ampullae	X
Sandbar sharks	*Carcharhinus plumbeus*	Ampullae	
Electric rays	*Torpediniformes*	Active	X
Carps	*Cyprinidae*		

Table 4-28. GOM Fish Species With Electromagnetic Capabilities (Cont'd)

Common Name	Scientific Name	Electromagnetic Detection Method	Present in NSWC PCD Study Area
Yellowfin tuna	*Thunnus albacares*	Magnetite	X
Rainbow trout	*Oncorhynchus mykiss*	Magnetite	
Transparent catfish	*Kryptopterus bicirrhis*	Ampullae	
Brown ghost knifefish	*Apteronotus leptorhynchus*	Ampullae and tuberous receptors	
Lampreys	*Ichthyomyzon unicuspis and Petromyzon marinus*	Ampullae	X
Mormyrid	*Gnathonemus petersii* *Brienomyrus niger*	Ampullae	
European eel	*Anguilla anguilla*	Possible magnetic detection	X

Sources: Teeter et al., 1980; Wilkens et al., 2003; Jury et al., 2005; Gill et al., 2005; Walker et al. 1982; Diebel et al., 2000; Teeter and Bennett, 1981; Bastian, 1987; Bodznick and Preston, 1983; Kramer, 1976

Scientists know that certain species like rays, sharks, eels, and some fish may be able to respond to EMF in the water column. Uncertainty exists in whether animals that are electromagnetically sensitive will respond and what the consequence of a response may be (Gill et al., 2005). The literature on the effects of EMF to marine species is limited, and the majority of studies have focused on permanent infrastructure related to offshore wind farms (Gill et al., 2005). Sharks such as scalloped hammerhead and sandbar sharks respond to magnetic fields of 25 to 100 microtesla (μT) while some species of fish (flounder), exhibit no changes to the magnetic field (Gill et al., 2005). The review of the literature on infrastructure in European waters shows that electric ray populations continue to inhabit areas where permanent extensive cables generating EMF lie on the sea floor. These areas include English and Welsh waters throughout the Eastern Irish Sea, the Bristol Channel, and the Thames Estuary (Gill et al., 2005). From these studies, it can be inferred that fields of these strengths have no significant impact on fish or fish populations. As the fields from the towed arrays will be similar in strength, except at larger distances from the source, the impacts related to field strength would be expected to be similar, except for fish in the immediate vicinity of the array. Studies of short-term electric fields in the water (e.g. Fields, 2007) have shown no effects on fish other than that they can detect and, therefore, be attracted to or repelled from electromagnetic fields of sufficient strength and characteristics.

Elasmobranches (sharks, rays, and skates) have the ability to perceive EMFs through electroreceptors. The electromagnetic sensory systems are composed of gel filled ampullae (or pores) in the rostrum (or the snout like area) called the Ampullae of Lorenzini. Electroreceptors enable these species to not only perceive, but also to interpret EMFs (SeaChange™ Technology, 2004). This information has a variety of applications including navigation, communication, prey detection, and social behavior.

Some species are able to detect electromagnetic signals in the microvolt range over short distances (approximately 30 cm, or 12 in). At this level of sensitivity, many species can detect the nerve impulses of other animals and use this ability for prey detection (SeaChange™ Technology, 2004). In addition, many species can detect the earth's magnetic field (approximately 0.5 G), and some appear to use this information in navigation. Because of the ability to perceive EMFs, introduction of these fields during mine countermeasures activities has the potential to influence the behavior of marine species.

Because of the highly developed sensory system and the concern that humans exhibit toward sharks, the majority of research into the effects of EMFs on marine life has been conducted on sharks (SeaChange™ Technology, 2004). All shark species are not equally sensitive, and sensitivity has been found to vary with age. Actively predatory sharks (those that seek out their prey) like bull sharks have a more refined and sensitive electromagnetic sense than those species that trap their prey, such as nurse sharks. Skates and rays demonstrate sensitivity to EMFs comparable to actively predatory sharks. In fact, the species most sensitive to EMFs are the marine electric rays. Two electric ray species, the Atlantic torpedo ray (*Torpedo nobiliana*) and the lesser electric ray (*Narcine brasiliensis*), occur in the NSWC PCD Study Area. Elasmobranch species specialized for deep water environments are presumed to be sensitive to changes in EMFs due to the high number of sensory organs present.

No studies have been found that directly examine the electric capabilities of Gulf sturgeon or smalltooth sawfish. However, smalltooth sawfish are elasmobranchs (sharks, skates and rays) and it is known that, like other elasmobranchs they use ampullae of Lorenzini located in their rostrums for hunting prey and sensing their environment (Bleckman and Hofmann, 1999; Fields, 2007). Bleckman and Hofmann, (1999) note that elasmobranchs are sensitive to fields as low as 1 µV/cm (100 G) and that the sensitivity remains even in the presence of 1 mV/cm DC (100,000 G) electric fields. Given that sawfish use ampullae of Lorenzini just like other elasmobranchs – of which sharks, skates and rays have all been studied, sawfish would be expected to have similar susceptibilities to direct effects from electrical and magnetic fields in the water.

The Gulf sturgeon's EMF sensitivities have not been studied. However, Teeter et al. (1980) studied the ampullary receptors in the skin of the shovelnose sturgeon, *Scaphirhynchus platorynchus*. The researchers found that these receptors were similar in design to the ampullae of Lorenzini in elasmobranchs and the activity of the primary afferent nerve fibers innervating the ampullae responded to electrical stimuli in a similar range. They also found that the organs responded similarly to chemicals that temporarily block signals from the ampullae of Lorenzini and concluded that in form and function they were very similar. Teeter et al. concluded that the "ampullary organs of chondrostean fishes … should be classified as ampullae of Lorenzini". Wilkens et al., (2003) showed that these ampullae in paddlefish, a close relative of the sturgeon, are used in hunting prey, which is the method of the bottom-feeding smalltooth sawfish.

From a behavioral point of view, electro-sensitive fish may be attracted to the source, or may flee from it, but this would depend on their ability to actually detect it. All of the behaviors listed above are related to the animal's (target or hunter) muscle movements or changes of position with respect to the earth's magnetic field. All of these involve low-frequency signals. Sharks' electrical sensitivities are strongest at low frequencies (1 Hz) which corresponds to signals given off by the muscles of prey species (Hafemeister, 1996). Given that the towed array is designed to simulate a ship's electromagnetic signal in the water, it seems unlikely that the towed systems would have any significant impact. Furthermore, if the towed array accurately models ships electromagnetic field, the small number of hours of deployment will be insignificant compared to the ship-generated electric fields already experienced by pelagic fish.

Research reported by V. V. Alexandrov in the Russian Academy of Sciences journal indicates that there is synchronization between geomagnetic fields and the movement of *Cyprinidae* fish species. When influenced by an external EMF greater than the geomagnetic field, these fish exhibited increased movement and a loss of stability. Gill et al. (2005) prepared a report on the effects of EMF from wind farm developments on sensitive marine organisms. The authors found that at one of the sites, certain bony fish exhibited sensitivity to electromagnetic fields; however, this sensitivity only extended out to 1 m (3.28 ft) from the cable with a field property of 33.1 μT (Gill et al., 2005).

4.3.3.3.2 Territorial Waters – Fish (Electromagnetic Operations)

The generation of EMFs during NSWC PCD RDT&E activities has the potential to affect electromagnetically sensitive marine species, mainly from interference with prey detection and navigation. The static magnetic field generated by the EMF systems is of relatively minute strength (typically 23 G at the cable surface and 0.002 G at a radius of 200 m [656 ft]). As discussed earlier in this section, the strength of the EMF decreases quickly away from the cable down to the earth's magnetic field (0.5 G) at less than 4 m (13.12 ft) from the source (DON, 2005a). Although little data exist on the effect of exposure of marine life to magnetic fields, scientists have investigated human exposure. The maximum safe exposure for humans (time weighted average exposure in 8 hours) is 2,000 G. The maximum safe whole body exposure for humans is estimated at 20,000 G (International Commission on Non-Ionizing Radiation Protection [ICNIRP], 1998).

Although there are no direct measurements of the impacts of EMF on Gulf sturgeon or smalltooth sawfish, the aforementioned research of all related fish species studied supports that there would not be any anticipated impact. This conclusion is especially true given that sturgeon and sawfish are bottom-feeders which would limit their opportunities to closely interact with the towed systems, which are pulled in the water column and not directly along the bottom. Furthermore, smalltooth sawfish are not anticipated to be in the NSWC PCD Study Area.

Based on the findings for species sensitive to electromagnetic fields, the Navy finds that the use of EMF during NSWC PCD RDT&E activities under the No Action Alternative, Alternative 1, or Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon, in accordance with the ESA. Further, based on the best available data including the study on generation of short-term electric fields by Fields (2007), in accordance with NEPA, there will be no significant impact to fish from the use of EMF during NSWC PCD RDT&E activities under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.3.3.3 Non-Territorial Waters – Fish (Electromagnetic Operations)

The generation of EMFs during NSWC PCD RDT&E activities has the potential to affect electromagnetically sensitive marine species, mainly from interference with prey detection and navigation. The static magnetic field generated by the EMF systems is of relatively minute strength (typically 23 G at the cable surface and 0.002 G at a radius of 200 m [656 ft]). As discussed earlier in this section, the strength of the EMF decreases quickly away from the cable down to the earth's magnetic field (0.5 G) at less than 4 m (13.12 ft) from the source (DON, 2005a). Although little data exist on the effect of exposure of marine life to magnetic fields, scientists have investigated human exposure. The maximum safe exposure for humans (time weighted average exposure in 8 hours) is 2,000 G. The maximum safe whole body exposure for humans is estimated at 20,000 G (ICNIRP, 1998).

Based on the findings for species sensitive to electromagnetic fields and the fact that Gulf sturgeons are not typically found in non-territorial waters of the NSWC PCD Study Area and smalltooth sawfish are extralimital to the NSWC PCD Study Area, the Navy finds that the use of EMF during NSWC PCD RDT&E activities under the No Action Alternative, Alternative 1, or Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon, in accordance with the ESA. Further, based on the best available data including the study on generation of short-term electric fields by Fields (2007), in accordance with EO 12114, there will be no significant harm to fish from the use of EMF during NSWC PCD RDT&E activities under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.3.4 Laser Operations – Marine Fish Species

4.3.3.4.1 Introduction and Approach to Analysis – Fish (Laser Operations)

As discussed previously in Section 4.3.2.3., laser test operations include both underwater and air-to-water mine identification operations. As with humans, the greatest laser-related concern for marine species is visual damage. Lasers may also cause burns to the scales, but the threshold energy for eye damage is considerably lower and is considered the threshold of concern. Effects to an animal's scales are not addressed because the necessary laser power to cause damage is much greater than that which will cause damage to the eyes (Ulrich, 2004). No research has been conducted on fish. However, light and associated laser energy rapidly attenuates through the water column. Approximately 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Due to this scattering, the greatest potential for laser effects by NSWC PCD RDT&E activities is at the surface of the ocean.

4.3.3.4.2 Territorial Waters – Fish (Laser Operations)

Laser test events will be separated by both time and geography. Approximately 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Thus, the potential for effects will be greatest at the surface. The duration that any given area will be illuminated will be extremely short considering the majority of the platforms will be continuously moving within the test area. In addition, the potential for damage due to exposure to a laser beam below the surface of the water decreases as depth increases (Churnside, 2004). The Navy concludes in accordance with NEPA that there will be no significant impact for the No

Action Alternative, Alternative 1, or Alternative 2 because of the attenuation of the laser beam into the marine environment. In accordance with the ESA, the Navy also finds that the use of lasers during NSWC PCD RDT&E activities under the No Action Alternative, Alternative 1, or Alternative 2 will have no effect on smalltooth sawfish and Gulf sturgeon because they prefer benthic habitats on the seafloor.

4.3.3.4.3 Non-Territorial Waters – Fish (Laser Operations)

Potential effects on marine species in non-territorial waters will be similar to those with the No Action Alternative for territorial waters. Laser test events will be separated by both time and geography. Approximately 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Thus, the potential for effects will be greatest at the surface. The duration that any given area will be illuminated is extremely short considering the majority of the platforms will be continuously moving within the test area. In addition, the potential for damage due to exposure to a laser beam below the surface of the water decreases as depth increases (Churnside, 2004). The Navy concludes in accordance with EO 12114 that there will be no significant impact for the No Action Alternative, Alternative 1, or Alternative 2 because of the attenuation of the laser beam into the marine environment. In accordance with the ESA, the Navy also finds that the use of lasers during NSWC PCD RDT&E activities will have no effect on smalltooth sawfish and Gulf sturgeon under the No Action Alternative, Alternative 1, or Alternative 2 because they will not occur in non-territorial waters of the NSWC PCD Study Area.

4.3.3.5 Ordnance Operations – Fish

The use of underwater explosives has the potential to affect fish. Underwater shock waves can rupture swim bladders and blood vessels of fish, tear their tissues, and rupture and hemorrhage the spleen, kidney, liver, gonads, and sinus venosus (first chamber in the heart, which connects to the veins and receives blood from the body) of fish (Wright, 1982 and Govoni et al., 2003).

4.3.3.5.1 Introduction and Approach to Analysis – Fish (Ordnance Operations)

Fish that are located in the water column, in proximity to the source of detonation could be injured, killed, or disturbed by the impulsive sound and possibly temporarily leave the area. Continental Shelf Associates, Inc. (CSA) (2004) presented a few generalities from studies conducted to determine effects associated with removal of offshore structures (e.g., oil rigs) in the GOM. Their findings revealed that at very close range, underwater explosions are lethal to most fish species regardless of size, shape, or internal anatomy. For most situations, cause of death in fish has been massive organ and tissue damage and internal bleeding. At longer range, species with gas-filled swim bladders (e.g., snapper, cod, and striped bass) are more susceptible than those without swim bladders (e.g., flounders, eels). Studies also suggest that larger fish are generally less susceptible to death or injury than small fish. Moreover, elongated forms that are round in cross-section are less at risk than deep-bodied forms; and orientation of fish relative to the shock wave may affect the extent of injury. Open water pelagic fish (e.g., mackerel) also seem to be less affected than reef fish. The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors.

Table 4-29 provides an overview of the mortality and thresholds for fish exposed to an explosive sound source. Further information on metrics and definitions of measurement units are presented in Appendix L.

Table 4-29. Thresholds for Physical Injury to Fish and Invertebrates from Detonations

Effect	Marine Animal	Metric(s)	Threshold(s)	Reference
50% Lethal	Shrimp, Crabs	Peak Pressure	50 to 200 psi (231 to 243 dB)	Yelverton (1981)
"Safe"	Fish, Some Invertebrates	Peak Pressure; Positive Impulse	5 psi (211 dB); 5 psi-ms	Young (1991); Goertner (1982)
50% Lethal	Fish (0.1 kg [.22 lbs])	Positive Impulse	20 psi-ms	Yelverton (1981)
50% Lethal	Fish (1 kg [2.2 lbs])	Positive Impulse	50 psi-ms	Yelverton (1981)

dB = decibels; kg = kilogram; psi-ms = pounds per square inch per millisecond

The effects from the removal of an oil rig platform or structure, which is often performed using explosives can be compared to the possible effects that might result from underwater ordnance activities associated with the Proposed Action. There are two basic methods of platform removal including explosive and non-explosive techniques. Nearly two-thirds of the oil rig structures removed annually is performed through the use of explosives (MMS, 2005). The most common method uses 18 to 23 kg (40 to 50 lb) bulk charges of Composition B (Comp-B) and C-4, detonated inside the piling and well conductors at a depth of 4.5 m (15 ft) below the seafloor (MMS, 2005). Larger pilings may require larger charge sizes. However, since shock wave effects in water follow a cube root scaling, doubling the weight of an explosive charge does not result in a doubling of effects. A single detonation would result in less environmental impacts than a series of blasts at close intervals (MMS, 2005).

The environmental concerns with underwater explosions are associated with mortality of marine life in the vicinity of the detonation. Several studies have attempted to calculate the number of fish mortalities resulting from an underwater explosion including a study performed by the National Marine Fisheries Service (NMFS). The number of fish killed around oil and gas structures in the northern Gulf of Mexico was monitored by NMFS between 1986 and 1998 (MMS, 2005). The findings of the study were based on the number of fish floating on the surface after a detonation. Of the 742 platform structures monitored during the period, there was a total of 430,932 floating fish reported, averaging 567 floating fish per structure (CSA, 2004). Two years later, Gitschlag et al. (2000), calculated the fish mortality rate of floating and sinking fish during removal of nine platforms in depths ranging from 14-32 m (46-105 ft). The researchers recorded a total of 30,315 individual large (greater than 8 cm [3 in] in total length) floating and sinking fish represented by 55 fish taxa in 23 families. The number of large fish calculated for the individual structures at all nine platforms ranged from 1,765 to 5,216, averaging 3,400 per platform. At one of the nine platforms studied, a total of over 11,000 large and small (less than 8 cm [3 in] in total length) fish were killed within the footprint area plus a 100-m (328-ft) radius indicating that just calculating the number of large fish greatly underestimates the total number of fish mortalities (Gitschlag et al., 2000). However, small fish typically have a higher natural mortality rate and are probably not adding to the spawning biomass and are less likely to directly impact fisheries (MMS, 2005).

Estimates of fish mortality from an underwater blast are statistical in nature since many factors influence the outcome. Biological, environmental, explosive, and data acquisition variables make precise predictions of mortality resulting from an underwater blast difficult (MMS, 2005). However, in general the results from various studies indicate that fish with swimbladders, smaller fish (less than 8 cm. or 3 in.), and fish near the surface are more susceptible to injury and mortality from underwater blasts than fish without swim bladders, larger fish, or deep water fish (MMS, 2005).

4.3.3.5.2 Territorial Waters – Fish (Ordnance Operations)

Underwater explosions have the potential to injure or kill fish. These impacts are dependent upon their location in relation to the explosion. As indicated in Table 4-29 above, species that are found within the range of influence of 20 psi-ms (0.1 kg, or 0.22 lb, fish) and 50 psi-ms (1 kg, or 2.2 lbs, fish) are susceptible to injuries or mortality. However, with only three detonations per year with one line charge under the No Action Alternative, 18 detonations per year with two line charges under Alternative 1, and up to 54 detonations with three line charges per year under Alternative 2, the quantity of fish affected will be small relative to the abundance of these populations in the GOM. Furthermore, most fish species experience a large number of natural mortalities especially during early life-stages, and therefore any small level of mortality caused by the detonations during NSWC PCD RDT&E activities will be minor and have little effect to the population as a whole.

The Navy can use the data on effects to fish populations from the use of explosives for oil platform removal to compare with NSWC PCD RDT&E activities. In most instances, the detonation of several 40 to 50 lb (18 to 23 kg) charges of Comp-B and C-4 15 ft (4.5 m) below the seafloor is used to sever platform piling and well conductors and is expected to result in the loss of some portion of desirable fish populations (MMS, 2005). Detonations occur nearly simultaneously (0.9 second delay) in groups of 8 or less (NRC, 1996). Estimates suggest that on average, 5,000 large fish or all swim bladder fish within 50 m (160 ft) of the platform will be killed by the succession of underwater blasts from an oil rig removal (MMS, 2005). However, it has been determined that the total stocks of fish or their recovery status will not be affected by detonations associated with oil rig removals (MMS, 2005).

The explosives used for oil rig removal including Comp-B and C-4, are more explosive than TNT, which is the explosive used for ordnance activities in the NSWC PCD Study Area. Comp-B and C-4 have a higher velocity on detonation and have a 15 to 30 percent higher shattering power than TNT (NRC, 1996). Since the explosives used for the oil rig removal are more explosive than TNT and detonation of an oil rig were found not to affect the stock or recovery status of fish (MMS, 2005), then it could be assumed that detonation of 0.45 to 4.5 kg (1 to 10 lbs) and/or 5 to 34 kg (11-75 lbs) of TNT will result in the same or lesser impacts to fish resources as those impacts resulting from 40 to 50 lbs (18 to 23 kg) of Comp-B or C-4.

Test personnel at NSWC PCD have not observed any fish mortalities associated with the use of line charges or small detonations. Although no strict protocols were put into place during test activities, test personnel observed no fish kills during two past test events in the NSWC PCD Study Area (Branham, 2007). NSWC PCD mitigated fish kills during the line charge testing along Eglin on Santa Rosa Island by using 0.5 lb charges through standard explosive ordnance disposal (EOD) mitigations to clear the area along prior to tests. Furthermore, no fish kills occurred during line charge detonations off Tyndall property. No data exists on the density of fish in the NSWC PCD Study Area; therefore, the quantity of fish affected by medium and large detonations cannot be determined. In addition, fish have the ability to quickly and easily leave an area temporarily when vessels and/or helicopters approach; it is reasonable to assume that fish will leave an area prior to ordnance detonation and will return when operations are completed. Thus, it is anticipated that the quantity of fish affected will be small and will not imperil any fish populations. In accordance with NEPA, there will be no significant impact to fish from ordnance operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the best available scientific data, particularly comparison with the effects to fish populations from the use of explosives in oil platform removals.

The use of line charges will occur in the nearshore environmental where Gulf sturgeon may occur. In general it has been found that subadult and adult Gulf sturgeon will begin migrating downstream, specifically from the Apalachicola River to the GOM, in late September for the duration of the winter and will return the following spring by the end of May (USFWS and GSMFC, 1995). Tagging efforts have documented the occurrence of these Endangered Species Act (ESA)-listed species from typically about one-half to one mile off the shore of Tyndall Air Force Base (AFB) and as far as 6.4 km (4 mi) in the GOM (USFWS PC, 2004). The potential exists that if NSWC PCD conducts tests of line charges from late September through April, ordnance operations may affect Gulf sturgeon under the No Action Alternative, Alternative 1, and Alternative 2. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

The smalltooth sawfish is extralimital to the NSWC PCD Study Area. Historic records show that the species at one time likely existed in the Florida panhandle; however, current scientific research has shown that the species distribution is limited predominantly to the Florida Everglades and throughout peninsular Florida (NMFS, 2006). These locations are outside of the NSWC PCD Study Area; therefore, in accordance with the ESA, the Navy finds that ordnance operations will have no effect on the smalltooth sawfish under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.3.5.3 Non-Territorial Waters – Fish (Ordnance Operations)

No Action Alternative – Fish (Ordnance Operations, Non-Territorial)

No ordnance operations will occur in non-territorial waters under the No Action Alternative.

Alternatives 1 & 2 – Fish (Ordnance Operations, Non-Territorial)

Potential effects to fish in non-territorial waters will be similar to those with the No Action Alternative for territorial waters. Although there will be up to 16 large detonations annually, the area affected will only be a small portion of the entire GOM.

Ordnance activities in non-territorial waters would involve detonation of 34.5 to 272 kg (76 to 600 lbs) of TNT. Limited experimental data is available for underwater explosions of this size which makes predicting impacts to fish resources difficult. One study has calculated a 10 percent mortality range for fish in relation to underwater explosions. The 10 percent mortality range is the distance from the source where 90 percent of the fish present would be expected to survive the detonation (CSA, 2004). For ordnances with a 416 lb (189 kg) NEW, the 10 percent mortality range for large fish is approximately 131 m (430 ft) from the source (DON, 2008c). A 10 percent mortality range was calculated for a 945 lb (429 kg) NEW explosive to be 165 m (541 ft) (DON, 2008c); however NSWC PCD RDT&E activities do not employ explosives larger than 600 lb (272 kg). While no data is available for explosives with a 600 lb (272 kg) NEW, it can be inferred that the 10 percent mortality range would be between 131 m and 165 m (430 ft and 541 ft). Beyond this range, 90 percent of large fish would not be impacted by the explosion. Given that detonations of this size will only be utilized a maximum of four times per year under Alternative 1 and sixteen times per year under Alternative 2 it is unlikely that fish stocks and their recovery status will be impacted.

The Navy can also use the data on effects to fish populations from the use of explosives for oil platform removal to compare with NSWC PCD RDT&E activities in non-territorial waters. In most instances, the detonation of several 40 to 50 lb (18 to 23 kg) charges of Comp-B and C-4 15 ft (4.5 m) below the seafloor in oil platform removals is expected to result in the loss of some portion of desirable fish populations (MMS, 2005). However, Sulfredge et al (2005) suggest that a 300 lb (135 kg) charge of TNT with a gas bubble radius greater than 20 ft (6 m) would result in damage to any equipment or structure within the gas bubble formed. It is assumed that a detonation that would damage a physical structure would also damage fish species and therefore any fish species present within the gas bubble would also be impacted. Assuming that a 600 lb (272 kg) charge of TNT would result in double the size of the gas bubble formed and hence the diameter of impacted area, therefore would suggest that damages to fish species would occur within 40 ft (12 m) from the detonation site. This is less than the estimated area of impact from an underwater oil rig removal which would impact approximately 5,000 large fish or all swimbladder fish within 50 m (160 ft) of the underwater blast (MMS, 2005). However, it has been determined that the total stocks of fish or their recovery status will not be affected by detonations associated with oil rig removals (MMS, 2005). Similar to the underwater impacts from an oil rig removal therefore, it is assumed that while there would be impacts to fish resources, there would no significant impacts to fish stocks or recovery status.

Furthermore, fish have the ability to quickly and easily leave an area temporarily when vessels and/or helicopters approach. It is reasonable to assume, therefore, that fish will leave an area prior to ordnance detonation and will return once tests are completed. It is anticipated that the quantity of fish affected will be small and will not imperil any fish populations because most fish species experience a large number of natural mortalities especially during early life-stages. Detonations during NSWC PCD RDT&E activities will be insignificant to the population as a whole.

The Gulf sturgeon occurs along the coast and in nearshore environments. The smalltooth sawfish is extralimital to the NSWC PCD Study Area. Current scientific research shows that the species distribution is limited predominantly to the Florida Everglades and throughout peninsular Florida (National Marine Fisheries Service [NMFS], 2006), which is outside the NSWC PCD Study Area. Historic records indicate that smalltooth sawfish did exist in the Florida panhandle at one time (NMFS, 2006a); however, their present occurrence is considered extralimital. Generally, their occurrence is not expected beyond 22 km (12 NM). Thus, in accordance with

EO 12114, there will be no significant harm to fish in non-territorial waters under Alternative 1 or Alternative 2 based on the best available scientific data including potential effects to fish from the use of explosives in oil rig removals and the ability of fish to temporarily leave the area and return when tests are complete. In accordance with the ESA, the Navy finds that ordnance operations in non-territorial waters will have no effect on the Gulf sturgeon or smalltooth sawfish under Alternative 1 or Alternative 2 because neither species occurs in non-territorial waters of the NSWC PCD Study Area.

4.3.3.6 Projectile Firing – Marine Fish Species

4.3.3.6.1 Introduction and Approach to Analysis – Fish (Projectile Firing)

NSWC PCD RDT&E activities encompass projectile firing from surface vessels and aircraft. The use of these projectiles has the potential to directly strike fish and affect their habitat.

4.3.3.6.2 Territorial Waters – Fish (Projectile Firing)

No projectile firing will occur in territorial waters.

4.3.3.6.3 Non-Territorial Waters – Fish (Projectile Firing)

As described in Section 4.2.1 *Geology and Sediments* the various projectiles will fall on soft bottom where they will likely become buried immediately in the sediments. Except for the 5-inch and the 30 mm rounds, which are fired from a helicopter, all the projectiles will be aimed at surface targets. These targets will absorb most of the projectiles' energy before they strike the surface of the water and sink. This factor will limit the possibility of high velocity impacts to occur to fish from the rounds entering the water. Furthermore, fish have the ability to quickly and easily leave an area temporarily when vessels and/or helicopters approach. It is reasonable to assume, therefore, that fish will leave an area prior to projectile firing and will return once tests are completed. In accordance with EO 12114, there will be no significant harm to fish in non-territorial waters under Alternative 1 or Alternative 2 based on the nature of the potential effects to habitat and the likelihood that fish will temporarily leave an area during operations. In accordance with the ESA, the Navy finds that ordnance operations in non-territorial waters will have no effect on the Gulf sturgeon or smalltooth sawfish under Alternative 1 or Alternative 2 because neither species nor critical habitat for either species occurs in non-territorial waters of the NSWC PCD Study Area.

4.3.4 Essential Fish Habitat

The designation of essential fish habitat is required under the Magnuson-Stevens Fishery Conservation and Management Act for any fish species covered by a management plan. EFH is defined as the waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. A federal agency must consult with NMFS regarding any action undertaken, funded, or authorized that may adversely affect EFH. Adverse effects are defined as effects that reduce quality and/or quantity of EFH and may include contamination, physical disruption, loss of prey, and reduction in species' fecundity (fertility).

The Act also identifies a second, more limited habitat designation in addition to EFH—HAPC. The Florida Middle Grounds is located within the non-territorial waters of W-470 and is the only

HAPC located within the NSWC PCD Study Area. HAPCs are subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. EFH has been identified for several species within the NSWC PCD Study Area (Table 3-11 in Chapter 3). Habitat types include hardbottom, softbottom, estuaries, reefs, wrecks, inshore areas, oyster reefs, and vegetated bottom. Hardbottom, estuaries, reefs, inshore areas, and submerged vegetation are addressed in Section 4.3.1, Marine Habitats. Again, shipwreck locations are shown in Figure 3-8, and are considered comparable to artificial reefs in terms of vulnerability to NSWC PCD activities occurring within the NSWC PCD Study Area. Oyster reefs have not been identified in SAB. Softbottom areas may consist of sand, silt, clay, mud, or some combination of these substances. This type of substrate comprises the great majority of substrate in the NSWC PCD Study Area.

4.3.4.1.1 Territorial Waters – Essential Fish Habitat

All operations that have the potential to disturb the sea floor (i.e., mine placement, detonations, crawler operations, etc.) will not be conducted within the boundaries of seagrasses, hardbottom areas, coral reefs, and wrecks in accordance with the protective measures described in Chapter 5. Therefore, in accordance with NEPA, there will be no significant impact to EFH from operations conducted in territorial waters with the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the MSA, there will be no adverse effect to EFH from operations conducted in territorial waters with the No Action Alternative, Alternative 1, or Alternative 2.

4.3.4.1.2 Non-Territorial Waters – Essential Fish Habitat

Softbottom areas will be the primary habitat type to be affected by NSWC PCD operations occurring in non-territorial waters. There will be no crawler operations or line charges in the non-territorial waters, and all detonations associated with this alternative will occur within the water column and are not expected to impact the bottom. Thus, the only bottom-disturbing activity conducted will be the placement of inert mines, MLO, and VEMs. All operations that have the potential to disturb the sea floor (i.e., mine placement, detonations, etc.) will not be conducted within the boundaries of seagrasses, hardbottom areas, coral reefs, and wrecks in accordance with the protective measures described in Chapter 5. Therefore, in accordance with EO 12114, there will be no significant harm to EFH from operations conducted in non-territorial waters with the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the MSA, there will be no adverse effect to EFH from operations conducted in non-territorial waters with the No Action Alternative, Alternative 1, or Alternative 2.

4.3.5 Birds

4.3.5.1 Birds (Air Operations)

4.3.5.1.1 Introduction and Approach to Analysis – Birds (Air Operations)

The use of helicopters during some missions could potentially expose birds to air-generated sound. The duration of flights could occur up to four hours per operation with tests occurring up to several times per week. Studies of in-air hearing in birds shows that behavioral measurement of absolute auditory sensitivity in a wide variety of birds show a region of maximum sensitivity between 1 and 5 kHz (NMFS, 2003a).

4.3.5.1.2 Territorial Waters – Birds (Air Operations)

Effects to seabirds are not expected because the sensitivity of hearing in seabirds is in a lower frequency range than that produced during air operations. The approaching aircraft will likely cause the birds to leave the area temporarily and return when operations cease. Therefore, based on the hearing sensitivity of seabirds and their temporary behavioral response to operations, in accordance with NEPA, there will be no significant impact to birds from air operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.5.1.3 Non-Territorial Waters – Birds (Air Operations)

Source levels of helicopter sound, and resulting received sound for birds, for operations in non-territorial waters will not differ from operations in territorial waters. The hearing range for birds is lower than the level produced by aircraft operations during NSWC PCD RDT&E activities in non-territorial waters. Any birds that are disturbed by flights will leave the immediate area temporarily and return after operations conclude. Therefore, based on the hearing sensitivity of seabirds and their temporary behavioral response to operations, in accordance with EO 12114, there will be no significant harm to birds in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.5.2 Birds (Sonar Operations)

4.3.5.2.1 Introduction and Approach to Analysis

NMFS issued an Environmental Assessment in 2003 for the purpose of determining whether to issue a scientific research permit for "takes" of gray whales by "level B harassment" in accordance with the Marine Mammal Protection Act of 1972 (MMPA). As part of the environmental documentation, seabirds were analyzed for potential effects associated with exposure to the active sonar. Little is known about the general hearing or underwater hearing capabilities of birds, but research suggests an in-air maximum auditory sensitivity between 1 and 5 kHz (NMFS, 2003a). Although the potential hearing capability of seabirds was outside the proposed high-frequency of 20 kHz, it was concluded effects were unlikely even if some diving birds were able to hear the signal for the following reasons:

- There is no evidence seabirds use underwater sound.
- Seabirds spend a small fraction of time submerged.
- Seabirds could rapidly fly away from the area and disperse to other areas if disturbed.
- It is scientifically reasonable to extend these reasons to mid- and high-frequency active sonar as well.

4.3.5.2.2 Territorial Waters – Birds (Sonar Operations)

While seabirds are likely to hear some mid-frequency sounds in-air, there is no scientific evidence to suggest birds can hear these sounds underwater. Additionally, little published literature exists on the effects of underwater sound to diving birds. A review of available articles indicates that the most extensive research has focused on pile-driving and seismic surveys.

During these studies, airguns have not caused any harm (Turnpenny and Nedwell, 1994). Moreover, seabirds spend a short period of time underwater; thus, it is extremely unlikely that the dive of a seabird will coincide with the exact moment of a sonar ping. Therefore, based on the best available scientific data and the low likelihood that a seabird dive would exactly coincide with a sonar ping, in accordance with NEPA, there will be no significant impact to seabirds from active sonar activities in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.5.2.3 Non-Territorial Waters – Birds (Sonar Operations)

The potential effects to birds in non-territorial waters will be similar to effects in territorial waters. Although the number of hours will increase here, no scientific evidence exists to show that birds can hear mid-frequency sounds underwater. Furthermore, it is extremely unlikely that active sonar use will coincide with the dive of a seabird particularly because seabirds spend a short period of time underwater. Thus, based on the best available scientific data and the low likelihood that a seabird dive would exactly coincide with a sonar ping, in accordance with EO 12114, there will be no significant harm to seabirds from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.5.3 Laser Operations – Birds

4.3.5.3.1 Introduction and Approach to Analysis

One of the main concerns with the use of lasers is the potential to damage the vision of sea birds and migratory birds. Lustick (1973) conducted an experiment using pulsing light, which indicated that starlings and gulls were able to look directly into the laser beam and not change their behavior. A later study conducted through the National Wildlife Research Center's Mississippi Field Station, demonstrated that there was no eye damage to double-crested cormorants that had been exposed to a moderate-power red laser as close as three feet (National Wildlife Research Center, 2004).

For several decades, pulsing light has been used on aircraft, aircraft hangers, and high towers as a means of avian management or bird control. In 2001, the U.S. Department of Agriculture's (USDA) National Wildlife Research Center (NWRC) conducted research on low- to moderate – power, long-wavelength lasers (630-650 nm) as an effective, environmentally safe means of dispersing specific bird species under low-light (sunset to dusk) conditions (Blackwell et al., 2002). Results of the USDA research concluded that waterfowl species – wading birds, gulls, vultures, and American crows – have all exhibited avoidance of laser beam during field trials (Blackwell et al., 2002). However, avoidance reaction times and duration is dependent upon context and species (Blackwell et al., 2002). In general, diurnal birds, or birds that are active during the day and rest during the night, are not sensitive to extremely intense laser light and elicit a slow avoidance response to lasers. In contrast, nocturnal birds are more sensitive to light and react more quickly to avoid intense light (Blackwell et al., 2002).

4.3.5.3.2 Territorial Waters – Birds (Laser Operations)

Studies on the potential effects to bird vision and behavior from the use of lasers are limited. However, the species studied that occur in the NSWC PCD Study Area include gulls, double-crested cormorants, and wading birds. Lasers employed by NSWC PCD would be similar to the moderate-powered lasers in the study and therefore, no damaging effects to vision would be anticipated. Furthermore, birds may quickly and easily leave an area temporarily when operations occur (i.e., when vessels and/or helicopters approach) and return when operations conclude. In accordance with NEPA, the Navy concludes that there would be no significant impact to birds from employing the various laser systems based on the best available scientific data on effects to bird vision and behavior from the use of lasers.

4.3.5.3.3 Non-Territorial Waters – Birds (Laser Operations)

Studies on the potential effects to bird vision and behavior from the use of lasers are limited. However, the species studied that occur in the NSWC PCD Study Area include gulls, double-crested cormorants, and wading birds. Lasers employed by NSWC PCD would be similar to the moderate-powered lasers in the study and therefore, no damaging effects to vision would be anticipated. Furthermore, birds may quickly and easily leave an area temporarily when operations occur (i.e., when vessels and/or helicopters approach) and return when operations conclude. In accordance with EO 12114, the Navy concludes that there would be no significant harm to birds from employing the various laser systems based on the best available scientific data on effects to bird vision and behavior from the use of lasers.

4.3.5.4 Ordnance Operations - Birds

4.3.5.4.1 Territorial Waters – Birds (Ordnance Operations)

Ordnance operations during NSWC PCD RDT&E activities have the potential to affect birds, particularly birds at rest on the water's surface and diving birds, which could be injured or killed if an underwater detonation occurred nearby. This possibility is considered remote because seabirds can quickly and easily leave an area temporarily when vessels and/or helicopters approach and return when operations conclude. Furthermore, seabirds spend a short period of time underwater and it is extremely unlikely that a detonation will coincide with the dive of a seabird. During studies conducted on pile-driving and seismic surveys, airguns were not found to have caused any harm. Explosives have only resulted in injury when the seabirds occurred near the detonation (Turnpenny and Nedwell, 1994).

In addition, with the majority of the tests including only small detonations (less than 4.5 kg, or 10 lbs) with no successive charges and up to three line charges per year, overall effects will not imperil any bird populations. Migratory bird flyway corridors in the vicinity of the NSWC PCD Study Area are shown in Figure 3-7 in Chapter 3. In accordance with NEPA, based on the best available scientific data coupled with the temporary behavioral response by birds to operations and the low likelihood that a seabird dive would closely coincide with a detonation, there will be no significant impact to birds from ordnance operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.5.4.2 Non-Territorial Waters – Birds (Ordnance Operations)

No Action Alternative – Birds (Ordnance Operations, Non-Territorial)

With the No Action Alternative, no ordnance operations will occur in non-territorial waters. .

Alternatives 1 & 2 – Birds (Ordnance Operations, Non-Territorial)

Potential effects to birds in non-territorial waters will be similar to those with the No Action Alternative for territorial waters. Although there will be up to 16 large detonations (34 to 45 kg [76 to 100 lbs]) annually, the area affected will only be a small portion of the entire GOM. In addition, the detonations will be spread out in time and location and there will be no successive charges.

Seabirds can quickly and easily leave an area when vessels and/or helicopters approach. It is reasonable to assume, therefore, that birds will temporarily leave an area prior to ordnance detonation and return once operations conclude. Furthermore, seabirds spend a short period of time underwater and it is extremely unlikely that a detonation will coincide with the dive of a seabird. It is anticipated that the quantity of birds affected will not imperil any bird populations. Thus, based on the best available scientific data coupled with the temporary behavioral response by birds to operations and the low likelihood that a seabird dive would closely coincide with a detonation, in accordance with EO 12114, there will be no significant harm to birds in non-territorial waters under Alternative 1 or Alternative 2.

4.3.6 Marine Mammals

4.3.6.1 Air Operations

4.3.6.1.1 Introduction and Approach to Analysis (Air Operations)

The sound levels used in analyzing the potential effects that air operations may have on marine mammals will be identical to those presented in Section 4.3.3.1.

4.3.6.1.2 Territorial Waters – Marine Mammals (Air Operations)

The maximum underwater sound level potentially experienced by marine animals from air operations is expected to be 130 decibels referenced to 1 micropascal squared second (dB re 1 μPa^2-s). This level will be experienced at 1 m (3.2 ft) with a helicopter flying at an altitude of 15 m (49 ft). This altitude is below the operating altitude during air operations during NSWC PCD RDT&E activities.

Furthermore, many marine mammals dive deep and for extended periods of time. Marine mammals present in the territorial waters of the NSWC PCD Study Area include bottlenose dolphins and Atlantic spotted dolphins. These species are considered intermediate divers (Pabst et al., 1999). Therefore, the time that these dolphins spend at the surface or just 1 m (3.2 ft) below it is likely less than the accumulated length of time they spend at depth. Based on the maximum sound levels and the dive characteristics of marine mammals in territorial waters, the Navy has determined that there will be no reasonably foreseeable exposures of marine mammals to sound likely to result in Level A or Level B harassment from air operations under the No Action Alternative, Alternative 1, or Alternative 2. Therefore, in accordance with NEPA, there will be no significant impact to marine mammals from air operations in territorial waters under the No Action Alternative, Alternative 1, and Alternative 2. In addition, in accordance with the ESA, the Navy finds that air operations in territorial waters will have no effect on threatened or endangered marine mammal species because no ESA-listed species occur here.

4.3.6.1.3 Non-Territorial Waters – Marine Mammals (Air Operations)

Potential effects to marine mammals in non-territorial waters will be the same as those described for territorial waters. The level of sound transmitted into the underwater environment will be no greater than 130 dB re 1 μPa^2-s. In addition to the Atlantic spotted and bottlenose dolphin that occur in territorial waters, additional species of dolphin and some whales have been documented in the NSWC PCD Study Area. Many of the whale species that occur in non-territorial waters dive for extended periods of time. For example, the sperm whale may dive for as long as two hours before coming to the surface to breathe (Elsner, 1999). Therefore, the likelihood of a whale surfacing or coming within 1 m (3.2 ft) of the surface at the same time a helicopter flies above the same location is unlikely.

Based on the level of sound transmitted into the water and the characteristics of many of the species occurring in the non-territorial waters, the Navy has determined that there will be no reasonably foreseeable exposures of marine mammals to sound likely to result in Level A or Level B harassment from air operations under the No Action Alternative, Alternative 1, or Alternative 2. Therefore, in accordance with EO 12114, there will be no significant harm to marine mammals from air operations in non-territorial waters under the No Action Alternative, Alternative 1 and Alternative 2. In addition, in accordance with the ESA, the Navy finds that air operations in non-territorial waters will have no effect on threatened or endangered species based on the previous analysis.

4.3.6.2 Surface Operations – Marine Mammals

4.3.6.2.1 Introduction and Approach to Analysis (Surface Operations)

Typical operations occurring at the surface includes the deployment or towing of MCM equipment, retrieval of equipment, and clearing and monitoring for non-participating vessels. As such, the potential exists for a vessel to strike a marine mammal while conducting Surface Operations. In an effort to reduce the likelihood of a vessel strike, the protective measures described in Chapter 5 will be implemented. The following sections will discuss the potential for vessel strikes relative to the three alternatives occurring in territorial and non-territorial waters.

4.3.6.2.2 Territorial Waters – Marine Mammals (Surface Operations)

Collisions with commercial and U.S. Navy vessels can cause major wounds and may occasionally cause fatalities to marine mammals. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). Laist et al. (2001) identified 11 species known to be hit by ships. Of these species, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly. More specifically, from 1975 through 1996, there were 31 dead whale strandings involving four large whales along the GOM coastline. Stranded animals included two sei whales, four minke whales, eight Bryde's whales, and 17 sperm whales. Only one of the stranded animals, a sperm whale with propeller wounds found in Louisiana on 9 March 1990, was identified as a result of a possible ship strike (Laist et al., 2001). In addition, from 1999 through 2003, there was only one stranding involving a false killer whale in the northern GOM (Alabama 1999) (Waring et al., 2006). None of these identified species are likely to occur in the territorial waters of the NSWC PCD Study Area. This area encompasses waters that are less than 33 m (108 ft) in depth and it is unlikely any species including Bryde's whales are located here.

In addition, manatee mortality statistics from 1986 through 2005 list four watercraft-related manatee deaths in Taylor and Wakulla Counties. The May 1997 death in Taylor County occurred in the Steinhatchee River; the June 2000 death in Wakulla County occurred in St. Marks River; the April 2002 death in Taylor County occurred in the GOM; and the June 2004 death in Wakulla County occurred in the Wakulla River (FWC, 2007c). Details regarding the circumstances or the type of ship (i.e., naval, commercial, recreational, etc.) involved in these four strikes are not available. The NSWC PCD Study Area does not include Taylor or Wakulla County. Although manatees have been sporadically sighted in the NSWC PCD Study Area, their occurrence is unlikely because this area is to the north and west of their preferred habitat and outside of conditions for their optimal habitat. Therefore, there will be no effect to manatees from vessel strikes.

It is unlikely that activities in territorial waters will result in a vessel strike because of the nature of the operations and size of the vessels. For example, the hours of surface operations take into consideration operation times for multiple vessels during each test event. These vessels range in size from small rigid hull inflatable boat (RHIB) to surface vessels of approximately 180 feet. The majority of these vessels are small RHIBs and medium-sized vessels. A large proportion of the timeframe for NSWC PCD test events include periods when vessels remain stationary within the test site. The greatest time spent in transit for tests includes navigation to and from the sites. At these times, the Navy follows standard operating procedures (SOPs). The captain and other crew members keep watch during vessel transits to avoid objects in the water. Furthermore, the proposed protective measures described in Chapter 5 will ensure that no vessel strikes will occur. As such, the Navy has determined that there will be no reasonably foreseeable injury or mortality of marine mammals by surface operations in territorial waters with the No Action Alternative. Therefore, based on the characteristics of NSWC PCD RDT&E activities coupled with the fact that the marine mammals most likely to be struck by boats do not regularly occur within territorial waters of the NSWC PCD Study Area and the implementation of protective measures, in accordance with NEPA, there will be no significant impact to marine mammals from surface operations in territorial waters under the No Action Alternative, Alternative 1, and Alternative 2. In addition, in accordance with the ESA, the Navy finds that there will be no effect on threatened or endangered species from surface operations in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 because no ESA-listed marine mammals regularly occur here and the Navy will implement protective measures to avoid direct strikes.

4.3.6.2.3 Non-Territorial Waters – Marine Mammals (Surface Operations)

As stated in Section 4.3.6.2.2., there are six reports of possible watercraft related marine mammal deaths in the GOM. These deaths include one sperm whale found with propeller wounds in Louisiana in March 1990; one false killer whale in Alabama in 1999; and four manatees in Taylor and Wakulla Counties, Florida, from May 1997 through June 2004 (Laist et al., 2001; Waring et al., 2006; and FWC, 2007c). Although West Indian manatees are expected to inhabit nearshore areas, a few individuals have been sighted offshore. This species is not likely to occur as far offshore as the non-territorial waters of the NSWC PCD Study Area. There are sightings in waters within W-151 (includes Pensacola OPAREA) and W-155 (includes Panama City OPAREA), although manatee experts note that these should be considered anomalies due to the known habitat preferences of this species (DON, 2007). According to the 2005 Stock Assessment Report, no other marine mammal that is likely to occur in the northern GOM has been reported as either seriously or fatally injured from 1999 through 2003 (Waring et al., 2005). Thus, the potential effects to marine mammals in non-territorial waters will be similar to those described in territorial waters.

It is unlikely that activities in territorial waters will result in a vessel strike because of the nature of the operations and size of the vessels. For example, the hours of surface operations take into consideration operation times for multiple vessels during each test event. These vessels range in size from small RHIB to surface vessels of approximately 180 feet. The majority of these vessels are small RHIBs and medium-sized vessels. A large proportion of the timeframe for NSWC PCD test events include periods when vessels remain stationary within the test site. The greatest time spent in transit for tests includes navigation to and from the sites. At these times, the Navy follows SOPs. The captain and other crew members keep watch during vessel transits to avoid objects in the water. In addition, the proposed protective measures and Navy SOPs and protective measures listed in Chapter 5 will ensure that no vessel strikes occur to marine mammals in non-territorial waters. Thus, based on the characteristics of NSWC PCD RDT&E activities and the implementation of protective measures, in accordance with EO 12114, there will be no significant harm to marine mammals from surface operations in non-territorial waters under the No Action Alternative, Alternative 1, and Alternative 2. In addition, in accordance with the ESA, the Navy finds that there will be no effect on threatened or endangered species from surface operations in non-territorial waters with the No Action Alternative, Alternative 1, and Alternative 2 given all of the factors previously described.

4.3.6.3 Sonar Operations – Marine Mammals

NSWC PCD RDT&E activities include sonar operations in the mid- and high-frequency ranges. The majority of operating hours for systems encompass high frequencies; less than 10 percent of the test hours involve mid-frequency systems while over 90 percent of all NSWC PCD RDT&E sonar activities encompass high-frequency sonar systems. The test events differ significantly from major Navy exercises and training. Sonar systems are deployed for short periods of time by NSWC PCD personnel and its customers to evaluate systems while major Navy training involves the use of sonar over long periods of time. Unlike the training environment where the Navy may sometimes deploy multiple sonar systems or may sometimes operate many systems at once from multiple platforms, testing at NSWC PCD involves only one system and a limited number of acoustic sources activated at once. The following subsections present the background information for evaluation of potential exposures marine mammals from active sonar at the NSWC PCD.

MMPA Level A and Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, MMPA Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury is the destruction or loss of biological tissue (DON, 2006; DON, 2006a). The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, the NSWC PCD EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and policies (DON, 2006; DON, 2006a), all injuries (slight to severe) are considered Level A harassment under the MMPA.

Public Law (PL) 108-136 (2004) amended the definition of Level B harassment under the MMPA for military readiness activities, such as this action (and also for scientific research on marine mammals conducted by or on the behalf of the federal government). For military readiness activities, MMPA Level B harassment is now defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered." Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

The amended definition of Level B harassment serves to clarify and codify NMFS's existing interpretation of Level B harassment. The intent of the unique definition of harassment for military readiness activities and specific scientific activities was to provide greater clarity for DoD and the regulatory agencies. In addition the definition now takes a more science-based approach by properly focusing on activities that result in significant behavioral changes in biologically important activities, rather than activities with *de minimus* effects. Replacement of the threshold standard "potential" with "likely" eliminates from consideration those activities that have a mere "potential" to have effects. Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

Some physiological responses to sound exposure can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary threshold shift (TTS) suffers no injury to its auditory system but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns—the animal is impeded from responding in a normal manner to an acoustic stimulus. The analysis presented in this document assumes that all

TTS (slight or severe) is considered Level B harassment, even if the effect from the temporary impairment is biologically insignificant.

The harassment status of slight behavioral disruption (without physiological effects as defined in this EIS/OEIS) has been addressed in workshops, previous actions and rulings (DON, 2006). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as Level B harassment. A more general conclusion, that Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent actions and policies (DON, 2006).

Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered Level B harassment. These conclusions and definitions, including the 2004 amendments to the definitions of harassment, were considered in developing conservative thresholds for behavioral disruptions. As a result, the actual incidental harassment of marine mammals associated with this action may be less than calculated.

MMPA Exposure Zones

Two acoustic modeling approaches are used to account for both physiological and behavioral effects to marine mammals. This subsection on exposure zones is specific to the modeling of total energy. When using a threshold of accumulated energy, the volumes of ocean in which Level A and Level B harassment are predicted to occur are called "exposure zones." As a conservative estimate, all marine mammals predicted to be in an exposure zone are considered exposed to accumulated sound levels that may result in harassment within the applicable Level A or Level B harassment categories. Figure 4-1 illustrates exposure zones extending from a hypothetical, directional sound source

The Level A exposure zone extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes into account all more serious injuries within the Level A exposure zone.

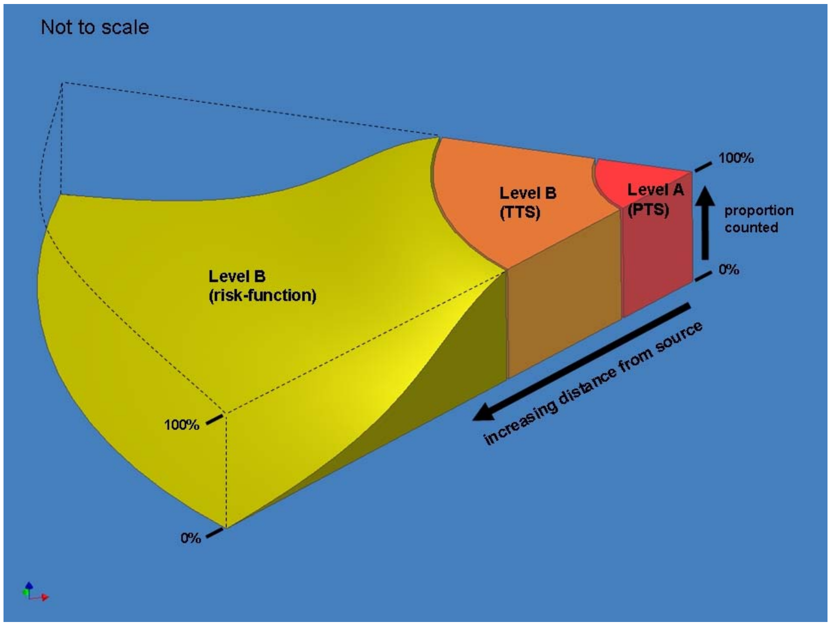


Figure 4-1. Illustration of the Acoustic Effect Framework Used in this EIS/OEIS

The Level B exposure zone begins just outside the point of slightest injury and extends outward from that point to include all animals that may possibly experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue. The animals predicted to be in this zone are assumed to experience Level B harassment by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior.

Auditory Tissues as Indicators of Physiological Effects

Exposure to continuous-type sound may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward, 1997). Exposure to high-intensity, continuous-type sounds of sufficient duration may cause injury to the lungs and intestines (e.g., Dalecki et al., 2002). Sudden, intense sounds may elicit a "startle" response and may be followed by an orienting reflex (Ward, 1997; Jansen, 1998). The primary physiological effects of sound, however, are on the auditory system (Ward, 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the middle ears to fluids within the inner ear, except in cetaceans. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to overstimulation by sound exposure (Yost, 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost, 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a sound-induced threshold shift, or simply a threshold shift (TS) (Miller, 1974). A TS may be either permanent, in which case it is called a permanent threshold shift (PTS), or temporary (TTS), in which case it is called a temporary threshold shift (TTS). PTS does not equal permanent hearing loss; it is more correctly described as a permanent loss of hearing sensitivity, usually over a subset of the animal's hearing range. Similarly, TTS is a temporary hearing sensitivity loss, usually over a subset of the animal's hearing range. Still lower levels of sound may result in auditory masking, which may interfere with an animal’s ability to hear other concurrent sounds.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, PTS and TTS are used in this EIS/OEIS as the biological indicators of physiological responses that qualify as harassment. TTS is the first indication of physiological noninjurious change and is not physical injury. The remainder of this section is, therefore, focused on TSs, including PTSs and TTSs. Since masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect for this assessment but rather a potential behavioral effect.

Sound-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy leads to approximately equal effects (Ward, 1997). For intermittent sounds, less TS occurs than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1966; Ward, 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the initial TS. If the TS activity returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al., 1998). For example, TTS_2 means a TTS measured two minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 4-2 shows two hypothetical TSs: one that completely recovers (a TTS) and one that does not completely recover, leaving some PTS.

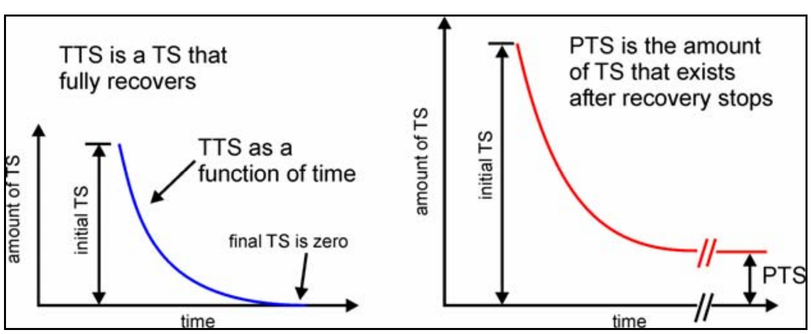


Figure 4-2. Hypothetical Temporary and Permanent Threshold Shifts

PTS, TTS and Exposure Zones

PTS is nonrecoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS, therefore, qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In this EIS/OEIS, the smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A exposure zone.

TTS is recoverable and, as in recent rulings (NOAA, 2001; 2002a), is considered to result from the temporary, noninjurious distortion of hearing-related tissues. In the NSWC PCD Study Area, the smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the Level B exposure zone attributable to a physiological impairment, and within which all animals are assumed to incur Level B harassment. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, in this EIS/OEIS, the potential for TTS is considered as a Level B harassment that is mediated by a physiological effect upon the auditory system.

ESA Harm and Harassment

Sound exposure criteria and thresholds relevant to MMPA regulations were developed using the MMPA Level A and Level B definitions. Regulations established by the ESA establish different criteria for determining impacts to animals covered by the ESA. ESA regulations define harm as "an act which actually kills or injures" fish or wildlife (50 CFR 222.102). Based on this definition, if any ESA-listed marine mammal is predicted to experience a MMPA Level A harassment, then that species is considered to potentially experience ESA harm.

ESA regulations do not define harassment, nor has NMFS defined this term pursuant to the ESA through regulation. However, under the 1994 Amendments to the MMPA, harassment was defined for military readiness activities, as "any act that disrupts or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered" (Public Law 106-136, 2004).

As used in this document, ESA harassment is defined as an intentional or unintentional human act or omission that creates the probability of impact to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents. Based on this definition, if any ESA-listed marine mammal is predicted to experience a MMPA Level B harassment, then that species is considered to potentially experience ESA harassment.

Criteria and Thresholds for Physiological Effects

This section presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. The tissues of the ear are the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. This section is, therefore, focused on criteria and thresholds to predict PTS and TTS in marine mammals.

The most appropriate information from which to develop PTS/TTS criteria for marine mammals is experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be developed from TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this EIS/OEIS are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and sound pressure level (SPL), and the use of SPL and EL in previous environmental compliance documents.

Energy Flux Density Level and Sound Pressure Level

EL is a measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re 1 μPa^2-s for underwater sound and dB re 20 μPa^2-s for airborne sound.

SPL is a measure of the root-mean square, or "effective," sound pressure in decibels. SPL is expressed in dB re 1 μPa for underwater sound and dB re 20 μPa for airborne sound.

TTS in Marine Mammals

A number of investigators have measured underwater TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset TTS levels—exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (e.g., Schlundt et al., 2000). The Navy set TTS to be 6 dB for the analysis. The existing marine mammal TTS data are summarized in the following paragraphs.

Schlundt et al. (2000) reported the results of TTS experiments conducted with bottlenose dolphins and beluga whales exposed to one second tones. This paper also includes a re-analysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kilohertz (kHz), SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 μPa (EL = 192 to 201 dB re 1 μPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 μPa and 195 dB re 1 μPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two beluga whales) make the Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in this EIS/OEIS.

Finneran et al. (2001, 2003, 2005) described TTS experiments conducted with bottlenose dolphins exposed to 3 kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 μPa^2-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.

Nachtigall et al. (2003, 2004) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall et al. (2003) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of sound with SPL 179 dB re 1 μPa (EL about 213 dB re μPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 μPa. Nachtigall et al. (2004) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of sound with SPL 160 dB re 1 μPa (EL about 193 to 195 dB re 1 μPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall et al. (2003). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.

Finneran et al. (2000, 2002) conducted TTS experiments with dolphins and beluga whales exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic waterguns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.

Kastak et al. (1999, 2005) conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal, and a Pacific harbor seal exposed to continuous underwater sounds at levels of 80 and 95 dB Sensation Level (SL) at 2.5 and 3.5 kHz for up to 50 minutes. Mean TTS shifts of up to 12.2 dB occurred with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Figure 4-3 shows the existing TTS data for cetaceans (dolphins and beluga whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al., 2000 and 2002, respectively. The circles show the 3, 10, and 20 kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2004).

Figure 4-3 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration.

The solid line in the upper panel of Figure 4-3 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 µPa and the exposure duration is 1 second. Since EL = SPL + $10\log_{10}$ (duration), doubling the duration *increases* the EL by 3 dB. Subtracting 3 dB from the SPL *decreases* the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an *equal energy line* – all points on the line have the same EL, which is, in this case, 195 dB re 1 µPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 µPa^2-s. The equal energy line at 195 dB re 1 µPa^2-s fits the tonal and sound data (the nonimpulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.

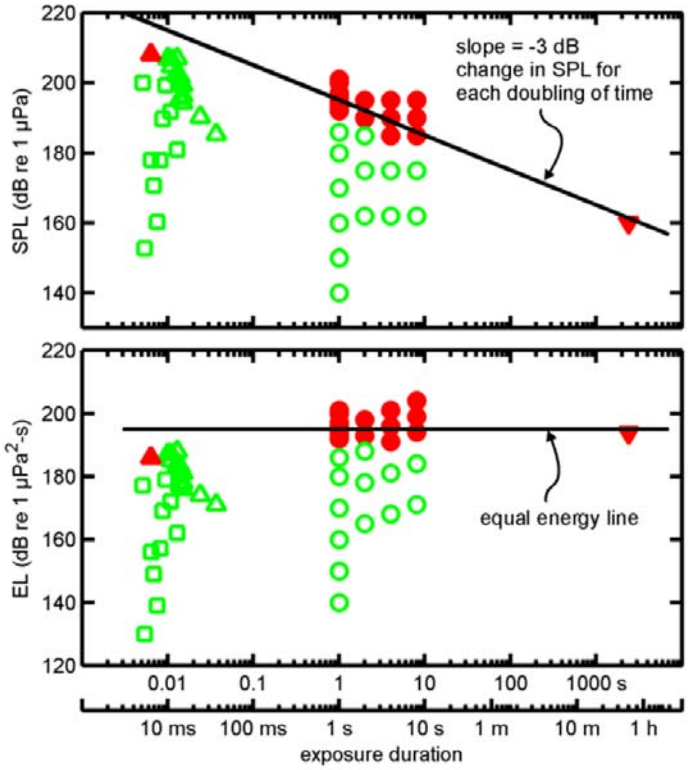
In summary, the existing marine mammal TTS data show that, for the species studied and sounds (nonimpulsive) of interest, the following is true:

- The growth and recovery of TTS are comparable to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Ward, 1997).

- SPL by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.

- Exposure EL is correlated with the amount of TTS and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).

- An EL of 195 dB re 1 µPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure.



Legend:

Filled symbol:	Exposure that produced TTS
Open symbol:	Exposure that did not produce TTS
Squares:	Impulsive test results from Finneran et al., 2000
Triangles:	Impulsive test results from Finneran et al., 2002
Circles:	3-, 10-, and 20-kHz data from Schlundt et al. (2000) and results of Finneran et al. (2003a)
Inverted triangle:	Data from Nachtigall et al., 2003b

Figure 4-3. Existing TTS Data for Cetaceans

Relationship Between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS_2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al., 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.

- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS — how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward, 1960; Ward et al., 1958, 1959). Ward et al. (1959) also reported slower recovery times when TTS_2 approached and exceeded 50 dB, suggesting that 50 dB of TTS_2 may represent a "critical" TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: "A TTS_2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent." These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few minutes to hours), TTS_2 varies with the logarithm of exposure time (Ward et al., 1958, 1959; Quaranta et al., 1998). For shorter exposure durations, the growth of TTS with exposure time appears to be less rapid (Miller, 1974; Keeler, 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al., 1977; Mills et al., 1979).

Ward et al. (1958, 1959) provided detailed information on the growth of TTS in humans. Ward et al. presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 4-4 shows results from Ward et al. (1958, 1959) plotted as the amount of TTS_2 versus the exposure EL. The data in Figure 4-4(a) are from broadband (75 hertz [Hz] to 10 kHz) sound exposures with durations of 12 to 102 minutes (Ward et al., 1958). The symbols represent mean TTS_2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 4-4(a) is approximately 1.5 dB TTS_2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS_2.

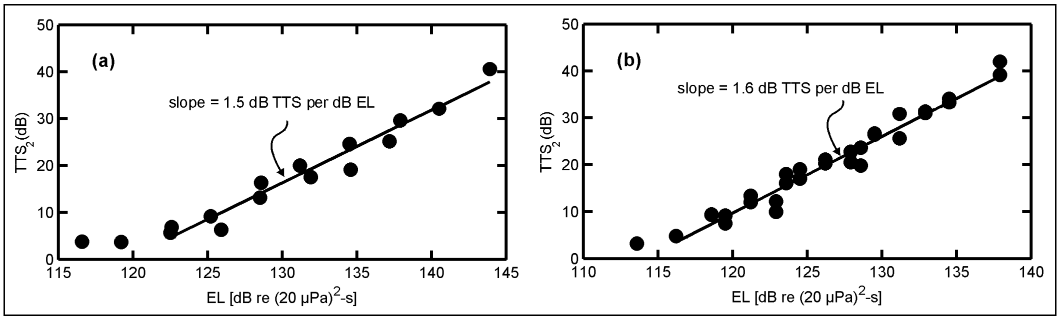


Figure 4-4. Growth of TTS versus the Exposure EL
(from Ward et al. [1958, 1959])

The data in Figure 4-4(b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 minutes (Ward et al., 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest exposure EL. The results are similar to those shown in Figure 4-4(a). The slope of the regression line fit to the mean TTS data was 1.6 dB TTS_2/dB EL. A similar procedure was carried out for the remaining data from Ward et al. (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS_2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS_2 per dB increase in exposure EL is the upper range of values from Ward et al. (1958, 1959) and gives the most conservative estimate—it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation. To summarize:

- In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:
- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the growth rate of TTS, i.e., determining how much additional TTS is produced by an increase in exposure level.
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative estimate is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.
- Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS_2 and exposure EL. A 1.6 dB TTS_2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous-type sounds.

- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

Threshold Levels for Harassment from Physiological Effects

For this specified action, sound exposure thresholds for TTS and PTS are as presented in the following box:

195 dB re 1 μPa^2-s received EL for TTS
215 dB re 1 μPa^2-s received EL for PTS

Marine mammals predicted to receive a sound exposure with EL equal to or greater than the PTS threshold are assumed to experience PTS and are counted as Level A harassment exposures. Marine mammals predicted to receive a sound exposure with EL greater than or equal to the TTS threshold but less than the PTS threshold are assumed to experience TTS and are counted as Level B harassment exposures.

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 μPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2000 and 2003) and the long-duration sound data from Nachtigall et al. (2003, 2004). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s.

The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

Use of EL for Physiological Effect Thresholds

Thresholds for PTS/TTS are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds (non-impulsive sounds) of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 µPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 µPa and duration = 2 seconds.

The EL for each individual ping is calculated from the following equation:

$$EL = SPL + 10\log_{10}(\text{duration})$$

The EL includes both the ping SPL and duration. Longer duration pings and/or higher-SPL pings will have a higher EL. The analysis in this EIS/OEIS used a conservative approach where the sonars were modeled at a worst case scenario using the assumption that the sonar was pinging for the entire duration of each hour modeled at the given interval for each system. Lengths of pings range from fractions of seconds to up to 3 seconds long. Refer to Table M-4 in Appendix M for the actual duration used for acoustical modeling.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammals exhibit lower TSs from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the severity of a particular exposure. Therefore, estimates are conservative because recovery is not taken into account—intermittent exposures are considered comparable to continuous exposures.

Summary of Criteria and Thresholds for Physiological Effects

PTS and TTS are used as the criteria for physiological effects resulting in injury (Level A harassment) and disturbance (Level B harassment), respectively. Sound exposure thresholds for TTS and PTS are 195 dB re 1 μPa^2-s received EL for TTS and 215 dB re 1 μPa^2-s received EL for PTS. The TTS threshold is primarily based on cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on extrapolations from terrestrial mammal data indicating that PTS occurs at 40 dB or more of TS, and that TS growth occurring at a rate of approximately 1.6 dB/dB increase in exposure EL.

Analytical Methodology – MMPA Behavioral Harassment For MFA/HFA Sources

<u>Background</u>

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individuals, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al., 1995; Wartzok et al., 2003; Southall et al., 2007). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

It is possible that some marine mammal behavioral reactions to anthropogenic sound may result in strandings. Several "mass stranding" events—strandings that involve two or more individuals of the same species (excluding a single cow-calf pair)—that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Sonar exposure has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Advisory Committee Report on Acoustic Impacts on Marine Mammals, 2006). Based on geographic features of the NSWC PCD Study Area and the number, types, and intensity of NSWC PCD RDT&E activities performed, stranding events are not expected in the NSWC PCD Study Area.

In these circumstances, exposure to acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al., 2006). A popular hypothesis regarding a potential cause of the strandings is that tissue damage results from a "gas and fat embolic syndrome" (Fernandez et al., 2005; Jepson et al., 2003; 2005). Models of nitrogen saturation in diving marine mammals have been used to suggest that altered dive behavior might result in the accumulation of nitrogen gas such that the potential for nitrogen bubble formation is increased (Houser et al., 2001; Zimmer and Tyack, 2007). If so, this mechanism might explain the findings of gas and bubble emboli in stranded beaked whales. It is also possible that stranding is a behavioral response to a sound under certain contextual conditions and that the subsequently observed physiological effects of the strandings (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding versus exposure to sonar (Cox et al., 2006).

Methodology for Applying Risk Function

Risk Function Adapted from Feller (1968)

The particular acoustic risk function developed by the Navy and NMFS estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) for the probability as defined in the SURTASS LFA Sonar Final OEIS/EIS (U.S. Department of the Navy, 2001c), and relied on in the Supplemental SURTASS LFA Sonar EIS (U.S. Department of the Navy, 2007d) for the probability of MFA sonar risk for MMPA Level B behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes and odontocetes.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in U.S. Department of the Navy (2001), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L - B}{K} \right)^{-A}}{1 - \left(\frac{L - B}{K} \right)^{-2A}}$$

Where: R = risk (0 – 1.0);
L = received level (RL) in dB;
B = basement RL in dB; (120 dB);
K = the RL increment above basement in dB at which there is 50 percent risk;
A = risk transition sharpness parameter (A=10 odontocetes; A=8 mysticetes) (explained in *Input Parameters for the Risk Function*: *Risk Transition—The A Parameter*).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. As further explained in the section titled *Input Parameters for the Risk Function*, the values used in this analysis are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran, et al., (2001, 2003, and 2005) and Finneran and Schlundt (2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in Department of Commerce (National Marine Fisheries Service, 2005); U.S. Department of the Navy (2004); and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004a). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

Data Sources Used for Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments (Cox et al., 2006l Southall et al., 2007). The Navy is contributing to an ongoing behavioral response study in the Bahamas that is anticipated to provide some initial information on beaked whales, the species identified as the most sensitive to MFA sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures.

Until additional data is available, NMFS and the Navy have determined that the following three data sets are most applicable for the direct use in developing risk function parameters for MFA/HFA sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources. Until applicable data sets are evaluated to better qualify harassment from HFA sources, the risk function derived for MFA sources will apply to HFA.

Data from SSC's Controlled Experiments: Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al., 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al., 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Schlundt et al., 2000, Finneran et al., 2002). Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 micropascal (μPa) root mean square (rms), and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al., 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al., 1997; Schlundt et al., 2000).

Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, 2005) experiments featuring 1-sec tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1μPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000)

reported eight individual TTS experiments. Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000) reported that "behavioral alterations," or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 µPa/Hz), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 µPa were randomly presented.

Data from Studies of Baleen (Mysticetes) Whale Responses: The only mysticete data available resulted from a field experiment in which baleen whales (mysticetes) were exposed to sounds ranging in frequency from 50 Hz (ship noise playback) to 4,500 Hz (alert stimulus) (Nowacek et al., 2004a). Behavioral reactions to an alert stimulus, consisting of a combination of tones and frequency and amplitude modulated signals ranging in frequency from 500 Hz to 4500 Hz, was the only portion of the study used to support the risk function input parameters.

Nowacek et al. (2004a; 2007) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1µPa.

Observations of Killer Whales in Haro Strait in the Wild: In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while the USS Shoup was engaged in MFA sonar operations in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field associated with the sonar operations had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS Shoup provide the only data set available of the behavioral responses of wild, non-captive animals upon exposure to the AN/SQS-53 MFA sonar.

U.S. Department of Commerce (National Marine Fisheries, 2005); U.S. Department of the Navy (2004); Fromm (2004a, 2004b) documented reconstruction of sound fields produced by the USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an estimate of 169.3 dB SPL, which represents the mean received level at a point of closest approach within a 500 m (1,640 ft) wide area in which the animals were exposed. Within that area, the estimated received levels varied from approximately 150 to 180 dB SPL.

Limitations of the Risk Function Data Sources

There are substantial limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.
The risk function presented here is based on three data sets that NMFS and Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data is the most rigorous and applicable for the following reasons:

- The data represents the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the MFA sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to MFA sonar.
- The behavioral responses of marine mammals that were observed in the wild are based solely on an estimated received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
    - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or
    - Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

SSC San Diego Trained Bottlenose Dolphins and Beluga Whales Data Set:

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan, 1998).
- The tests were designed to measure TTS, not behavior.
- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.
- The tones used in the tests were 1-sec pure tones similar to MFA sonar.

North Atlantic Right Whales in the Wild Data Set:

- The observations of behavioral response were from exposure to an alert stimuli that contained mid-frequency components but was not similar to an MFA sonar ping. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-minute alert stimuli is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set:

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the observed response as opposed to baseline conditions.

Input Parameters for the Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined in *Methodology for Applying Risk Function*. The risk continuum function approximates the dose response in a manner analogous to pharmacological risk assessment (U.S. Department of the Navy, 2001, Appendix A). In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

Basement Value for Risk—The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the MFA/HFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the scientists, and has been used in other publications. The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero.

The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS Shoup incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the 5 maximum received levels at which Nowacek et al. (2004a) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

Risk Transition—The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing received level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. NMFS has recommended that Navy use A=10 as the value for odontocetes and A=8 for mysticetes (Figures 4-5 and 4-6) (National Marine Fisheries Service, 2008).

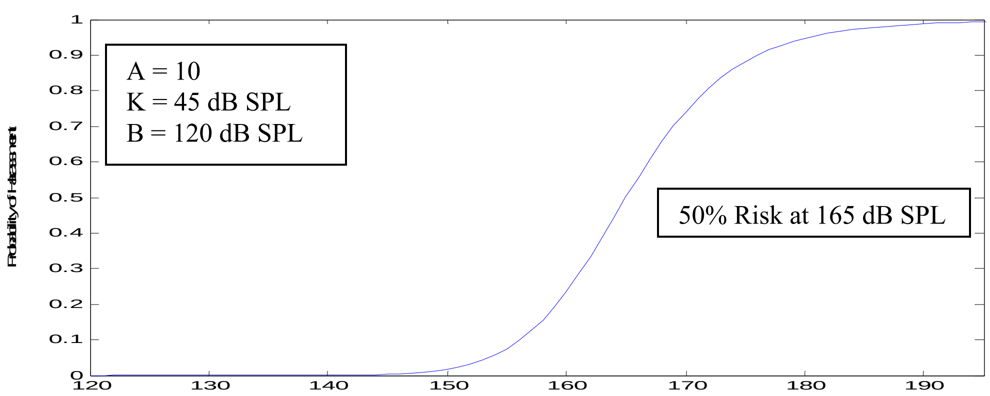


Figure 4-5. Risk Function Curve for Odontocetes (toothed whales)

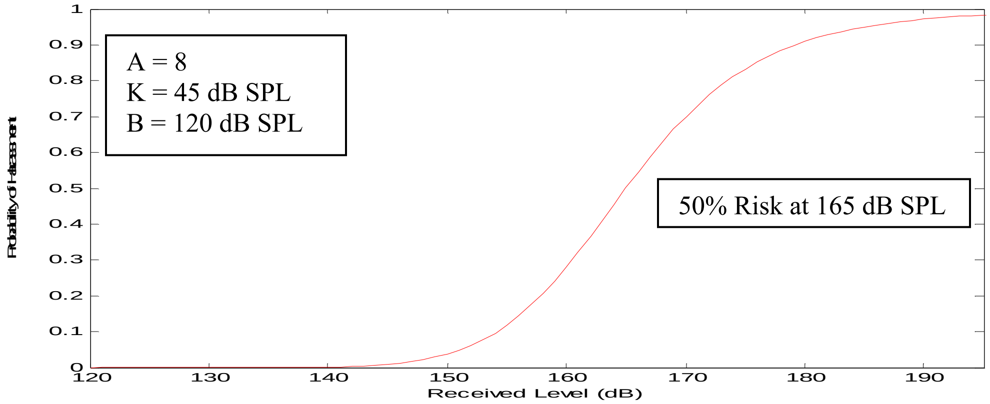


Figure 4-6. Risk Function Curve for Mysticetes (Baleen Whales)

Justification for the Steepness Parameter of A=10 for the Odontocete Curve

The NMFS independent review process described in Section 4.1.2.4.9 of U.S. Department of the Navy (2008) provided the impetus for the selection of the parameters for the risk function curves. One scientist recommended staying close to the risk continuum concept as used in the SURTASS LFA sonar EIS. This scientist opined that both the basement and slope values; B=120 dB and A=10 respectively, from the SURTASS LFA sonar risk continuum concept are logical solutions in the absence of compelling data to select alternate values supporting the Feller-adapted risk function for MFA sonar. Another scientist indicated a steepness parameter needed to be selected, but did not recommend a value. Four scientists did not specifically address selection of a slope value. After reviewing the six scientists' recommendations, the two NMFS scientists recommended selection of A=10. Direction was provided by NMFS to use the A=10 curve for odontocetes based on the scientific review of potential risk functions explained in Section 4.1.2.4.9.2 of U.S. Department of Navy (2008).

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA FEIS (U.S. Department of the Navy, 2001). The analysis was performed to support the A=10 parameter for mysticete whales responding to a low-frequency sound source, a frequency range to which the mysticete whales are believed to be most sensitive to. The sensitivity analysis results confirmed the increased risk estimate for animals exposed to sound levels below 165 dB. Results from the Low Frequency Sound Scientific Research Program (LFS SRP) phase II research showed that whales (specifically gray whales in their case) did scale their responses with received level as supported by the A=10 parameter (Buck and Tyack, 2000). In the second phase of the LFS SRP research, migrating gray whales showed responses similar to those observed in earlier research (Malme et al., 1983, 1984) when the LF source was moored in the migration corridor (2 km [1.1 nm] from shore). The study extended those results with confirmation that a louder SL elicited a larger scale avoidance response. However, when the source was placed offshore (4 km [2.2 nm] from shore) of the migration corridor, the avoidance response was not evident. This implies that the inshore avoidance model – in which 50 percent of the whales avoid exposure to levels of 141 + 3 dB – may not be valid for whales in proximity to an offshore source (U.S. Department of Navy, 2001c). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (U.S. Department of the Navy, 2001c), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al., 1984; Buck and Tyack, 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D, and National Marine Fisheries Service, 2008).

Justification for the steepness parameter of A=8 for the Mysticete Curve

The Nowacek et al. (2004a) study provides the only available data source for a mysticete species behaviorally responding to a sound source (i.e., alert stimuli) with frequencies in the range of tactical mid-frequency sonar (1-10 kHz), including empirical measurements of received levels (RLs). While there are fundamental differences in the stimulus used by Nowacek et al. (2004a) and tactical mid-frequency sonar (e.g., source level, waveform, duration, directionality, likely range from source to receiver), they are generally similar in frequency band and the presence of modulation patterns. Thus, while they must be considered with caution in interpreting behavioral responses of mysticetes to mid-frequency sonar, they seemingly cannot be excluded from this consideration given the overwhelming lack of other information. The Nowacek et al. (2004a) data indicate that five out of the six North Atlantic right whales exposed to an alert stimuli "significantly altered their regular behavior and did so in identical fashion" (i.e., ceasing feeding and swimming to just under the surface). For these five whales, maximum RLs associated with this response ranged from root- mean-square sound (rms) pressure levels of 133-148 dB (re: 1 μPa).

When six scientists (one of them being Nowacek) were asked to independently evaluate available data for constructing a risk function curve based on a solution adapted from Feller (1968), the majority of them (4 out of 6; one being Nowacek) indicated that the Nowacek et al. (2004a) data were not only appropriate but also necessary to consider in the analysis. While other parameters associated with the solution adapted from Feller (1968) were provided by many of the scientists (i.e., basement parameter [B], increment above basement where there is 50 percent risk [K]), only one scientist provided a suggestion for the risk transition parameter, A.

A single curve may provide the simplest quantitative solution to estimating behavioral harassment. However, the policy decision, by NMFS-Office of Protected Resources (OPR), to adjust the risk transition parameter from A=10 to A=8 for mysticetes and create a separate curve was based on the fact that the use of this shallower slope better reflected the increased risk of behavioral response at relatively low RLs suggested by the Nowacek et al. (2004a) data. In other words, by reducing the risk transition parameter from 10 to 8, the slope of the curve for mysticetes is reduced. This results in an increase in the proportion of the population being classified as behaviorally harassed at lower RLs. It also slightly reduces the estimate of behavioral response probability at quite high RLs, though this is expected to have quite little practical result owing to the very limited probability of exposures well above the mid-point of the function. This adjustment allows for a slightly more conservative approach in estimating behavioral harassment at relatively low RLs for mysticetes compared to the odontocete curve and is supported by the only dataset currently available. It should be noted that the current approach (with A=8) still yields an extremely low probability for behavioral responses at RLs between 133-148 dB, where the Nowacek data indicated significant responses in a majority of whales studied. (Note: Creating an entire curve based strictly on the Nowacek et al. [2004a] data alone for mysticetes was advocated by several of the reviewers and considered inappropriate, by NMFS-OPR, since the sound source used in this study was not identical to tactical mid-frequency sonar, and there were only five data points available). The policy adjustment made by NMFS-OPR was also intended to capture some of the additional recommendations and considerations provided by the scientific panel (i.e., the curve should be more data driven and that a greater probability of risk at lower RLs be associated with direct application of the Nowacek et al. 2004a data).

Basic Application of the Risk Function

Relation of the Risk Function to the Current Regulatory Scheme

The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing with MFA sonar) at a given received level of sound. For example, at 165 dB SPL (dB re: 1µPa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables, such as the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al., 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available.

NMFS and the Navy made the decision to apply the MFA risk function curve to HFA sources due to lack of available and complete information regarding HFA sources. As more specific and applicable data become available for MFA/HFA sources, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic. Ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions. As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al., 2003). The distances would influence whether animals might perceive the sound source as a potential threat, and their behavioral responses to that threat. Though there are data showing marine mammal responses to sound sources at particular received levels, NMFS does not currently have any data that describe the response of marine mammals to sounds at a particular distance(or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances. However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates.

Last, pursuant to the MMPA, an applicant is required to estimate the number of animals that will be "taken" by their activities. This estimate informs the analysis that NMFS must perform to determine whether the activity will have a "negligible impact" on the species or stock. Level B (behavioral) harassment occurs at the level of the individual(s) and does not assume any resulting population-level consequences, though there are known avenues through which behavioral disturbance of individuals can result in population-level effects. Alternately, a negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes, alone, is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS must consider other factors, such as the nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), or any of the other variables mentioned in the first paragraph (if known), as well as the number and nature of estimated Level A takes, the number of estimated mortalities, and effects on habitat. Generally speaking, the Navy and NMFS anticipate more severe effects from takes resulting from exposure to higher received levels (though this is in no way a strictly linear relationship throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels. Table 4-30 gives a comparison of behavior harassments projected at each acoustic level band for level of behavioral harassment in the NSWC PCD Study Area. Figure 4-7 compares harassments resulting from risk functions based on increments of five decibels. As shown in the table and figure, less Level B behavioral harassments occur at higher decibel levels; however, the number of Level B harassments at these higher levels encompasses Level B TTS exposures, in addition to the smaller number of behavioral harassments.

Table 4-30. Behavioral Harassments at Each Received Level Band

Received Level	Distance from source at which Levels Occur in the NSWC PCD Study Area	Percent of Behavioral Harassments Occurring at Given Levels
Below 140 dB SPL	18 km - 65 km	<1%
140<Level<150 dB SPL	7.4 km–18 km	2%
150<Level<160 dB SPL	2.7 km–7.4 km	18%
160<Level<170 dB SPL	0.9 km–2.7 km	41%
170<Level<180 dB SPL	230–880 meters	27%
180<Level<190 dB SPL	80–230 meters	11%
Above 190 dB SPL	0–80 meters	<1%

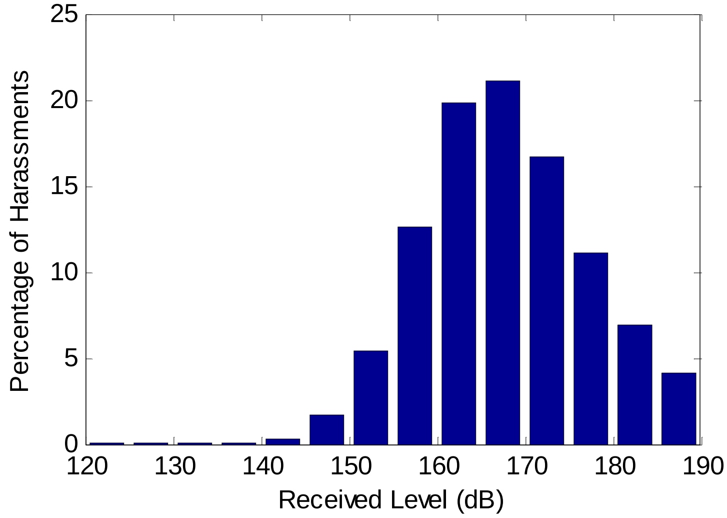


Figure 4-7. The Percentage of Behavioral Harassments Resulting from the Risk Function for Every 5 dB of Received Level

Navy Post Acoustic Modeling Analysis

The quantification of the acoustic modeling results includes additional analysis to increase the accuracy of the number of marine mammals affected. Post modeling analysis includes reducing acoustic footprints where they encounter land masses to better account for the maximum number of individuals of a species that could potentially be exposed to sonar within the course of one day or a discreet continuous sonar event.

Analytical Framework for Assessing Marine Mammal Response to Active Sonar

Marine mammals respond to various types of man-made sounds introduced into the ocean environment. Responses are typically subtle and can include shorter surfacings, shorter dives, fewer blows per surfacing, longer intervals between blows (breaths), ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (NRC, 2005). However, it is not known how these responses relate to significant effects (e.g., long-term effects or population consequences) (NRC, 2005). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. The Navy enlisted the expertise of NMFS as the cooperating agency in the preparation of this EIS/OEIS.

Estimating potential acoustic effects on cetaceans entails answering the following questions:

- **What action will occur?** This requires identification of all acoustic sources that would be used in the RDT&E activities and the specific outputs of those sources.
- **Where and when will the action occur?** The place, season, and time of the action are important to:

- ○ Determine which marine mammal species are likely to be present. Species occurrence and density data (discussed in Section 3.6) are used to determine the subset of marine mammals for consideration and to estimate the distribution of those species.
- ○ Predict the underwater acoustic environment that would be encountered. The acoustic environment here refers to environmental factors that influence the propagation of underwater sound.

- **What are the predicted sound exposures for the species present?** This requires appropriate sound propagation models to predict the anticipated sound levels as a function of source location, animal location and depth, and season and time of the action.
- **What are the potential effects of sound on the species present?** This requires an analysis of the manner in which sound interacts with the physiology of marine mammals and the potential responses of those animals to sound. When possible, specific criteria and numeric values are derived to relate acoustic exposure to the likelihood of a particular effect.
- **How many marine mammals are predicted to be harmed or harassed?** This requires potential effects to be evaluated within the context of the existing regulations. The Section on the *Regulatory Framework* reviews the regulatory framework and premises upon which the effects analyses in this OEIS/EIS are based. Numeric criteria for MMPA harassment are also presented in that section. The *Effects to Threatened and Endangered Marine Mammal Species from Sonar* Section discusses the anticipated acoustic effects to ESA-listed and non-ESA-listed marine mammals.
- **Does the number of marine mammals predicted to be harmed or harassed have a population-, stock-, or species-level effect?** Once the potential number of marine mammals harmed or harassed is predicted, this estimate is compared with the best estimate of abundance for each specific species in the NSWC PCD Study Area. The percentage of harassed or harmed marine mammals is calculated for each species to determine if there is a population-, stock-, or species-level effect.

Conceptual Biological Framework

The regulatory language of the MMPA and ESA requires that all anticipated responses to sound resulting from NSWC PCD RDT&E activities be considered relative to their potential impact on animal growth, survivability and reproduction. Although a variety of effects may result from an acoustic exposure, not all effects will impact survivability or reproduction (e.g., short-term changes in respiration rate would have no effect on survivability or reproduction). Whether an effect significantly affects a marine mammal must be determined from the best available science regarding marine mammal responses to sound.

A conceptual framework has been constructed (Figure 4-9) to assist in ordering and evaluating the potential responses of marine mammals to sound. Although the framework is described in the context of effects of sonars on marine mammals, the same approach could be used for fish, sea turtles, sea birds, etc., that are exposed to other sound sources (e.g., impulsive sounds from explosions); the framework need only be consulted for potential pathways leading to possible effects.

Organization

The framework is a "block diagram" or "flow chart", organized from left to right, and grossly compartmentalized according to the phenomena that occur within each. These include the physics of sound propagation (Physics component), the potential physiological responses associated with sound exposure (Physiology component), the behavioral processes that might be affected (Behavior component), and the life functions that may be immediately affected by changes in behavior at the time of exposure (Life Function – Proximate). These are extended to longer term life functions (Life Function – Ultimate) and into population and species effects.

Throughout the flow chart, dotted and solid lines are used to connect related events. Solid lines are those items which "will" happen, and dotted lines are those which "might" happen, but which must be considered (including those hypothesized to occur but for which there is no direct evidence). Blue dotted lines indicate instances of "feedback", where the information flows back to a previous block. Some boxes are colored according to how they relate to the definitions of harassment in the MMPA, with red indicating Level A harassment (injury) and yellow indicating Level B harassment (behavioral disturbance).

The following sections describe the flowthrough of the framework, starting with the production of a sound, and flowing through marine mammal exposures, responses to the exposures, and the possible consequences of the exposure. Along with the description of each block, an overview of the state of knowledge is described with regard to marine mammal responses to sound and the consequences of those exposures. Application of the conceptual framework to impact analyses and regulations defined by the MMPA and ESA are discussed in subsequent sections.

Physics Component

Sounds emitted from a source propagate through the environment to create a spatially variable sound field. To determine if an animal is "exposed" to the sound, the received sound level at the animal's location is compared to the background ambient noise. An animal is considered exposed if the predicted received sound level (at the animal's location) is above the ambient level of background noise. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal's physiology, responses of the auditory system, and responses of non-auditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and non-auditory tissues.

Physiology Component

Auditory System Response

The primary physiological effects of sound are on the auditory system (Ward, 1997). The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the outer and middle ears to fluids within the inner ear. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to overstimulation by noise exposure (Yost, 1994).

Potential auditory system effects are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity/susceptibility of the exposed animals. Some of these assessments can be numerically based, while others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists. Potential physiological responses to a sound exposure are discussed here in order of increasing severity, progressing from perception of sound to auditory trauma.

No Perception

The received level is not of sufficient amplitude, frequency, and duration to be perceptible to the animal (i.e., the sound is not audible). By extension, this cannot result in a stress response or a change in behavior.

Perception

Sounds with sufficient amplitude and duration to be detected within the background ambient noise are assumed to be perceived (i.e., sensed) by an animal. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing. To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity. Within this conceptual framework, a sound capable of auditory masking, auditory fatigue, or trauma are assumed to be perceived by the animal.

Information on hearing sensitivity exists for approximately 25 of the nearly 130 species of marine mammals. Within the cetaceans, these studies have focused primarily on odontocete species (e.g., Szymanski et al., 1999; Kastelein et al., 2002a; Nachtigall et al., 2005; Yuen et al., 2005; Houser and Finneran, 2006). Because of size and availability, direct measurements of mysticete whale hearing are nearly non-existent (Ridgway and Carder, 2001). Measurements of hearing sensitivity have been conducted on species representing all of the families within the pinnipeds (Phocidae, Otariidae, Odobenidae, Schusterman et al., 1972; Moore and Schusterman, 1987; Terhune, 1988; Thomas et al., 1990a; Turnbull and Terhune, 1990; Kastelein et al., 2002b; Wolski et al., 2003; Kastelein et al., 2005). Hearing sensitivity measured in these studies can be compared to the amplitude, duration and frequency of a received sound, as well as the ambient environmental noise, to predict whether or not an exposed marine mammal will perceive a sound to which it is exposed.

The features of a perceived sound (e.g., amplitude, frequency, duration, and temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences, to the animal from the exposure). Although preliminary because of the small numbers of samples collected, different types of sounds (impulsive vs. continuous broadband vs. continuous tonal) have been shown to produce variable stress responses in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al., 1990b), but showed an increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al., 2004). A dolphin, exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate an elevation in aldosterone, a hormone that has been suggested as being a significant indicator of stress in odontocetes (St.Aubin and Geraci, 1989; St.Aubin et al., 2001). Increases in heart rate were observed in dolphins to which conspecific calls were played, although no increase in heart rate was observed when tank noise was played back (Miksis et al., 2001). Collectively, these results suggest a variable response that depends on the characteristics of the received signal and prior experience with the received signal.

Audible natural and artificial sounds can potentially result in auditory masking, a condition that occurs when a sound interferes with an animal's ability to hear other sounds. Masking occurs when the perception of a sound is interfered with by a second sound and the probability of masking increases as the two sounds increase in similarity. It is important to distinguish auditory fatigue, which persists after the sound exposure, from masking, which occurs during the sound exposure. Critical ratios have been determined for pinnipeds (Southall et al., 2000; Southall et al., 2003) and detections of signals under varying masking conditions have been determined for active echolocation and passive listening tasks in odontocetes (Johnson, 1971; Au and Pawloski, 1989; Erbe, 2000). These studies provide baseline information from which the probability of masking can be estimated. The potential impact to a marine mammal depends on the type of signal that is being masked; important cues from conspecifics, signals produced by predators, or interference with echolocation are likely to have a greater impact on a marine mammal when they are masked than will a sound of little biological consequence.

Unlike auditory fatigue, which always results in a localized stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, since it depends on the degree and duration of the masking effect and the signal that is being masked. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case the change in behavior is the *lack of a response* that would normally be made if sensory impairment did not occur. For this reason masking also may lead directly to behavior change without first causing a stress response.

The most intense underwater sounds in the NSWC PCD Study Area are those produced by sonars and other acoustic sources that are in the mid-frequency or higher range. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal, frequency, and spatial domains. In particular, the pulse lengths are short, the duty cycle low, the total number of hours of operation per year small, and the tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave). Finally, high levels of sound are confined to a volume around the source and are constrained by attenuation at mid- and high-frequencies, as well as by limited beam widths and pulse lengths. For these reasons, the likelihood of sonar operations causing masking effects is considered negligible in this OEIS/EIS.

Auditory Fatigue

The most familiar effect of exposure to high intensity sound is hearing loss, meaning an increase in the hearing threshold. This phenomenon is called a noise-induced threshold shift (NITS), or simply a threshold shift (TS) (Miller, 1974). A TS may be either permanent, in which case it is called a permanent threshold shift (PTS), or temporary, in which case it is called a temporary threshold shift (TTS). The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. If the TS eventually returns to zero (the threshold returns to the preexposure value), the TS is a TTS. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. Figure 4-8 (Two Hypothetical Threshold Shifts) shows one hypothetical TS that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

Although both auditory trauma and fatigue may result in hearing loss, the mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic fatigue and exhaustion of the hair cells and cochlear tissues. Note that the term "auditory fatigue" is often used to mean "TTS"; however, in this OEIS/EIS we use a more general meaning to differentiate fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) from trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure). Auditory fatigue may result in PTS or TTS but is always assumed to result in a stress response. The actual amount of threshold shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure.

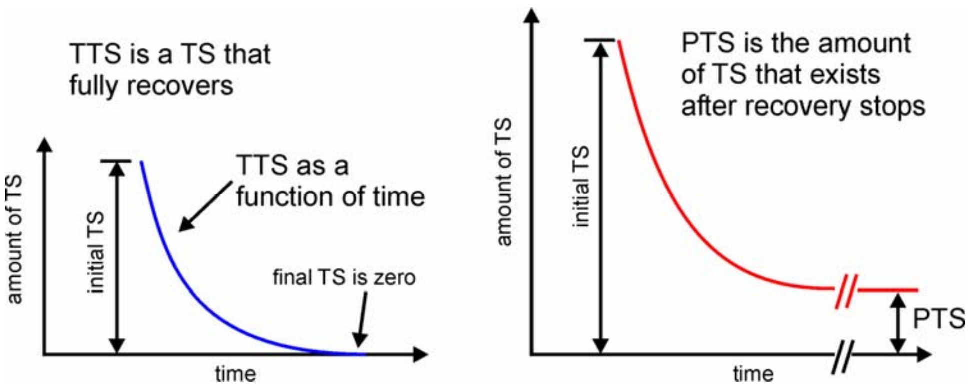


Figure 4-8. Two Hypothetical Threshold Shifts

There are no PTS data for cetaceans; however, a number of investigators have measured TTS in cetaceans (Schlundt et al., 2000, 2006; Finneran et al., 2000, 2002, 2005, 2007; Nachtigall et al., 2003, 2004). In these studies hearing thresholds were measured in trained dolphins and belugas before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example, Schlundt et al., 2000). The existing cetacean TTS data show that, for the species studied (non-impulsive) mid-frequency sounds of interest in this OEIS/EIS.

- The growth and recovery of TTS are analogous to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur during the quiet period between exposures) (Kryter et al., 1966; Ward, 1997).
- Sound pressure level (SPL) by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.

- Exposure energy flux density level (EL) is correlated with the amount of TTS and is a good predictor for onset-TTS from single, continuous exposures with variable durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).

The most relevant TTS data for analyzing the effects of mid-frequency sonars are from Schlundt et al. (2000, 2006) and Finneran et al. (2005). These studies point to an energy flux density level of 195 dB re 1 μPa^2-s as the most appropriate predictor for onset-TTS in dolphins and belugas from a single, continuous exposure in the mid-frequency range. This finding is supported by the recommendations of a panel of scientific experts formed to study the effects of sound on marine mammals (Southall et al., 2007).

In contrast to TTS data, PTS data do not exist and are unlikely to be obtained for marine mammals. Differences in auditory structures and the way that sound propagates and interacts with tissues prevent terrestrial mammal PTS thresholds from being directly applied to marine mammals; however, the inner ears of marine mammals are analogous to those of terrestrial mammals. Experiments with marine mammals have revealed similarities between marine and terrestrial mammals with respect to features such as TTS, age-related hearing loss, ototoxic drug-induced hearing loss, masking, and frequency selectivity. Therefore, in the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS (assumed here to indicate PTS). This requires estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

A variety of terrestrial mammal data sources indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS (Ward et al., 1958, 1959, 1960; Miller et al., 1963; Kryter et al., 1966). A conservative assumption is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.

The TTS growth rate as a function of exposure EL is nonlinear; the growth rate at small amounts of TTS is less than the growth rate at larger amounts of TTS. In other words, the curve relating TTS and EL is not a straight line but a curve that becomes steeper as EL and TTS increase. This means that the relatively small amounts of TTS produced in marine mammal studies limit the applicability of these data to estimate the TTS growth rate — since the amounts of TTS are generally small the TTS growth rate estimates would likely be too low. Fortunately, data exist for the growth of TTS in terrestrial mammals at higher amounts of TTS. Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS and exposure EL with growth rates of 1.5 to 1.6 dB TTS per dB increase in EL. Since there is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB), the additional exposure above onset-TTS that is required to reach PTS would be 34 dB divided by 1.6 dB, or approximately 20 dB. Therefore, exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. For an onset-TTS exposure with EL = 195 dB re 1 μPa^2-s, the estimate for onset-PTS for cetaceans would be 215 dB re 1 μPa^2-s. This extrapolation process and the resulting TTS prediction is identical to that recently proposed by a panel of scientific experts formed to study the effects of sound on marine mammals (Southall et al., 2007). The method predicts larger (worse) effects than have actually been observed in tests on a bottlenose dolphin [Schlundt et al. (2006) reported a TTS of 23 dB (no PTS) in a bottlenose dolphin exposed to a 3 kHz tone with an EL = 217 dB re 1 μPa^2-s].

Auditory Trauma

Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. The potential for trauma is related to the frequency, duration, onset time, and received sound pressure as well as the sensitivity of the animal to the sound frequencies. Because of these interactions, the potential for auditory trauma will vary among species. Auditory trauma is always injurious, but could be temporary and not result in permanent hearing loss. Auditory trauma is always assumed to result in a stress response.

Relatively little is known about auditory system trauma in marine mammals resulting from known sound exposure. A single study spatially and temporally correlated the occurrence of auditory system trauma in humpback whales with the detonation of a 5,000 kg (11,023 lb) explosive (Ketten et al., 1993). The exact magnitude of the exposure in this study cannot be determined and it is possible that the trauma was caused by the shock wave produced by the explosion (which would not be generated by a sonar). There are no known occurrences of direct auditory trauma in marine mammals exposed to tactical sonars.

Non-Auditory System Response

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of non-auditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information on the mechanical properties of the tissues and their function. Each of the potential responses may or may not result in a stress response.

Direct Tissue Effects

Direct tissue responses to sound stimulation may range from tissue trauma (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response whereas non-injurious stimulation may or may not.

Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration ,or the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (e.g., lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA, 2002b). They modeled and evaluated the likelihood that Navy mid-frequency sonars caused resonance effects in beaked whales that eventually led to their stranding (DoC and DON, 2001). The conclusions of that group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding (NOAA, 2002b). The frequencies at which resonance was predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations, even at resonant frequencies, were not considered to be of sufficient amplitude to cause tissue damage, even under the worst-case scenario in which air volumes would be undamped by surrounding tissues and the amplitude of the resonant response would be maximal. These same conclusions would apply to other actions involving mid-frequency tactical sonar.

Indirect Tissue Effects

Based upon the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, one suggested (indirect) cause of injury to marine mammals is rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage (injury) occurs; (2) bubbles develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based upon what is known about the specific process involved.

Rectified diffusion is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). The dive patterns of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser et al., 2001b). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness (DCS).

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario, the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size.

Recent research with *ex vivo* supersaturated tissues suggested that sound exposures of approximately 215 dB re 1 μPa would be required before microbubbles became destabilized and grew (Crum et al. 2005). Assuming spherical spreading loss and a nominal sonar source level of

235 dB re 1 μPa, a whale would need to be within 10 m (33 ft) of the sonar system to be exposed to such sound levels. Furthermore, tissues were supersaturated by exposing them to pressures of 400 to 700 kPa for periods of hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as 400 to 700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser et al., 2001b). It is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings. Both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert.

Yet another hypothesis has speculated that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003; Fernandez et al., 2005). This is accounted for in the conceptual framework via a feedback path from the behavioral changes of "diving" and "avoidance" to the "indirect tissue response" block. In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Recent modeling suggests that unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected in beaked whales (Zimmer and Tyack, 2007). Recently, Tyack et al. (2006) suggested that emboli observed in animals exposed to mid-frequency range sonar (Jepson et al., 2003; Fernandez et al., 2005) could stem instead from a behavioral response that involves repeated dives shallower than the depth of lung collapse. Given that nitrogen gas accumulation is a passive process (i.e. nitrogen is metabolically inert), a bottlenose dolphin was trained to repetitively dive a profile predicted to elevate nitrogen saturation to the point that nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of even asymptomatic nitrogen gas bubbles (Houser et al., 2008).

There is considerable disagreement among scientists as to the likelihood of this phenomenon (Piantadosi and Thalmann, 2004; Evans and Miller, 2003). Although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003; Fernandez et al., 2005), nitrogen bubble formation as the cause of the traumas has not been verified. The presence of bubbles postmortem, particularly after decompression, is not necessarily indicative of bubble pathology. Prior experimental work has demonstrated the post-mortem presence of bubbles following decompression in laboratory animals can occur as a result of invasive investigative procedures (Stock et al., 1980).

Additionally, the fat embolic syndrome identified by Fernández et al. (2005) is the first of its kind. The pathogenesis of fat emboli formation is as yet undetermined and remains largely unstudied, and it would therefore be inappropriate to causally link it to nitrogen bubble formation. Because evidence of nitrogen bubble formation following a rapid ascent by beaked whales is arguable and requires further investigation, this EIS/OEIS makes no assumptions about it being the causative mechanism in beaked whale strandings associated with sonar operations. No similar findings to those found in beaked whales stranding coincident with sonar activity have been reported in other stranded animals following known exposure to sonar operations. By extension, no marine mammals addressed in this EIS/OEIS are given differential treatment due to the possibility for acoustically mediated bubble growth.

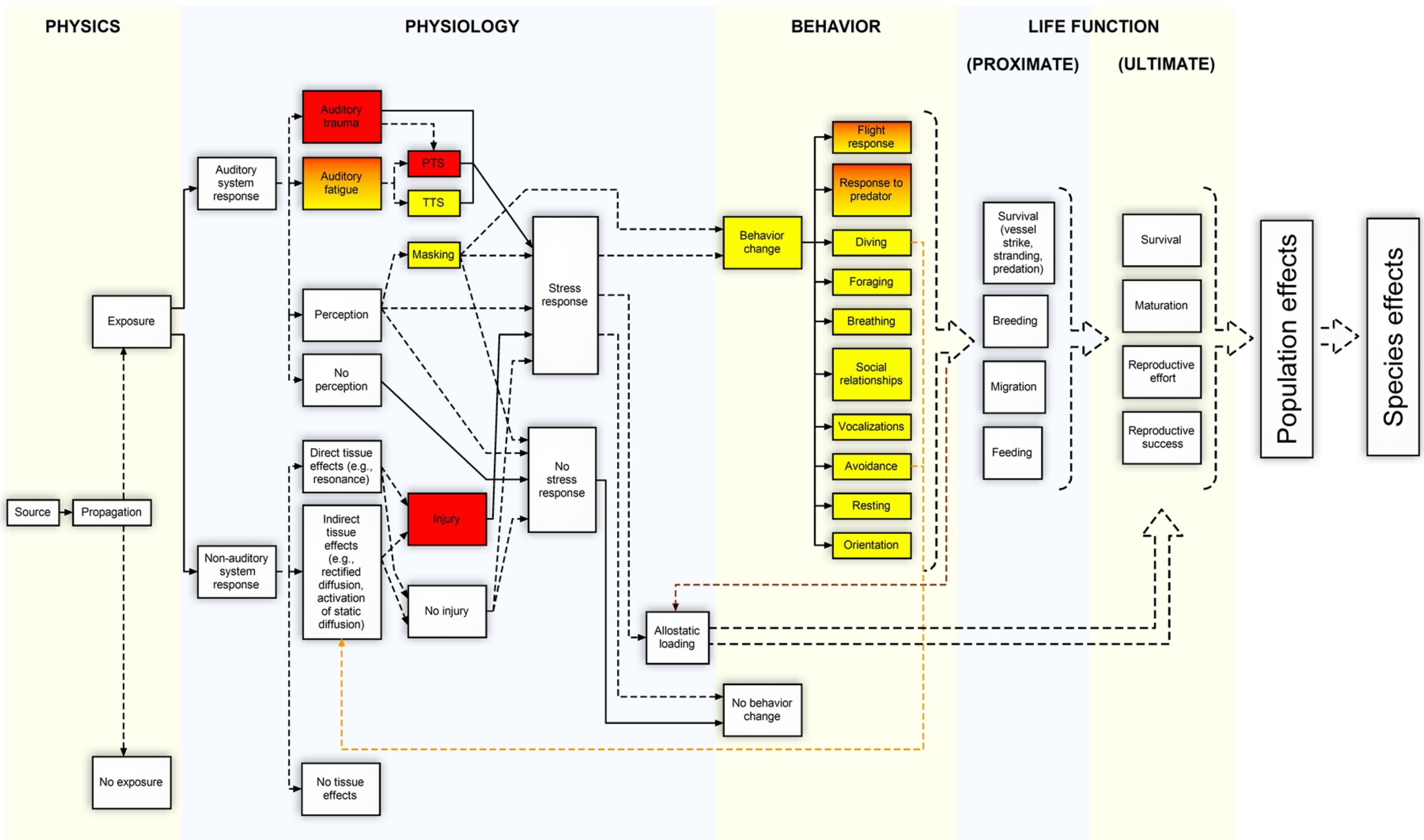


Figure 4-9. Analytical Framework Flow Chart

No Tissue Effects

The received sound is insufficient to cause either direct (mechanical) or indirect effects to tissues. No stress response occurs.

The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term "stress" has taken on an ambiguous meaning in the scientific literature, but with respect to Figure 4-9 and the later discussions of allostasis and allostatic loading, the term "stress response" will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer, 2005), or through oxidative stress, as occurs in noise-induced hearing loss. The SNS response to a stressor is immediate and acute and is characterized by the release of the catecholamine neurohormones norepinephrine and epinephrine (i.e., adrenaline). These hormones produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipids for energy. The HPA response is ultimately defined by increases in the secretion of the glucocorticoid steroid hormones (e.g. cortisol, aldosterone). The amount of increase in circulating glucocorticoids above baseline may be an indicator of the overall severity of a stress response (Hennessy et al., 1979). Each component of the stress response is variable in time, e.g., adrenalines are released nearly immediately and are used or cleared by the system quickly, whereas cortisol levels may take long periods of time to return to baseline.

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal's life history stage (e.g., neonate, juvenile, and adult), the environmental conditions, reproductive or developmental state, and experience with the stressor. Not only will these factors be subject to individual variation, but they will also vary within an individual over time. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf, 2001). In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, as observed in stranded animals with long-term debilitating conditions (e.g., disease), has been demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al., 2006). Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. Potential stressors resulting from anthropogenic activities must be considered not only as to their direct impact on the animal but also as to their cumulative impact with environmental stressors already experienced by the animal.

Studies on the stress response of odontocete cetaceans to acute acoustic stimuli were previously discussed (Thomas et al., 1990b; Miksis et al., 2001; Romano et al., 2004). Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling, and stranding. Pursuit, capture and short-term holding of belugas has been observed to result in a decrease in thyroid hormones (St. Aubin and Geraci, 1988) and increases in epinephrine (St. Aubin and Dierauf, 2001). In dolphins the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (St. Aubin et al., 1996; Ortiz and Worthy, 2000; St. Aubin, 2002). Elephant seals demonstrate an acute cortisol response to handling, but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al., 2002). With respect to anthropogenic sound as a stressor, the current limited body of knowledge will require extrapolation from species for which information exists to those for which no information exists.

The stress response may or may not result in a behavioral change, depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield, 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (Wingfield, 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior (see the Behavior section, below).

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 4-9 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (i.e., red boxes on the flow chart in Figure 4-9) is assumed to also produce a stress response and contribute to the allostatic load.

Behavior Component

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is conservatively based on the assumption that some sort of physiological trigger must exist for an anthropogenic stimulus to alter a biologically significant behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 4-9 lists only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as a flight response, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event precipitated by anthropogenic noise would be considered a Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading (physiology block).

The response of a marine mammal to an anthropogenic sound source will depend on the frequency content, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The direction of the responses can vary, with some changes resulting in either increases or decreases from baseline (e.g., decreased dive times and increased respiration rate). Responses can also overlap; for example, an increased respiration rate is likely to be coupled to a flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecology of individual species is unlikely to completely overlap.

A review of marine mammal responses to anthropogenic sound was first conducted by Richardson and others in 1995. A more recent review (Nowacek et al., 2007) addresses studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sections provide a very brief overview of the state of knowledge of behavioral responses. The overviews focus on studies conducted since 2000 but are not meant to be comprehensive; rather, they provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists.

<u>Flight Response</u> – A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Relatively little information on flight responses of marine mammals to anthropogenic signals exists, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (Evans and England, 2001).

<u>Response to Predator</u> – Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al., 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

<u>Diving</u> – Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (e.g., foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (e.g., increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek et al. (2004a) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung, 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach, and speed of approach seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung, 2003). Low frequency signals of the ATOC sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000) or to overtly affect elephant seal dives (Costa et al., 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Jepson et al., 2003). Although hypothetical, the potential process is currently being debated in the scientific community.

<u>Foraging</u> - Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (e.g., bubble nets or sediment plumes), or changes in dive

behavior. Noise from seismic surveys was not found to impact the feeding behavior in western gray whales off the coast of Russia (Yazvenko et al., 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen et al., 2006). Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity (Croll et al., 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek et al., 2004a). Although the received sound pressure level at the animals was similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. A determination of whether foraging disruptions incur fitness consequences will require information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Breathing – Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey et al., 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein et al., 2001; Kastelein et al., 2006a) and emissions for underwater data transmission (Kastelein et al., 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein et al., 2006a), again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Social relationships - Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships therefore depends on the disruption of other behaviors (e.g., caused avoidance, masking, etc.) and no specific overview is provided here. However, social disruptions must be considered in context of the relationships that are affected. Long-term disruptions of mother/calf pairs or mating displays have the potential to affect the growth and survival or reproductive effort/success of individuals, respectively.

Vocalizations - Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active (LFA) sonar, humpback whales have been observed to increase the length of their "songs" (Miller et al., 2000; Fristrup et al., 2003), possibly due to the overlap in frequencies between the whale song and the LFA sonar. A similar compensatory effect for the presence of low frequency vessel noise has been suggested for right whales; right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al., 2007). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (e.g., whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote et al., 2004). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al., 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Avoidance - Avoidance is the displacement of an individual from an area as a result of the presence of a sound. It is qualitatively different from the flight response in its magnitude (i.e., directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. Longer term displacement is possible, however, which can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Blackwell et al., 2004; Bejder et al., 2006; Teilmann et al., 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein et al., 2001; Finneran et al., 2003; Kastelein et al., 2006a; Kastelein et al., 2006b). Short term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents has also been noted in wild populations of odontocetes (Bowles et al., 1994; Goold, 1996; 1998; Stone et al., 2000; Morton and Symonds, 2002) and to some extent in mysticetes (Gailey et al., 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell et al., 2007; Miksis-Olds et al., 2007).

Orientation - A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone, and thus are placed at the bottom of the framework behavior list. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

Special considerations are given to the potential for avoidance and disrupted diving patterns. Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation. Although hypothetical in nature, the potential process is currently popular and hotly debated.

Life Function

Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

<u>Ultimate Life Functions</u>

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.) and which related to the animal's fitness. The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, NSWC PCD RDT&E activities over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions.

Application of the Framework

For each species in the region of a proposed action, the density and occurrence of the species in the region relative to the timing of the proposed action should be determined. The probability of exposing an individual will be based on the density of the animals at the time of the action and the acoustic propagation loss. Based upon the calculated exposure levels for the individuals, or proportions of the population, an assessment for auditory and non-auditory responses should be made. Based on the available literature on the bioacoustics, physiology, dive behavior, and ecology of the species, Figure 4-9 should be used to assess the potential impact of the exposure to the population and species.

4.3.6.3.1 Introduction and Approach to Analysis

Regulatory Framework

MMPA prohibits the unauthorized harassment of marine mammals and provides the regulatory processes for authorization for any such harassment that might occur incidental to an otherwise lawful activity.

The regulatory framework for estimating potential acoustic effects from NSWC PCD RDT&E activities on marine mammal species makes use of the methodology that was developed in cooperation with National Oceanic and Atmospheric Administration (NOAA) for the Navy's Draft *Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (OEIS/EIS)* (DON, 2005b). Via response comment letter to USWTR received from NMFS 30 January 2006, NMFS concurred with the use of EL for the determination of physiological effects to marine mammals. Therefore, this methodology was used to estimate the annual exposure of marine mammals that may be considered Level A harassment (sound level threshold of 215 dB or above) or Level B harassment (sound levels below 215 dB down to 195 dB) as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential acoustic effects from NSWC PCD RDT&E activities on marine mammals makes use of the comments received on the Navy's Draft *Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (OEIS/EIS)* (DON, 2005b), the *2006 Rim of the Pacific Supplemental Overseas Environmental Assessment* (DON, 2006a), and the *Hawaii Range Complex (HRC) Environmental Impact Statement (EIS)* (DON, 2008). NMFS and other commentors recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects (sound levels below the 195 dB threshold). As a result of these comments, this assessment used a risk function approach to evaluate the potential for behavioral effects.

A number of Navy actions and NMFS rulings have helped to qualify possible activities deemed as "harassment" under the MMPA. "Harassment" under the MMPA includes both potential injury (Level A) and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). The acoustic effects analysis and exposure calculations are based on the following premises:

- Harassment that may result from Navy operations described in this NSWC PCD EIS/OEIS is unintentional and incidental to those operations.
- This EIS/OEIS uses an unambiguous definition of injury as defined in the *Undersea Warfare Training Range Draft OEIS/DEIS* (DON, 2005b) and in previous rulings (NOAA, 2001, 2002a): injury occurs when any biological tissue is damaged or lost as a result of the action.
- Behavioral disruption might result in subsequent injury and injury may cause a subsequent behavioral disruption, so Level A and Level B harassment categories (defined below in Section 4.7.3.1) can overlap and are not necessarily mutually exclusive. However, based on prior ruling (NOAA, 2001, 2006a), this EIS/OEIS assumes that Level A and B do not overlap.
- An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both is counted as a single take (see NOAA, 2001, 2006a). An animal whose behavior is disrupted by an injury has already been counted as a Level A harassment and will not also be counted as a Level B harassment.
- The acoustic effects analysis is based on primary exposures to the action. Secondary or indirect effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior may not be readily determined unless directly observed, or the

risk of occurrence concluded from previous well-documented examples. Consideration of secondary effects would result in some Level A harassment being considered Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of harassment.

- Animals are uniformly distributed and remain stationary during the active sonar events; therefore, the model does not account for any animal response.

Integration of Regulatory and Biological Frameworks

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework of injury (Level A) and behavioral disruption (Level B). The information presented in the subsections below was used to develop specific numerical exposure thresholds and risk function estimations. Exposure thresholds were combined with sound propagation models and species distribution data to estimate the potential exposures.

Physiological and Behavioral Effects

Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as amended directs which traits should be used when determining effects. Effects that address injury are considered Level A harassment under MMPA. Effects that address behavioral disruption are considered Level B harassment under MMPA.

The biological framework discussed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed to determine which qualify as injury or behavioral disturbance under MMPA regulations. Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological effect may not be observable over short periods of observation. Ecological information is considered in the analysis of the effects to individual species.

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. Physiological effects may range from the most significant of effects (i.e., mortality and serious injury) to lesser effects that define the lower end of the physiological effects range, such as the noninjurious distortion of auditory tissues. This latter physiological effect is important to the integration of the biological and regulatory frameworks and receives additional attention in later sections.

A “behavioral effect” is one in which the “normal” behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA and the ESA.

In this EIS/OEIS the term “normal” is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic (e.g., man-made) acoustic sources. As a result, this NSWC PCD EIS/OEIS uses the following definitions:

- A physiological effect is a variation in an animal’s physiology that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in physiological function.
- A behavioral effect is a variation in an animal’s behavior or behavior patterns that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in behavior but arises through normal physiological process.
- The definitions of physiological effect and behavioral effect used here are specific to this document and should not be confused with more global definitions applied to the field of biology.

It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the sound source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on the received sound level. Behavioral responses also depend on an animal’s learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented. However, to provide a tractable approach to predicting acoustic effects that is relevant to the terms of behavioral disruption described in the MMPA, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source. Figure 4-10 shows the relationship between severity of effects, source distance, and exposure level, as defined in this EIS/OEIS.

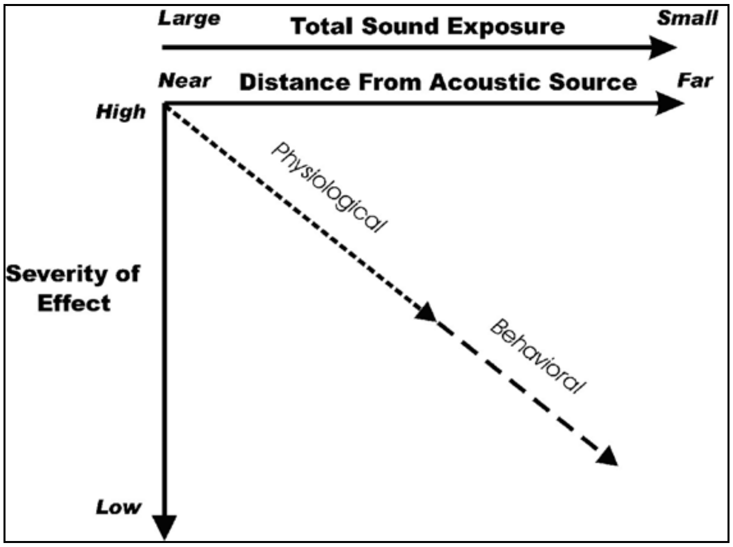


Figure 4-10. Relationship Between Severity of Effects, Source Distance, and Exposure Level

Other Potential Acoustic Effects to Marine Mammals

<u>Acoustically Mediated Bubble Growth</u>

One suggested cause of injury to marine mammals is rectified diffusion, which is the process of increasing the size of a bubble by exposing it to a sound field (Crum and Mao, 1996). This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with a gas, such as nitrogen, which makes up approximately 78 percent of air. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser et al., 2001). Conversely, studies have shown that marine mammal lung structure (both pinnipeds and cetaceans) facilitates collapse of the lungs at depths below approximately 50 m (164 ft) (Kooyman et al., 1970). Collapse of the lungs would force air into the nonair exchanging areas of the lungs (into the bronchioles away from the alveoli) thus significantly decreasing nitrogen diffusion into the body. Deep-diving pinnipeds such as the northern elephant (*Mirounga angustirostris*) and Weddell seals (*Leptonychotes weddellii*) typically exhale before long deep dives, further reducing air volume in the lungs (Kooyman et al., 1970). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings will be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size.

Another hypothesis suggests that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Cox et al. (2006), with experts in the field of marine mammal behavior, diving, physiology, respiration physiology, pathology, anatomy, and bio-acoustics considered this to be a plausible hypothesis that requires further investigation. Conversely Fahlman et al. (2006) suggested by formulation of a mathematical model that diving bradycardia (reduction in heart rate and circulation to the tissues), lung collapse, and slow ascent rates would reduce nitrogen uptake and thus reduce the risk of decompression sickness by 50 percent in models of marine mammals. Recent information on the diving profiles of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales (Baird et al., 2006) in the Ligurian Sea in Italy (Tyack et al., 2006) showed that while these species do dive deeply (regularly exceed depths of 800 m [.5 mi]) and for long periods (48–68 minutes), they have significantly slower ascent rates than descent rates. This fits well with Fahlman et al., (2006) model of deep and long duration divers that would have slower ascent rates to reduce nitrogen saturation and reduce the risk of decompression sickness. Therefore, if nitrogen saturation remains low, then a rapid ascent should not cause decompression sickness. Currently it is not known if beaked whales rapidly ascend in response to sonar or other disturbances. Deep diving animals may be better protected by diving to depth to avoid predators, such as killer whales, rather then ascending to the surface where they may be more susceptible to predators, subsequently eliminating a rapid ascent.

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004; Evans and Miller, 2004). To date, ELs predicted to cause *in vivo* bubble formation within diving cetaceans have not been evaluated (NOAA, 2002b). Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli- and bubble-induced tissue separations (Jepson et al., 2003), there is no conclusive evidence of this occurrence. In addition, there may be complicating factors associated with introduction of gas into the venous system during necropsy. Because evidence supporting it is debatable, no marine mammals addressed in this EIS/OEIS are given special treatment due to the possibility for acoustically mediated bubble growth.

<u>Resonance</u>

Another suggested cause of injury in marine mammals is air cavity resonance due to sonar exposure. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration, or the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (e.g., lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA, 2002b). They modeled and evaluated the likelihood that U.S. Navy MFA sonar caused resonance effects in beaked whales that eventually led to their stranding (Department of Commerce [DOC] and DON, 2001). The conclusions of that group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding (NOAA, 2002b). Furthermore, air cavity vibrations due to the resonance effect were not considered to be of sufficient amplitude to cause tissue damage. The NSWC PCD EIS/OEIS assumes that similar phenomenon will not be problematic in other cetacean species.

Prolonged Exposure

NSWC PCD RDT&E activities will not result in prolonged exposure because of the intermittent nature of sonar transmissions and the generally short duration of tests. The implementation of the mitigation and protective measures discussed in Chapter 5 will further reduce the likelihood of any prolonged exposure.

Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure.

Historically, principal masking concerns have been with prevailing background sound levels from natural and man-made sources (for example, Richardson et al., 1995). Dominant examples of the latter are the accumulated sound from merchant ships and sound of seismic surveys. Both cover a wide frequency band and are long in duration.

The majority of proposed NSWC PCD RDT&E activities is away from harbors or heavily traveled shipping lanes. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, and these active sonars transmit within a narrow band of frequencies (typically less than one-third octave). For the reasons outlined above, the chance of sonar operations causing masking effects is considered negligible.

Potential for Long-Term Effects

NSWC PCD RDT&E activities will be conducted in the same general areas, so marine mammal populations could be exposed to repeated activities over time. However, as described earlier, this EIS/OEIS assumes that short-term non-injurious SELs predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. It is highly unlikely that all behavioral disruptions or instances of TTS will result in long-term significant effects.

4.3.6.3.2 Calculation Methods for Sonar Sound

Detailed information and formulas to model the effects of sonar from RDT&E activities in the NSWC PCD Study Area is provided in Appendix M, Supplemental Information for Underwater

Noise Analysis. The following section provides an overview of the methods used to conduct the analysis.

The quantitative analysis was based on conducting sonar operations in 16 different geographical regions, or provinces. Using combined marine mammal density and depth estimates, which is detailed later in this section, acoustical modeling was conducted to calculate the actual exposures. Refer to Appendix E, Geographic Description of Environmental Provinces, for additional information on provinces. Refer to Appendix L, Definitions and Metrics for Acoustic Quantities, and Appendix M, Supplemental Information for Underwater Noise Analysis, for additional information regarding the acoustical analysis.

The approach for estimating potential acoustic effects from NSWC PCD RDT&E activities on cetacean species uses the methodology that the DON developed in cooperation with NOAA for the Navy's USWTR Draft OEIS/EIS (DON, 2005b), Undersea Warfare Exercise (USWEX) EA/OEA (DON, 2007d), RIMPAC EA/OEA (DON, Commander Third Fleet, 2006), Composite Training Unit Exercises (COMPTUEX)/ Joint Task Force Exercises (JTFEX) (DON, 2007e), and HRC Draft EIS (DON, 2007c). The exposure analysis for behavioral response to sound in the water uses energy flux density for Level A harassment and the methods for risk function for Level B harassment (behavioral). The methodology is provided here to determine the number and species of marine mammals for which incidental take authorization is requested.

To estimate acoustic effects from the NSWC PCD RDT&E activities, acoustic sources to be used were examined with regard to their operational characteristics as described in the previous section. In addition, systems with an operating frequency greater than 200 kHz were not analyzed in the detailed modeling as these signals attenuate rapidly resulting in very short propagation distances. Acoustic countermeasures were previously examined and found not to be problematic. These acoustic sources, therefore, did not require further examination in this analysis. Based on the information above, the Navy modeled the following representative systems:

- Kingfisher
- Sub-bottom profilers
- SAS-LFs and SAS-HFs (Synthetic Aperture Sonars)
- Modems (underwater communication devices)
- AN/SQQ-32 (shipboard mounted mine detection system)
- BPAUVs (autonomous underwater vehicle systems)
- TVSS (toroidal volume search sonar)
- F84Y (parametric sonar)
- AN/AQS-20 (helicopter towed mine detection system)
- Navigation Systems

Sonar parameters including source levels, ping length, the interval between pings, output frequencies, directivity (or angle), and other characteristics were based on records from previous test scenarios and projected future testing. Although NSWC PCD modeled these systems, they are representative and future systems that fall within these parameters will be covered by this EIS/OEIS. Additional information on sonar systems and their associated parameters is in Appendix M, Supplemental Information for Underwater Noise Analysis.

Every active sonar operation includes the potential to expose marine animals in the neighboring waters. The number of animals exposed to the sonar in any such action is dictated by the propagation field and the manner in which the sonar is operated (i.e., source level, depth, frequency, pulse length, directivity, platform speed, repetition rate). The modeling for NSWC PCD RDT&E activities involving sonar occurred in five broad steps, listed below and was conducted based on the typical RDT&E activities planned for the NSWC PCD Study Area.

- Step 1. Environmental Provinces. The NSWC PCD Study Area is divided into 16 environmental provinces, and each has a unique combination of environmental conditions. These represent various combinations of eight bathymetry provinces, one Sound Velocity Profile (SVP) province, and three Low-Frequency Bottom Loss geo-acoustic provinces and two High-Frequency Bottom Loss classes. These are addressed by defining environments in two seasons that span the variety of depths, bottom types, sound speed profiles, and sediment thicknesses found in the NSWC PCD Study Area. The two seasons encompass winter and summer, which are the two extremes and for the GOM the acoustic propagation characteristics do not vary significantly between the two. Each marine modeling area can be quantitatively described as a unique combination of these environments.
- Step 2. Transmission Loss. Since sound propagates differently in these environments, separate transmission loss calculations must be made for each, in both seasons. The transmission loss is predicted using CASS-GRAB sound modeling software.
- Step 3. Exposure Volumes. The transmission loss, combined with the system characteristics, gives the energy field of a single ping. The energy of over 10 hours of pinging is summed, carefully accounting for overlap of several pings, so an accurate average exposure of an hour of pinging is calculated for each depth increment. At more than ten hours, the source is too far away and the energy is negligible. In addition, the acoustic modeling takes into account the use of a single system. Only one system will operate at any one time during NSWC PCD RDT&E activities.

  Repeating this calculation for each environment in each season gives the hourly ensonified volume, by depth, for each environment and season. This step begins the method for risk function modeling.
- Step 4. Marine Mammal Densities. The marine mammal densities were given in two dimensions, but using peer-reviewed literature sources (published literature and agency reports) described in the following subsection, the depth regimes of these marine mammals are used to project the two dimensional densities (expressed as the number of animals per area where all individuals are assumed to be at the water's surface) into three dimensions (a volumetric approach whereby two-dimensional animal density incorporates depth into the estimates).
- Step 5. Exposure Calculations. Each marine mammal's three dimensional density is multiplied by the calculated impact volume—to that marine mammal depth regime. This value is the number of exposures per hour for that particular marine mammal. In this way, each marine mammal's exposure count per hour is based on its density, depth habitat, and the ensonified volume by depth.

The planned sonar hours for each system were inserted and a cumulative number of exposures was determined for each alternative. The analysis used a conservative approach and assumed that the systems were active for the entire duration of each hour listed in the alternatives table. Refer to Appendix M for additional information on sonar system parameters.

Marine Mammal Density

For the purposes of this analysis, NSWC PCD has adopted a conservative approach to underwater sound and marine mammals. Baleen and toothed whales, collectively known as cetaceans, spend their entire lives in the water and spend most of the time (greater than 90 percent for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and also exposes them to underwater sound, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface. Therefore, the analysis assumes that the time cetaceans spend underwater and exposed to sound is 100 percent. The following subsection describes the density calculations and values used in this analysis. Appendix M, Supplemental Information for Underwater Noise Analysis, provides detailed information on the formulation of three-dimensional data based on depth and densities for marine mammal species.

The density estimates that were used in previous Navy environmental documents have been recently updated to provide a compilation of the most recent data and information on the occurrence, distribution, and density of marine mammals and sea turtles in the southeast OPAREAs. The updated density estimates presented in this EIS/OEIS are derived from the *Navy OPAREA Density Estimates (NODE) NODE for the GOMEX OPAREA* report (DON, 2007h).

Density estimate calculations for cetaceans in Navy environmental documents can be modeled using available line-transect survey data or derived in order of preference: 1) through spatial models using line-transect survey data provided by NMFS; 2) using abundance estimates from Mullin and Fulling (2003), Fulling et al. (2003), and/or Mullin and Fulling (2004); 3) or based on the cetacean abundance estimates found in the most current NOAA stock assessment report (SAR) (Waring et al., 2008). In the NSWC PCD Study Area which includes the GOMEX OPAREA, density estimates were derived via abundance estimates found in the NOAA stock assessment report (Waring et al., 2008) based on Mullin and Fulling (2004).

For the model-based approach, density estimates were calculated for each species within areas containing survey effort. A relationship between these density estimates and the associated environmental parameters such as depth, slope, distance from the shelf break, sea surface temperature (SST), and chlorophyll *a* (chl *a*) concentration was formulated using generalized additive models (GAMs). This relationship was then used to generate a two-dimensional density surface for the region by predicting densities in areas where no survey data exist. For the GOMEX, all analyses for cetaceans were based on data collected through NMFS-SEFSC shipboard surveys conducted between 1996 and 2004. Species-specific density estimates derived through spatial modeling were compared with abundance estimates found in the most current NOAA SAR to ensure consistency. All spatial models and density estimates were reviewed by NMFS technical staff.

A list of each species and how their density was derived is shown in Table 4-31. It is important to note that various factors influence the detectability of marine mammals at sea including animal behavior and appearance, group size, blow characteristics, dive characteristics and dive interval, viewing conditions (sea state, wind speed, wind direction, sea swell, and glare);

observer experience, fatigue, and concentration; and vessel platform characteristics (pitch, roll, yaw, speed, and height above water). Because certain species can dive for long periods of time, their sightability/detectability during surface surveys can be diminished, which leads to underestimated density. The density estimates detailed in the NODE report are not corrected for dive times and may be underestimates for some species. For a more detailed description of the methodology involved in calculating the density estimates provided in this EIS/OEIS, please refer to the NODE for the GOMEX OPAREA (DON, 2007h,).

Abundance is the total number of individuals that make up a given stock as in the NMFS SARs, or the total number estimated within a particular study area as in Mullin and Fulling (2003). NMFS stock abundances for most species represent the total estimate of individuals within the geographic area, if wholly known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. Survey abundances are the total individuals estimated within the survey study area, which may or not align completely with a stock's geographic range as defined in the SARs. These surveys may also extend beyond U.S. waters. Both stock abundance and survey abundance are used in this EIS/OEIS to determine a density of marine mammal species within the NSWC PCD Study Area. That some portion of the animals range may extend beyond the NSWC PCD Study Area or U.S. waters is irrelevant to the concentration of animals that could be present within the NSWC PCD Study Area at a given time. It is this concentration or density that is most important for conducting the analysis of effects to NSWC PCD RDT&E activities.

Table 4-31. Method of Density Estimation for Each Species/Species Group in the GOMEX Operating Area

Model-Derived Density Estimates
Sperm whale (*Physeter macrocephalus*)
Kogia spp.
Beaked Whales (Family Ziphiidae)
Rough-toothed dolphin (*Steno bredanensis*)
Bottlenose dolphin (*Tursiops truncatus*)
Pantropical spotted dolphin (*Stenella attenuata*)
Atlantic spotted dolphin (*Stenella frontalis*)
Striped dolphin (*Stenella coeruleoalba*)
Spinner dolphin (*Stenella longirostris*)
Risso's dolphin (*Grampus griseus*)
Leatherback turtle (*Dermochelys coriacea*)
Loggerhead turtle (*Caretta caretta*)
Hardshell Turtles
SAR or Literature-Derived Density Estimates
Bryde's whale (*Balaenoptera brydei/edeni*)
Clymene dolphin (*Stenella clymene*)
Fraser's dolphin (*Lagenodelphis hosei*)
Killer whale (*Orcinus orca*)
False killer whale (*Pseudorca crassidens*)
Pygmy killer whale (*Feresa attenuata*)
Melon-headed Whale (*Peponocephala electra*)
Short-finned pilot whale *(Globicephala macrorhynchus)*

Source: DON, 2007h

Depth Distribution

There are limited depth distribution data for most marine mammals. This is especially true for cetaceans, as they must be tagged at-sea by using a tag that either must be implanted in the skin/blubber in some manner or adhere to the skin. There are a few different methodologies/techniques that can be used to determine depth distribution percentages, but by far the most widely used technique currently is the time-depth recorder. These instruments are attached to the animal for a fairly short period of time (several hours to a few days) via a suction cup or glue, and then retrieved immediately after detachment. Depth information can also be collected via satellite tags, sonic tags, digital tags, and, for sperm and beaked whales, via acoustic tracking of sounds produced by the animal itself.

There are suitable depth distribution data for some marine mammal species. Sample sizes are usually extremely small, almost always encompassing fewer than 10 animals total and usually include only one or two animals. Depth distribution information can also be interpreted from other dive and/or preferred prey characteristics, and from methods including behavioral observations, stomach content analysis and habitat preference analysis. Depth distributions for species for which no data are available are extrapolated from similar species.

Density and Depth Distribution Combined

Density is nearly always reported for an area (e.g., animals/km^2). Analyses of survey results using distance sampling techniques include correction factors for animals at the surface but not seen and for animals below the surface but not observed. Therefore, although the area (e.g., km^2) appears to represent only the surface of the water (two-dimensional), density actually implicitly includes animals anywhere within the water column under that surface area. Density assumes that animals are uniformly distributed within the prescribed area, although this assumption is likely rare. Marine mammals are usually clumped in areas of greater importance, for example, in areas of high productivity, lower predation, and safe calving. Density can be calculated occasionally for smaller areas that are used regularly by marine mammals; however, oftentimes there are insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the standard method.

Assuming that marine mammals are distributed evenly within the water column does not accurately reflect marine mammal behavior. The ever-expanding database of marine mammal behavioral and physiological parameters obtained through tagging and other technologies has demonstrated that marine mammals use the water column in various ways. Some species are capable of regular deep dives greater than 800 m (2,625 ft) and others dive to less than 200 m (656 ft), regardless of the bottom depth. Assuming that all species are evenly distributed from the surface to the bottom is almost never appropriate and can present a distorted view of marine mammal distribution in any region.

By combining marine mammal density with depth distribution information, a three-dimensional (3-D) density estimate is possible. These 3-D estimates allow more accurate modeling of potential marine mammal exposures from specific sonar systems.

4.3.6.3.3 Territorial Waters – Marine Mammals (Sonar Operations)

Based on the calculation methods for sonar, the analysis results are presented in the following subsections.

No Action Alternative – Marine Mammals (Sonar Operations, Territorial)

Sonar operations under the No Action Alternative in territorial waters may expose bottlenose dolphin and Atlantic spotted dolphin to sound likely to result in Level B harassment (Table 4-32). The only potential for impact to marine mammals will occur at Level B harassment.

Table 4-32. No Action Alternative: Estimates of Marine Mammal Exposures from Sonar Missions in Territorial Waters Per Year

Marine Mammal Species	Level A	Level B (TTS)	Level B (Behavioral)
Bottlenose dolphin	0	2	254
Atlantic spotted dolphin	0	1	198

Alternative 1 – Marine Mammals (Sonar Operations, Territorial)

Sonar operations under Alternative 1 in territorial waters may expose bottlenose dolphin and Atlantic spotted dolphin to sound likely to result in Level B harassment (Table 4-33). The only potential for impacts to marine mammals will occur at Level B harassment.

Table 4-33 Alternative 1: Estimates of Marine Mammal Exposures from Sonar Missions in Territorial Waters Per Year

Marine Mammal Species	Level A	Level B (TTS)	Level B (Behavioral)
Bottlenose dolphin	0	3	513
Atlantic spotted dolphin	0	2	401

Alternative 2 – Marine Mammals (Sonar Operations, Territorial)

Sonar operations under Alternative 2 in territorial waters may expose bottlenose dolphin and Atlantic spotted dolphin to sound likely to result in Level B harassment (Table 4-34). The only potential for impacts to marine mammals will occur at Level B harassment.

Table 4-34. Alternative 2: Estimates of Marine Mammal Exposures from Sonar Missions in Territorial Waters Per Year

Marine Mammal Species	Level A	Level B (TTS)	Level B (Behavioral)
Bottlenose dolphin	0	3	521
Atlantic spotted dolphin	0	2	408

4.3.6.3.4 Non-Territorial Waters – Marine Mammals (Sonar Operations)

No Action Alternative – Marine Mammals (Sonar Operations, Non-Territorial)

Sonar operations under the No Action Alternative in non-territorial waters may expose up to nine species to sound likely to result in Level B harassment (Table 4-35). They include the sperm whale, melon-headed whale, Risso's dolphin, bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped dolphin, spinner dolphin, and Clymene dolphin. The only potential impacts to marine mammals will occur at Level B harassment.

Table 4-35. No Action Alternative: Estimates of Marine Mammal Exposures from Sonar Missions in Non-Territorial Waters Per Year

Marine Mammal Species	Level A	Level B (TTS)	Level B (Behavioral)
Bryde's whale	0	0	0
Sperm whale	0	0	1
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	1
Short-finned pilot whale	0	0	0
Risso's dolphin	0	0	1
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	0	1	27
Atlantic spotted dolphin	0	0	23
Pantropical spotted dolphin	0	0	9
Striped dolphin	0	0	2
Spinner dolphin	0	0	8
Clymene dolphin	0	0	3
Fraser's dolphin	0	0	0

Alternative 1 – Marine Mammals (Sonar Operations, Non-Territorial)

Alternative 1 sonar operations in non-territorial waters may expose up to ten species to sound likely to result in Level B harassment (Table 4-36). They include the sperm whale, melon-headed whale, short-finned pilot whale, Risso's dolphin, bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped dolphin, spinner dolphin, and Clymene dolphin. The only potential impacts to marine mammals will occur at Level B harassment.

Table 4-36. Alternative 1: Estimates of Marine Mammal Exposures from Sonar Missions in Non-Territorial Waters Per Year

Marine Mammal Species	Level A	Level B (TTS)	Level B (Behavioral)
Bryde's whale	0	0	0
Sperm whale	0	0	1
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	1
Short-finned pilot whale	0	0	1
Risso's dolphin	0	0	1
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	0	1	34
Atlantic spotted dolphin	0	1	29
Pantropical spotted dolphin	0	0	12
Striped dolphin	0	0	2
Spinner dolphin	0	0	10
Clymene dolphin	0	0	4
Fraser's dolphin	0	0	0

Alternative 2 – Marine Mammals (Sonar Operations, Non-Territorial)

Sonar operations under Alternative 2 in non-territorial waters may expose up to ten species to sound likely to result in Level B harassment (Table 4-37). They include the sperm whale, melon-headed whale, short-finned pilot whale, Risso's dolphin, bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped dolphin, spinner dolphin, and Clymene dolphin. In addition, sonar operations in non-territorial waters may expose up to one bottlenose dolphin and Atlantic spotted dolphin to levels of sound likely to result in TTS. The only potential impacts to marine mammals will occur at Level B harassment.

4.3.6.3.5 Summary of Potential Acoustic Effects from Sonar by Marine Mammal Species

The MMPA requires that federal agencies obtain authorization for activities that will take marine mammals by harassment. The ESA requires that federal agencies conduct a Section 7 consultation when a proposed action may affect endangered species. As such, NSWC PCD requested a Letter of Authorization (LOA) from NMFS per the MMPA and consulted with NMFS per Section 7 of the ESA. On conclusion of consultations, this Final EIS/OEIS incorporates the results and conclusions of the LOA request, the Navy's Biological Evaluation (BE), and NMFS's BO. Acoustical modeling provides an estimate of the actual exposures. As previously mentioned, NSWC PCD RDT&E activities involve mid-frequency sonar operation for only 10 percent of operational hours. Furthermore, testing generally involves short-term use and single systems at once. Refer to Appendix F for information on distribution, important reproductive, and feeding areas for each species.

Table 4-37. Alternative 2: Estimates of Marine Mammal Exposures from Sonar Missions in Non-Territorial Waters Per Year

Marine Mammal Species	Level A	Level B (TTS)	Level B (Behavioral)
Bryde's whale	0	0	0
Sperm whale	0	0	1
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	1
Short-finned pilot whale	0	0	1
Risso's dolphin	0	0	1
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	0	1	46
Atlantic spotted dolphin	0	1	39
Pantropical spotted dolphin	0	0	16
Striped dolphin	0	0	3
Spinner dolphin	0	0	13
Clymene dolphin	0	0	5
Fraser's dolphin	0	0	0

Territorial Waters

The bottlenose and Atlantic spotted dolphin are the only marine mammals that would occur in territorial waters and for which modeling was conducted. Sonar analysis indicates that zero bottlenose and Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level A harassment, therefore the following subsections will discuss the potential effects to these species from sonar exposure associated with NSWC PCD RDT&E activities at sound levels likely to result only in Level B (TTS) and Level B (behavioral) harassment. A qualitative assessment for the Florida manatee is also provided at the end of this section.

Bottlenose dolphin

Functional hearing for bottlenose dolphins is estimated to occur between approximately 150 Hz and 160 kHz, which places them in the mid-frequency cetacean group (Southall et al., 2007) with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). Bottlenose dolphins communicate via clicks and whistles at frequency ranges that overlap mid-frequency active sonar though best hearing sensitivity aligns more with that of high frequency sonar. Signature whistles, which identify individual dolphins and are a dominant characteristic of communications between mothers and calves, range from 3.4 to 14.5 kHz, comparable to the 1 to 10 kHz range of mid-frequency active sonar. Therefore, potential Level B exposures from MFA sonar could result in impaired communication between mother and calf pairs. Additionally, experiments support the likelihood that some HFA sonar frequencies could result in a behavioral response. Observed changes in behavior in one bottlenose dolphin were induced with an exposure to a 75 kHz one-second pulse at 178 dB re 1 μPa [root mean square (rms)]; these are received levels at the estimated position of the animals' ears (Ridgway et al., 1997; Schlundt et al., 2000). Exposure to MFA sonar that is below or HFA sonar that is above the functional hearing capability of bottlenose dolphins may not elicit a behavioral response since the respective frequencies are outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, bottlenose dolphin behavioral exposures may be an overestimate. Any behavioral responses that do occur are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures. Thus, interruptions in communication and other activities would be temporary. Furthermore, experienced marine mammal observers have not documented any behavioral changes during recent NSWC PCD RDT&E test activities (SAIC, 2007; SAIC 2005). Based on these observations, Ferrer (2008) has concluded that sonar use for two test events in territorial waters have not resulted in any behavioral changes or any injury or mortality of bottlenose dolphins during sonar use.

Sonar analysis indicated that only two bottlenose dolphins will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative, three under Alternative 1, and three under Alternative 2. The risk function and Navy post-modeling analysis estimates that 254 bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 513 under Alternative 1, and 521 under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. In the northern GOM, the stocks of concern include the continental shelf and oceanic stocks. The continental shelf stock is thought to overlap with both the oceanic stock as well as coastal socks in some areas (Waring et al., 2008); however, the coastal stock is generally limited to less than 20 m (66 ft) water depths. The best estimate of abundance for the GOM continental shelf stock is 21,531, (Waring et al., 2008). Based on exposure data and the best estimate of abundance, 0.0093 percent of the GOM continental shelf stock of bottlenose dolphins will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative and 0.014 under Alternative 1 and Alternative 2. Furthermore, 1.2 percent of the GOM continental shelf stock of bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 2.4 percent under Alternative 1, and 2.4 percent under Alternative 2.

The best estimate of abundance for the GOM oceanic stock of bottlenose dolphins is 3,708. The oceanic stock is provisionally defined for bottlenose dolphins inhabiting waters greater than 200 m (656 ft). Based on the bathymetry of the NSWC PCD Study Area, the deepest depth at the 12 NM limit is 33 m (99 ft), therefore this stock will be analyzed in the non-territorial water section.

Based on the best available science, the Navy concludes that exposures to bottlenose dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to bottlenose dolphins In accordance with NEPA, there will be no significant impact to bottlenose dolphins in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data, the characteristics of the sonars tested and nature of tests, and the current records from marine mammal monitoring during NSWC PCD RDT&E test activities. The Navy sought an LOA from NMFS in accordance with the MMPA.

Atlantic spotted dolphin

Functional hearing for Atlantic spotted dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al., 2007). Atlantic spotted dolphins produce a variety of sounds in frequencies from 0.1 to above 100 kHz. Whistles range from 7.1 to 14.5 kHz which overlaps with mid-frequency active sonar (1 to 10 kHz) while echolocation clicks ranging from 40 to 130 kHz overlap well with HFA sonar. Some communication does occur at frequencies below that for MFA sonar. Exposure to MFA sonar that is below or high-frequency active sonar that is above the functional hearing capability of Atlantic spotted dolphins may not elicit a behavioral response since the respective frequencies are outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, Atlantic spotted dolphin behavioral exposures may be an overestimate. Furthermore, NSWC PCD RDT&E test activities recently have incorporated marine mammal observers, who did not observe any behavioral change or any injury or mortality of Atlantic spotted dolphins during sonar use for two test events in territorial waters (Ferrer, 2008).

Sonar analysis indicated that one Atlantic spotted dolphin will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative, two under Alternative 1 and two under Alternative 2. Furthermore, the risk function and Navy post-modeling analysis estimates that 198 Atlantic spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 401 under Alternative 1, and 408 under Alternative 2.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for Atlantic spotted dolphins in the northern GOM is 37,611, with a minimum population estimate of 24,752 dolphins (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, 0.0027 percent of the northern GOM stock of Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative, 0.0053 percent under Alternative 1 and 0.0053 percent under Alternative 2. In addition, 0.53 percent of the northern GOM stock of Atlantic spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 1.1 percent under Alternative 1, and 1.1 percent under Alternative 2. These exposures will not necessarily occur to different individuals as the same species could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of Atlantic spotted dolphins experiencing harassment may be fewer than previously stated.

Based on best available science, the Navy concludes that exposures to Atlantic spotted dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Atlantic spotted dolphins. In accordance with NEPA, there will be no significant impact to Atlantic spotted dolphins in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data, the characteristics of the sonars tested and nature of tests, and the current records from marine mammal monitoring during NSWC PCD RDT&E test activities. The Navy sought an LOA from NMFS in accordance with the MMPA .

West Indian manatee

The manatee is considered to be an inshore species, with most sightings occurring in warm freshwater, estuarine, and extremely nearshore coastal waters. During winter, manatees are largely restricted to peninsular Florida in the Gulf of Mexico and to Florida and southeastern Georgia in the Atlantic Ocean. Distribution expands northward and eastward in warmer months. Exposure numbers for the manatees could not be calculated due to the lack of acoustic exposure criteria and lack of available density information.

Behavioral data on two animals indicate an underwater hearing range of approximately 0.4 to 46 kHz, with best sensitivity between 16 and 18 kHz (Gerstein et al., 1999), while earlier electrophysiological studies indicated best sensitivity from 1 to 1.5 kHz (Bullock et al., 1982). Therefore, it appears that manatees have the capability to hear active sonar. In one study, manatees reacted to the sound from approaching or passing boats by moving into deeper waters or increasing swim speed (Nowacek et al., 2004b). By extension, manatees could react to active sonar; however, there is no evidence to suggest the reaction would likely disturb the manatee to a point where their behaviors are abandoned or significantly altered. Specifically, manatees did not respond to sound at levels of 10 to 80 kHz produced by a pinger every 4 seconds for 300 milliseconds (Bowles et al., 2001). The pings' energy was predominantly in the 10 to 40 kHz range (the mid to high portion of manatee hearing). The level of sound was approximately 130 dB re 1 μPa.

Additionally, Hubbs-SeaWorld Research Institute (HSWRI) initially tested a manatee detection device based on sonar (Bowles et al., 2004). In addition to conducting sonar reflectivity, the experiments also included a behavioral response study. Experiments were conducted with 10 kHz pings, whereby the sound level was increased by 10 dB from 130 dB to 180 dB or until the researchers observed distress. Rapid swimming, thrashing of the body or paddle, and spinning while swimming indicated distress. Researchers found that manatees detected the 10 kHz pings and approached the transducer cage when the sonar was turned on initially. However, none of the responses indicated that the manatees responded with intense avoidance or distress. The authors concluded that manatees do not exhibit strong startle responses or an aggressive nature towards acoustic stimuli, which differs from experiments conducted on cetaceans and pinnipeds (Bowles et al., 2004).

Based on best available science manatees would hear mid-frequency and high-frequency sonar, but would not likely show a strong reaction or be disturbed from their normal range of behaviors. Furthermore, manatees do not regularly occur in the NSWC PCD Study Area. Based on the behavioral data and preferred habitat, in accordance with NEPA, there will be no significant impact to manatees in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy finds that sonar operations during NSWC PCD RDT&E activities will have no effect on manatees.

Non-territorial Waters

The following subsections present the summary for species with potential to be exposed to sound based on the previous sonar analysis. The results of this analysis indicate that no marine mammal species will be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, Alternative 1, and Alternative 2. Additionally, only two marine mammal species (bottlenose dolphin and Atlantic spotted dolphin) are expected to result in Level B (TTS) harassment in one or more of the alternatives. The subsections discussing those species will include those effects. The other subsections will only present information for the marine mammal species with the potential to be exposed to sound levels resulting in Level B (behavioral) harassment. A qualitative assessment for the West Indian manatee is also provided at the end of this section.

Sperm whale

Sperm whales functional hearing range is estimated to occur between approximately 150 Hz and 160 kHz, placing them in the mid-frequency cetacean group (Southall et al., 2007). No direct tests on sperm whale hearing have been made, although the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high frequency to ultrasonic frequency sounds. The overall sperm whale hearing range generally intersects MFA and HFA sonars used during NSWC PCD RDT&E activities. The intersection of common frequencies between sperm whale functional hearing and MFA and HFA sonars suggests that more often than not there is a potential for a behavioral response. However, behavioral observations have been made whereby during playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al., 1997). Additionally, even though the sperm whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

The risk function and Navy post-modeling analysis estimates that one sperm whale will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, Alternative 1, and Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. In the northern GOM, the best abundance estimate for sperm whales is 1,665, with a minimum population estimate of 1,114 (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, 0.060 percent of the northern GOM stock of sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, Alternative 1, and Alternative 2.

Based on best available science, the Navy concludes that exposures to sperm whales due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to sperm whales. In accordance with EO 12114, there will be no significant harm to sperm whales in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data and the characteristics of the sonars tested and nature of tests. In accordance with the ESA, the Navy finds that sonar operations during NSWC PCD RDT&E activities may affect sperm whales. The Navy sought an LOA from NMFS in accordance with the MMPA and initiated consultation under Section 7 of the ESA for concurrence.

Melon-headed Whale

The only published acoustic information for melon-headed whales is from the southeastern Caribbean (Watkins et al., 1997). Sounds recorded included whistles and click sequences. Recorded whistles have dominant frequencies between 8 and 12 kHz; higher-level whistles were estimated at no more than 155 dB re 1 μPa-m (Watkins et al., 1997). Clicks had dominant frequencies of 20 to 40 kHz; higher-level click bursts were estimated to be about 165 dB re 1 μPa-m (Watkins et al., 1997). No empirical data on hearing ability for this species are available.

The risk function and Navy post-modeling analysis estimates that one melon-headed whale will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, Alternative 1, and Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for melon-headed whales in the northern GOM is 2,283 individuals, with a minimum population estimate of 2,238 whales (Waring et al., 2008). Based on the exposure data, 0.044 percent of the northern GOM stock of melon-headed whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, Alternative 1, and Alternative 2.

Based on best available science, the Navy concludes that exposures to melon-headed whales due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to melon-headed whales. In accordance with NEPA, there will be no significant impact to melon-headed whales in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data, the characteristics of the sonars tested and nature of tests, and the current records from marine mammal monitoring during NSWC PCD RDT&E test activities. The Navy sought an LOA from NMFS in accordance with the MMPA.

Short-finned Pilot Whale

Pilot whales belong to the mid-frequency cetacean functional hearing group. Pilot whale sound production includes whistles and echolocation clicks. Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to 14 kHz and 30 to 60 kHz (Ketten, 1998; Richardson et al., 1995), respectively, at an estimated source level of 180 dB re 1 μPa-m peak (Fish and Turl, 1976; Ketten, 1998). There are no hearing data available for short-finned pilot whales. However, the most sensitive hearing range for odontocetes generally includes high frequencies (Ketten, 1997). The risk function and Navy post-modeling analysis estimates that zero short-finned pilot whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, one under Alternative 1, and one Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for short-finned pilot whales in the northern GOM is 716, with a minimum population estimate of 542 whales (Waring et al., 2008). Based on the exposure data, 0.14 percent of the northern GOM stock of short-finned pilot whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under Alternative 1 and 0.14 percent under Alternative 2.

Based on best available science, the Navy concludes that exposures to short-finned pilot whales due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to short-finned pilot whales. In accordance with NEPA, there will be no significant impact to short-finned pilot whales in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data, the characteristics of the sonars tested and nature of tests, and the current records from marine mammal monitoring during NSWC PCD RDT&E test activities. The Navy sought an LOA from NMFS in accordance with the MMPA.

Risso's dolphin

Functional hearing for Risso's dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al., 2007). Nachtigall et al. (1995; 2005) measured hearing in an adult and an infant Risso's dolphin. The adult hearing ranged from 1.6 to 100 kHz and was most sensitive between 8 and 64 kHz. The infant could hear frequencies ranging from 4 to 150 kHz, with best sensitivity at 90 kHz, well above MFA sonar frequencies but well within the HFA sonar frequency range. With regard to mid-frequency active sonar, exposure numbers for Risso's dolphins may be overestimated given that some functional hearing and communication frequencies do not overlap with MFA sonar frequencies. However, the intersection of common frequencies between Risso's dolphin best hearing sensitivity and HFA sonar suggests that more often than not there is a potential for a behavioral response.

The risk function and Navy post-modeling analysis estimates that one Risso's dolphin will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, Alternative 1, and Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammals species. The best estimate of abundance for Risso's dolphins in the northern GOM is 1,589, with a minimum population estimate of 1,668 Risso's dolphins (Waring et al., 2008). Based on this exposure data and the best estimate of abundance, 0.63 percent of the northern GOM stock of Risso's dolphin will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, Alternative 1**,** and Alternative 2.

Based on best available science, the Navy concludes that exposures to Risso's dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Risso's dolphins. In accordance with EO 12114, there will be no significant harm to Risso's dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data and the characteristics of the sonars tested and nature of tests. The Navy sought an LOA from NMFS in accordance with the MMPA.

Bottlenose dolphin

Functional hearing for bottlenose dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al., 2007) with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). Bottlenose dolphins communicate via clicks and whistles at frequency ranges that overlap mid-frequency active sonar though best hearing sensitivity aligns more with that of high frequency sonar. Signature whistles, which identify individual dolphins and are a dominant characteristic of communications between mothers and calves, range from 3.4 to 14.5 kHz, comparable to the 1 to 10 kHz range of mid-frequency active sonar. Therefore, potential Level B exposures from MFA sonar could result in impaired communication between mother and calf pairs. Additionally, experiments support the likelihood that some HFA sonar frequencies could result in a behavioral response. Observed changes in behavior in one bottlenose dolphin were induced with an exposure to a 75 kHz one-second pulse at 178 dB re 1 μPa [root mean square (rms)]; these are received levels at the estimated position of the animals' ears (Ridgway et al., 1997; Schlundt et al., 2000). Exposure to MFA sonar that is below or HFA sonar that is above the functional hearing capability of bottlenose dolphins may not elicit a behavioral response since the respective frequencies are outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, bottlenose dolphin behavioral exposures may be an overestimate. Any behavioral responses that do occur are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures. Thus, interruptions in communication and other activities would be temporary. Furthermore, NSWC PCD RDT&E test activities recently have incorporated dedicated marine mammal observers who have not documented any significant changes in behavior or any injury or mortality of bottlenose dolphins during sonar use for a test event in non-territorial waters (Ferrer, 2008).

This was one of the marine mammal species that may experience levels of sound likely to result in Level B (TTS) and Level B (behavioral) harassments. Sonar analysis indicated that one bottlenose dolphin will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative, Alternative 1, and Alternative 2. Furthermore, the risk function and Navy post-modeling analysis estimates that 27 bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 34 under Alternative 1, and 46 under Alternative 2.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. As previously mentioned, two stocks of bottlenose dolphins occur in the non-territorial waters of the NSWC PCD Study Area. The continental shelf and oceanic stocks are thought to overlap in some areas (Waring et al., 2008). For this analysis the best estimates of abundance for the continental shelf stock and the oceanic stock were combined to calculate the effects to GOM stocks of bottlenose dolphins in non-territorial waters. Therefore, the best estimate of abundance for the GOM continental shelf and oceanic stocks of bottlenose dolphins is 25,239 (Waring et al., 2008). Based on exposure data and the best estimates of abundance, 0.0040 percent of the northern GOM continental shelf and oceanic stocks of bottlenose dolphins will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative, Alternative 1, and Alternative 2. In addition, 0.11 percent of the northern GOM stock of bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 0.13 percent under Alternative 1 and 0.18 percent under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the exercises. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated.

The Navy used the best available science and concludes that exposures to bottlenose dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to bottlenose dolphins. In accordance with EO 12114, there will be no significant harm to bottlenose dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data, the characteristics of the sonars tested and nature of tests, and the current records from marine mammal monitoring during NSWC PCD RDT&E test activities. The Navy sought an LOA from NMFS in accordance with the MMPA.

Atlantic spotted dolphin

Functional hearing for Atlantic spotted dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al., 2007). Atlantic spotted dolphins produce a variety of sounds in frequencies from 0.1 to above 100 kHz. Whistles range from 7.1 to 14.5 kHz which overlaps with mid-frequency active sonar (1 to 10 kHz) while echolocation clicks ranging from 40 to 130 kHz overlap well with HFA sonar. Some communication does occur at frequencies below that for MFA sonar. Exposure to MFA sonar that is below or high-frequency active sonar that is above the functional hearing capability of Atlantic spotted dolphins may not elicit a behavioral response since the respective frequencies are outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, Atlantic spotted dolphin behavioral exposures may be an overestimate. Furthermore, NSWC PCD RDT&E test activities recently have incorporated dedicated marine mammal observers who have not documented any significant changes in behavior or any injury or mortality of Atlantic spotted dolphins during sonar use for a test event in non-territorial waters (Ferrer, 2008).

This was also one of the marine mammal species that may experience levels of sound likely to result in Level B (TTS) and Level B (behavioral) harassments. Sonar analysis indicated that zero Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level B (TTS) harassment under the No Action Alternative and one under Alternative 1 and Alternative 2. The risk function and Navy post-modeling analysis estimates that 23 Atlantic spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 29 under Alternative 1, and 39 under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of Atlantic spotted dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. As previously mentioned, the best estimate of abundance for Atlantic spotted dolphins in the northern GOM is 37,611, with a minimum population estimate of 24,752 dolphins (Waring et al., 2008). Based on exposure data and the best estimate of abundance, 0.0027 percent of the northern GOM Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level B (TTS) harassment under Alternative 1 and Alternative 2. Furthermore, based on the exposure data, 0.061 percent of the northern GOM stock of Atlantic spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 0.077 percent under Alternative 1 and 0.10 percent under Alternative 2.

The Navy used the best available science and concludes that exposures to Atlantic spotted dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Atlantic spotted dolphins. In accordance with EO 12114, there will be no significant harm to Atlantic spotted dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data, the characteristics of the sonars tested and nature of tests, and the current records from marine mammal monitoring during NSWC PCD RDT&E test activities. The Navy sought an LOA from NMFS in accordance with the MMPA.

Pantropical spotted dolphin

Functional hearing for pantropical spotted dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al., 2007). Pantropical spotted dolphins communicate, feed and socialize via clicks and whistles at frequency ranges that overlap MFA sonar though best hearing sensitivity aligns more with that of HFA. Pantropical spotted dolphin whistles have a frequency range of 3.1 to 21.4 kHz (Thomson and Richardson, 1995) which overlaps well with MFA sonar, while clicks are bimodal with peaks at 40 to 60 kHz and 120 to 140 kHz and are more aligned with HFA sonar (Schotten et al., 2004). Potential Level B exposures from MFA and HFA sonar could therefore result in impaired communication, changes in foraging and social interaction. However, any behavioral responses are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures. Thus, interruptions in communication and other activities would be temporary.

The risk function and Navy post-modeling analysis estimates that nine pantropical spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 12 under Alternative 1, and 16 under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of pantropical spotted dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for pantropical spotted dolphins in the northern GOM is 34,067 (Waring et al., 2008). Based on the exposure data, 0.026 percent of the northern GOM stock of pantropical spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 0.035 percent under Alternative 1 and 0.047 percent under Alternative 2.

Based on best available science, the Navy concludes that exposures to pantropical spotted dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pantropical spotted dolphins. In accordance with EO 12114, there will be no significant harm to pantropical spotted dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data and the characteristics of the sonars tested and nature of tests. The Navy sought an LOA from NMFS in accordance with the MMPA.

Striped dolphin

Functional hearing for striped dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al., 2007). Kastelein et al., (2003) determined the hearing sensitivity of a single striped dolphin to range from 0.5 to 160 kHz with best sensitivity at 64 kHz. Assuming this study may be applicable to striped dolphins in general, the frequency of best sensitivity for this species is much higher than the range of frequencies for MFA sonar but aligns well with that of HFA sonar. Dominant frequencies of whistles ranged from 8 to 12.5 kHz (Thomson and Richardson, 1995). Exposure numbers for striped dolphins may be overestimated given that some functional hearing and communication frequencies do not overlap with MFA sonar. However, the intersection of common frequencies between striped dolphin functional hearing and HFA sonar suggests that more often than not there is a potential for a behavioral response.

The risk function and Navy post-modeling analysis estimates that two striped dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, two under Alternative 1, and three under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of striped dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best abundance estimate for striped dolphins in the northern GOM is 6,505, with a minimum population estimate of 3,325 striped dolphins (Waring et al., 2008). Based on this exposure data and the best estimate of abundance, 0.060 percent of the northern GOM stock of striped dolphin will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 0.060 percent under Alternative 1, and 0.090 percent under Alternative 2.

Based on best available science, the Navy concludes that exposures to striped dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to striped dolphins. In accordance with EO 12114, there will be no significant impact to striped dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data and the characteristics of the sonars tested and nature of tests. The Navy sought an LOA from NMFS in accordance with the MMPA.

Spinner dolphin

Spinner dolphins are assumed to belong to the mid-frequency functional hearing group, though no data on their hearing exists. Spinner dolphins are known to produce sounds ranging from 1 to 160 kHz. Spinner dolphin whistles have been consistently recorded as high as 16.9 to 17.9 kHz which is above frequencies for MFA sonar but within the range for HFA sonar. Exposure to MFA sonar that is below or HFA sonar that is above the functional hearing capability of spinner dolphins may not elicit a behavioral response since the respective frequencies are outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, spinner dolphin behavioral exposures may be an overestimate.

The risk function and Navy post-modeling analysis estimates that eight spinner dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, ten under Alternative 1, and thirteen under Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for spinner dolphins in the northern GOM is 1,989 (Waring et al., 2008). Based on this exposure data and the best estimate of abundance, 0.40 percent of the northern GOM stock of spinner dolphin will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 0.50 percent under Alternative 1**,** and 0.65 percent under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of spinner dolphins experiencing harassment may be fewer than previously stated.

Based on best available science, the Navy concludes that exposures to spinner dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to spinner dolphins. In accordance with EO 12114, there will be no significant harm to spinner dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data and the characteristics of the sonars tested and nature of tests. The Navy sought an LOA from NMFS in accordance with the MMPA.

Clymene dolphin

Functional hearing for Clymene dolphins is estimated to occur between approximately 150 Hz and 160 kHz placing them in the mid-frequency cetacean group (Southall et al. 2007). Clymene dolphin whistle structure is similar to that of other stenellids, but it is generally higher in frequency (range of 6.3 to 19.2 kHz). This frequency range has some overlap with MFA sonar and aligns well with the lower end of the HFA sonar frequency range. Because some Clymene dolphin vocalizations are higher in frequency than mid-frequency active sonar, it is likely that behavioral exposure numbers may be overestimated.

The risk function and Navy post-modeling analysis estimates that three Clymene dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, four under Alternative 1, and five under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of Clymene dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for Clymene dolphins in the northern GOM is 6,575 (Waring et al., 2008). Based on this exposure data and the best estimate of abundance, 0.046 percent of the northern GOM stock of Clymene dolphin will exhibit behavioral responses that NMFS will classify as harassment under the MMPA under the No Action Alternative, 0.061 percent under Alternative 1**,** and 0.076 percent under Alternative 2.

Based on best available science, the Navy concludes that exposures to Clymene dolphins due to NSWC PCD RDT&E activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Clymene dolphins. In accordance with EO 12114, there will be no significant harm to Clymene dolphins in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2 based on the exposure data and the characteristics of the sonars tested and nature of tests. The Navy sought an LOA from NMFS in accordance with the MMPA.

West Indian manatee

As previously stated, the manatee is considered to be an inshore species, with most sightings occurring in warm freshwater, estuarine, and extremely nearshore coastal waters. Exposure numbers for the manatees could not be calculated due to the lack of acoustic exposure criteria and lack of available density information. The behavioral data indicates that while manatees have the capability to hear active sonar, there is no evidence to suggest their behavioral reaction would likely disturb the manatee to a point where their behaviors are abandoned or significantly altered (Bowles et al., 2004).

Based on best available science manatees would hear mid-frequency and high-frequency sonar, but would not likely show a strong reaction or be disturbed from their normal range of behaviors. Furthermore, this species is not likely to occur as far offshore as the non-territorial waters of the NSWC PCD Study Area. There are sightings in waters within W-151 (includes Pensacola OPAREA) and W-155 (includes Panama City OPAREA), although manatee experts note that these should be considered anomalies due to the known habitat preferences of this species (DON, 2007). Based on the behavioral data and preferred manatee habitat, in accordance with EO 12114, there will be no significant harm to manatees in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy finds that sonar operations during NSWC PCD RDT&E activities will have no effect on manatees.

4.3.6.4 Electromagnetic Operations – Marine Mammals

4.3.6.4.1 Introduction and Approach to Analysis

Potential effects by the generation of EMFs were analyzed for marine mammals. Neither regulations nor scientific literature provide threshold criteria to determine the significance of the potential effects from the NSWC PCD EMF activities. Data regarding the influence of EMFs on cetaceans is inconclusive. Dolman et al. (2003) provides a literature review of the influences of marine wind farms on cetaceans. The literature focuses on harbor porpoises and dolphin species due to their nearshore habitats. Teilmann et al. (2002) evaluated the frequency of harbor porpoise presence at wind farm locations around Sweden. Although EMF influences were not specifically addressed, the presence of cetacean species implies that at least some species are not repelled by the presence of EMFs. In an effort to reduce any potential effects to marine mammals, the protective measures presented in Chapter 5 will be implemented.

4.3.6.4.2 Territorial Waters – Marine Mammals (Electromagnetic Operations)

Although a small number of marine mammals in territorial waters will be exposed to EMFs, exposure does not equate to harm. EMFs have not been linked to any serious injury, mortality, or behavioral harassment in marine species. The EMF events will be spread out over time and location. The EMF field generated will dissipate quickly within the saltwater environment, and any influence it may have on the surrounding environment will be temporary and localized. The EMF levels generated above the earth's magnetic field will be of short duration and will extend out to only a 4-m (13.12-ft) radius from the cable's surface (DON, 2005a). Additionally, the proposed protective measures outlined Chapter 5 will be implemented. The Navy has determined that there will be no reasonably foreseeable injury, mortality, or behavioral harassment of marine mammals under the No Action Alternative, Alternative 1, or Alternative 2. Therefore, based on the best available scientific information coupled with the small amount of area affected (4 m [13.12-ft]) and implementation of protective measures, in accordance with NEPA, there will be no significant impact to marine mammals from electromagnetic operations in territorial waters under the No Action Alternative, Alternative 1, and Alternative 2. In addition, in accordance with the ESA, the Navy finds that there will be no affect to ESA-listed marine mammals because no ESA-listed species regularly occur here.

4.3.6.4.3 Non-Territorial Waters – Marine Mammals (Electromagnetic Operations)

As described in Section 4.3.6.4.2, although a small number of marine mammals in territorial waters will be exposed to EMFs, exposure does not equate to harm. EMFs have not been linked to any serious injury, mortality, or behavioral harassment in marine species and furthermore, the EMF events included in NSWC PCD RDT&E activities will be spread out over time and location. The EMF levels generated above the earth's magnetic field will be of short duration and will extend out to only a 4-m (13.12-ft) radius from the cable's surface (DON, 2005a). Additionally, the proposed protective measures outlined Chapter 5 will be implemented. The Navy has determined that there will be no reasonably foreseeable injury, mortality, or behavioral harassment of marine mammals under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with EO 12114, based on the best available scientific information coupled with the small amount of area affected (4 m [13.12-ft]) and the implementation of protective measures, there will be no significant harm to marine mammals from electromagnetic operations in non-territorial waters under the No Action Alternative, Alternative 1, and Alternative 2. In addition, in accordance with the ESA, the Navy finds that there will be no affect to ESA-listed marine mammals because of the implementation of protective measures and the analyses presented in Sections 4.3.6.4.1 and 4.3.6.4.2.

4.3.6.5 Laser Operations – Marine Mammals

4.3.6.5.1 Introduction and Approach to Analysis

The greatest potential for laser exposure is at the ocean's surface, where laser intensity is greatest. As the laser penetrates the water, 96 percent of a laser beam is absorbed, scattered, or otherwise lost (Ulrich, 2004). As with humans, the greatest laser-related concern for marine mammals is visual damage. Lasers may also cause burns to the skin, but the threshold energy for eye damage is considerably lower and is considered the threshold of concern. Effects to an animal's blubber are not addressed because the necessary laser power to cause damage is much greater than that which will cause damage to the eyes (Ulrich, 2004). While all points on an animal's body have roughly the same probability of laser exposure, only eye exposure is of concern. The sections below will focus on the potential for eye damage only.

Of the marine species considered, marine mammals are the most sensitive due to their frequent surfacing, coupled with the assumption that they have relatively better visual acuity than other marine species. Neither regulations nor scientific literature provide threshold criteria for determining the significance of the potential effects from the NSWC PCD laser activities.

Although many anatomical differences exist between marine mammal and human eyes, the pupil area, focal length, and retinal resolution can be used to determine a comparative laser effect sensitivity ratio. Zorn et al. (2000) calculated sensitivity ratios for various marine mammals, including cetacean species. The ratios suggest that cetaceans are less susceptible than humans to eye damage caused by lasers. Under exposure to laser energy, ocular damage may occur in the pigment granules of the retinal pigment epithelium. Due to the presence of the tapetum lucidum (a highly reflective membrane) in marine mammal eyes, the number of these granules is lower. The tapetum lucidum will also decrease the amount of laser energy transmitted to the choroids, which is an area of the eye that contains the granules. Further, cetacean eyes are not able to focus light as well as human eyes.

Another reason that eye damage to marine mammals is unlikely is that ocular damage is not dependent on wavelength with exposures of less than 10 seconds. Thus, an animal's eye will have to be exposed to a direct beam for at least 10 seconds or longer to sustain damage. With pulse durations less than 10 seconds combined with the laser platform movement and animal motion, exposures of more than 10 seconds will be very unlikely. In an effort to further reduce the potential effects to marine mammals, the protective measures included in Chapter 5 will be implemented.

4.3.6.5.2 Territorial Waters – Marine Mammals (Laser Operations)

Exposure to lasers does not imply harm. Any heat that the laser generates will be rapidly dissipated due to the large heat capacity of water and the large volume of water in which the laser is used (Churnside, 2004). There is no suspected effect due to heat loss from the laser beam.

Light Imaging Detection and Ranging (LIDAR) systems will be deployed in the air by helicopter. A dolphin or whale will have to surface and turn its head skyward at the exact moment that the helicopter is overhead to be exposed to a LIDAR laser. Similarly, a marine mammal will have to be looking directly into the underwater laser exit port for 10 seconds or more to be affected by LLS or directional laser systems. Furthermore, 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Therefore, species underwater will not be harmed. In addition, the protective measures listed in Chapter 5 will be implemented.

Thus, based on the best available scientific data showing that cetaceans are less susceptible than humans to eye damage from lasers (Zorn et al., 2000) and the low likelihood that an animal would directly stare into a laser port at the exact moment overhead or for the length of time required, in accordance with NEPA, there will be no significant impact to marine mammals from lasers under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy has determined that there will be no reasonably foreseeable injury or mortality of marine mammals and that the proposed action will have no effect on threatened or endangered species of marine mammals based on this analysis.

4.3.6.5.3 Non-Territorial Waters – Marine Mammals (Laser Operations)

As described in Section 4.3.6.5.2, exposure to lasers does not imply harm because any heat that the laser generates will be rapidly dissipated (Churnside, 2004). There is no suspected effect due to heat loss from the laser beam.

It is unlikely that a dolphin or whale will look directly into a laser exit port, which is required for an effect to occur. This implies that both the animal and the platform will have to be traveling in the same direction at an identical speed. LIDAR systems will be deployed in the air by helicopter. A dolphin or whale will have to surface and turn its head skyward at the exact moment that the helicopter is overhead to be exposed to a LIDAR laser. Similarly, a marine mammal will have to be looking directly into the underwater laser exit port for 10 seconds or more to be affected by LLS or directional laser systems. Furthermore, 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Since heat will not create effects and because exposure of the lasers to the blubber of an animal will not harm them, there will be no harm to marine mammals from laser operations. In addition, the protective measures listed in Chapter 5 will be implemented.

Therefore, based on the best available scientific data showing that cetaceans are less susceptible than humans to eye damage from lasers (Zorn et al., 2000) and the low likelihood that an animal would directly stare into a laser port at the exact moment overhead or for the length of time required, in accordance with EO 12114, there will be no significant harm to marine mammals in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy has determined that there will be no reasonably foreseeable injury or mortality of marine mammals and that the proposed action will have no effect on threatened or endangered species because of the remote likelihood for effects to occur.

4.3.6.6 Ordnance Operations – Marine Mammals

Live ordnance testing may occur from the surf zone out to the outer perimeter of the NSWC PCD Study Area. The size and weight of the explosives used would vary from 0.91 to 272 kg (2 to 600 lbs) TNT equivalent NEW. No detonations over 34 kg (75 lbs) NEW will be conducted within the territorial waters of the NSWC PCD Study Area. Operations involving live explosives include mine detonations and surf zone line charge detonations.

4.3.6.6.1 Introduction and Approach to Analysis

Underwater detonations may project pressure and sound intensities sufficient to cause physical trauma or acoustic or behavioral effects to protected marine mammals. Refer to Section 4.3.6.3 for information related to MMPA Level A and Level B harassment, as well as ESA harm and harassment, respectively.

Determining the potential exposures associated with ordnance operations is very similar to determining potential exposures associated with sonar operations. Refer to Appendix L for additional information.

Metrics: Underwater Explosive Sound

Four standard acoustic metrics for measuring underwater pressure waves were used in this analysis:

- Total Energy Flux Density Level (EFD)
- 1/3-Octave EFD
- Positive Impulse
- Peak Pressure

Total EFD

Total EFD is the metric used for analyzing the level of sound that would cause a permanent decrease in hearing sensitivity. Decibels are used to express this metric.

1/3-Octave EFD

One-third octave EFD is the metric used in discussions of temporary (i.e., recoverable) hearing loss and for behavioral response thresholds of protected species to sound. One-third octave EFD is the energy flux density in the 1/3-octave frequency band at which the animal potentially exposed hears best. Decibels are also used to express this metric. This metric is used for analyzing underwater detonations.

Positive Impulse

Positive impulse is the metric used for analyzing lethal sound levels, as well as sound that marks the onset of slight lung injury in cetaceans. Positive impulse as it is used here is based on an equation modified by Goertner (1982); thus it is more completely stated as the

Goertner-modified positive impulse. The units to express this metric are pounds per square inch millisecond (psi-ms).

Peak Pressure

This is the maximum positive pressure for an arrival of a sound pressure wave that a marine mammal would receive at some distance away from a detonation. Units used here are pounds per square inch (psi) and dB levels.

Criteria and Thresholds for Explosive Sound

Criteria and thresholds for estimating the effects on protected species including marine mammals and sea turtles from a single explosive event were established and publicly vetted through the NEPA process during the Seawolf Submarine Shock Test Final Environmental Impact Statement (FEIS) ("Seawolf") and the USS Winston S. Churchill (DDG-81) Ship Shock FEIS ("Churchill") (DON, 2001a). These criteria and thresholds were adopted by NMFS in its final rule on unintentional taking of marine animals incidental to the shock testing. The risk assessment approach for all gunfire-related sound in water was derived from the Seawolf/Churchill approach.

Criteria and Thresholds for Physiological Effects to Explosive Sound

The criterion for mortality for marine mammals used in the Churchill *Final EIS* is "onset of severe lung injury." This criteria is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure. The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms." Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31- psi-ms index is a complicated calculation. Again, to be conservative, Churchill used the mass of a calf dolphin (at 12.2 kg [26.9 lbs]), so that the threshold index is 30.5 psi-ms. For injury, two criteria are used: 50 percent eardrum rupture (i.e., tympanic membrane [TM] rupture) and onset of slight lung injury. These criteria are considered indicative of the onset of injury. The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM); this is stated in terms of an EL value of 1.17 inches per pound per square inch (in-lb/in^2) (about 205 dB re 1 μPa^2-s). This recognizes that TM rupture is not necessarily a serious or life-threatening injury but is a useful index of possible injury that is well-correlated with measures of permanent hearing impairment (e.g., Ketten [1998] indicates a 30 percent incidence of PTS at the same threshold). The threshold for onset of slight lung injury is calculated for a calf dolphin (12.2 kg [27 lbs]); it is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-ms. This is a departure from the Churchill and Seawolf approaches in the use of animal mass in the Goertner threshold for slight lung injury. In this assessment, cetaceans are assessed as calves, defined as those with mass less than 174 kg (384 lbs). The associated threshold is indexed to 13 psi-ms, which corresponds to a calf dolphin at 12.2 kg (27 lbs) (DON, 2001a).

The first criterion for non-injurious harassment is TTS, which is defined as a temporary, recoverable loss of hearing sensitivity (NMFS, 2001; DON, 2001a). The criterion for TTS is

182 dB re 1 squared micropascal second (dB re 1 μPa^2-s), which is the greatest energy flux density level in any 1/3-octave band at frequencies above 100 Hz for marine mammals.

The second criterion for estimating TTS threshold applies to all cetacean species and is stated in terms of peak pressure at 23 psi. The threshold is derived from the Churchill threshold which was subsequently adopted by NMFS in its Final Rule on the unintentional taking of marine animals incidental to the shock testing (NMFS, 2001). The original criteria in Churchill incorporated 12 psi. The current criteria and threshold for peak pressure over all exposures was updated from 12 psi to 23 psi for explosives less than 2,000 lbs based on an incidental harassment authorization (IHA) issued to the Air Force for a similar action (NOAA, 2006b). Peak pressure and energy scale at different rates with charge weight, so that ranges based on the peak-pressure threshold are much greater than those for the energy metric when charge weights are small—even when source and animal are away from the surface. In order to more accurately estimate TTS for smaller shots while preserving the safety feature provided by the peak pressure threshold, the peak pressure threshold is appropriately scaled for small shot detonations. This scaling is based on the similitude formulas (e.g., Urick, 1983) used in virtually all compliance documents for short ranges. Further, the peak-pressure threshold for marine mammal TTS for explosives offers a safety margin for source or animal near the ocean surface.

Criteria and Thresholds for Behavioral Effects to Explosive Sound

For a single explosion, to be consistent with Churchill, TTS is the criterion for Level B harassment. In other words, because behavioral disturbance for a single explosion is likely to be limited to a short-lived startle reaction, use of the TTS criterion is considered sufficient protection.

Summary of Criteria and Thresholds for Explosive Sound

Table 4-38 summarizes the criteria and thresholds used in calculating the potential impacts to marine mammal from explosive sound.

Table 4-38. Explosive Sound Criteria and Thresholds for Marine Mammals

Harassment Level	Criterion	Threshold
Level A Harassment Mortality	Onset of severe lung injury	"Goertner" modified positive impulse indexed to 31 psi ms
Injury	Tympanic membrane rupture	50% rate of rupture 205 dB re 1 µPa 2-s (Energy Flux Density)
Injury	Onset of slight lung injury	Goertner Modified Positive Impulse Indexed to 13 psi-ms
Level B Harassment Non-injury	TTS	182 dB re 1 µPa2-s (Energy Flux Density) in any 1/3-octave band at frequencies above 100 Hz for all toothed whales (e.g., sperm whales, beaked whales); above 10 Hz for all baleen whales
Non-injury dual criterion	Onset of TTS	23 psi peak pressure level (for small explosives)

psi-ms = pounds per square inch-milliseconds µPa2-s = squared micropascal-second; TTS = temporary threshold shift
These criteria were applied to all detonations including line charges, which are comprised of a 107 m (350 ft) detonation cord with explosives lined from one end to the other end in 2 kg (5 lb) increments.

4.3.6.6.2 Calculation Methods – Marine Mammals (Ordnance Operations)

An overview of the methods to determine the number of exposures of ESA-listed and MMPA-protected species to sound likely to result in injury, mortality, Level A harassment, or Level B harassment is provided in the following paragraphs. Appendix M, Supplemental Information for Underwater Noise Analysis, includes specific formulas and more detailed information. The number of potential exposures is calculated by applying estimated densities of marine mammals to the detonation zones. Acoustic thresholds exist for marine mammals. Species density estimates are identified in Section 4.3.6.3.2.

Acoustic threshold areas are derived from mathematical calculations and models that predict the distances or range to which threshold sound levels will travel. Sound is assumed to spread more or less spherically. Therefore, the range of influence is the radius of an ensonified area (the area exposed to sound). The equations for the models consider the amount of net explosive and the properties of detonations under water as well as environmental factors such as depth of the explosion, overall water depth, water temperature, and bottom type. Various combinations of these environmental factors result in a number of environmental provinces.

The result of the calculations and/or modeling is a volume. There are separate volumes for mortality, injury (hearing-related and slight lung), and harassment (TTS and behavioral). For mine detonations, the sound effects were modeled using the different net explosive weights at 16 environmental provinces during the winter and summer seasons. The three ranges of NEW for mine detonations mirror the ranges identified in the analysis of alternatives. Refer to Appendix M, Section M.1.2 for specific information on explosive modeling. Due to differences in delivery and orientation, line charges are not included within these three ranges of NEW, and their potential effects were analyzed and presented separately. A discussion of the environmental provinces and equations used is provided in Appendix E, Geographic Description of Environmental Provinces and Appendix M, Supplemental Information for Underwater Noise Analysis.

Analysis for mine-clearing line charges followed methods similar to detonations. The major differences in the line charge analysis included 1) focus on propagation through the sediment layer(s) rather than treating the bottom as a boundary with a particular reflection loss and 2) modeling according to its unique physical characteristics. The specific information on calculations for mine-clearing line charges is presented in Appendix M, Supplemental Information for Underwater Noise Analysis.

4.3.6.6.3 Territorial Waters – Marine Mammals (Ordnance Operations)

No Action Alternative – Marine Mammals (Ordnance Operations, Territorial)

The No Action Alternative includes detonations in territorial waters of small C4 charges associated with mine warfare, recovery operations, and line charges and could potentially affect marine mammals. Detonations under the No Action Alternative in territorial waters will not expose any species to sound likely to result in harassment (Table 4-39).

Table 4-39. No Action Alternative: Estimates of Marine Mammal Exposures from Live Detonations (0.45 to 4.5 kg [1 to 10 lbs]) in Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bottlenose dolphin	0	0	0
Atlantic spotted dolphin	0	0	0

The No Action Alternative also provides for the detonation of one line charge per year in shallow surf zone water. The maximum NEW will be 794 kg (1,750 lbs). Throughout the NSWC PCD Study Area, the surf zone area is fairly consistent in terms of depth and sediment type, and therefore has relatively consistent sound propagation features throughout the year. Line charge operations under the No Action Alternative in territorial waters will not expose any species to sound likely to result in harassment (Table 4-40).

Table 4-40. No Action Alternative: Estimates of Marine Mammal Exposures from a Line Charge Detonation (794 kg [1,750 lbs] NEW) in Territorial Waters

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bottlenose dolphin	0	0	0
Atlantic spotted dolphin	0	0	0

Alternative 1 – Marine Mammals (Ordnance Operations, Territorial)

Detonations under Alternative 1 may expose only one bottlenose dolphin and one Atlantic spotted dolphin to sound likely to result in harassment (Table 4-41). The only potential impacts to marine mammals will occur at Level B harassment.

Table 4-41. Alternative 1: Estimates of Marine Mammal Exposures from Detonations (0.45 to 34 kg [1 to 75 lbs]) in Territorial Waters

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bottlenose dolphin	0	0	1
Atlantic spotted dolphin	0	0	1

The use of line charges under Alternative 1 will not expose any species to sound likely to result in harassment (Table 4-42).

Table 4-42. Alternative 1: Estimates of Marine Mammal Exposures from Line Charge Detonations (794 kg [1,750 lbs]) in Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bottlenose dolphin	0	0	0
Atlantic spotted dolphin	0	0	0

Alternative 2 – Marine Mammals (Ordnance Operations, Territorial)

Detonations under Alternative 2 in territorial waters may expose up to three bottlenose dolphins and two Atlantic spotted dolphins to sound likely to result in harassment (Table 4-43). The only potential impacts to marine mammals will occur at Level B harassment.

Table 4-43. Alternative 2: Estimates of Marine Mammal Exposures from Detonations (0.45 to 34 kg [1 to 75 lbs]) in Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bottlenose dolphin	0	0	3
Atlantic spotted dolphin	0	0	2

The use of line charges under Alternative 2 in territorial waters will not expose any species to sound likely to result in harassment (Table 4-44).

Table 4-44. Alternative 2: Estimates of Marine Mammal Exposures from Line Charges (794 kg [1,750 lbs] NEW) in Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bottlenose dolphin	0	0	0
Atlantic spotted dolphin	0	0	0

4.3.6.6.4 Non-Territorial Waters – Marine Mammals (Ordnance Operations)

No Action Alternative– Marine Mammals (Ordnance Operations, Non Territorial)

With the No Action Alternative there will be no live detonations occurring within non-territorial waters.

Alternative 1 – Marine Mammals (Ordnance Operations, Non Territorial)

Detonations under Alternative 1 in non-territorial waters may expose up to five marine mammal species to sound likely to result in Level B harassment (Table 4-45). They include the bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, spinner dolphin, and Clymene dolphin. The only potential impacts to marine mammals will occur at Level B harassment.

Table 4-45. Alternative 1: Estimates of Marine Mammal Exposures from Live Detonations (34 to 272 kg [76 to 600 lbs]) in Non-Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bryde's whale	0	0	0
Sperm whale	0	0	0
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0

Table 4-45. Alternative 1: Estimates of Marine Mammal Exposures from Live Detonations (34 to 272 kg [76 to 600 lbs]) in Non-Territorial Waters Per Year (Cont'd)

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	0
Short-finned pilot whale	0	0	0
Risso's dolphin	0	0	0
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	0	1	9
Atlantic spotted dolphin	0	1	4
Pantropical spotted dolphin	0	0	2
Striped dolphin	0	0	0
Spinner dolphin	0	0	3
Clymene dolphin	0	0	1
Fraser's dolphin	0	0	0

Alternative 2 – Marine Mammals (Ordnance Operations, Non-Territorial)

Detonations under Alternative 2 in non-territorial waters may expose up to 8 marine mammal species to sound likely to result in Level B harassment (Table 4-46). They include the sperm whale, melon-headed whale, Risso's dolphin, bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped dolphin, and spinner dolphin. In addition, one bottlenose dolphin, one Atlantic spotted dolphin, one pantropical spotted dolphin, and one spinner dolphin may be exposed to levels of sound likely to result in Level A harassment.

Table 4-46. Alternative 2: Estimates of Marine Mammal Exposures from Detonations (34 to 272 kg [76 to 600 lbs]) in Non-Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bryde's whale	0	0	0
Sperm whale	0	0	1
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	1
Short-finned pilot whale	0	0	0
Risso's dolphin	0	0	1
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	1	1	38
Atlantic spotted dolphin	1	1	18
Pantropical spotted dolphin	0	1	6
Striped dolphin	0	0	2
Spinner dolphin	0	1	10
Clymene dolphin	0	0	0
Fraser's dolphin	0	0	0

4.3.6.6.5 Summary of Potential Acoustic Effects from Detonations by Marine Mammal Species

In accordance with MMPA and ESA requirements, NSWC PCD initiated the permitting and consultation processes, respectively. Acoustical modeling provides an estimate of the actual exposures. In an effort to reduce the potential exposures associated with live detonations, the mitigation and protective measures listed in Chapter 5 will be implemented.

Territorial Waters

The Atlantic spotted dolphin and bottlenose dolphin are the only marine mammals that occur in territorial waters. The acoustic analysis shows that exposures may occur to both species. The following subsections discuss the potential effects to dolphin species from explosive events associated with NSWC PCD RDT&E activities.

Atlantic spotted dolphins

For Atlantic spotted dolphins, no individuals will be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, one under Alternative 1, and two under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for Atlantic spotted dolphins in the northern GOM is 37,611 (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, 0.0027 percent of the northern GOM stock of Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.0053 percent under Alternative 2.

Based on best available science, the Navy concludes that exposure to Atlantic spotted dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Atlantic spotted dolphins. In accordance with NEPA, there will be no significant impact to Atlantic spotted dolphins in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Bottlenose dolphins

Analysis for detonations indicated that zero bottlenose dolphin will be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, one under Alternative 1 and three under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. In the northern GOM, the stocks of concern include the continental shelf and oceanic stocks. The continental shelf stock is thought to overlap with both the oceanic stock as well as coastal stocks in some areas (Waring et al., 2008); however, the coastal stock is generally limited to less than 20 m (66 ft) water depths. The best estimate of abundance for the GOM continental shelf stock is 21,531, (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, 0.0046 percent of the northern GOM continental shelf stock of bottlenose dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.014 percent under Alternative 2.

The best estimate of abundance for the GOM oceanic stock of bottlenose dolphins is 3,708. The oceanic stock is provisionally defined for bottlenose dolphins inhabiting waters greater than 200 m (656 ft). Based on the bathymetry of the NSWC PCD Study Area, the deepest depth at the 12 NM limit is 33 m (99 ft), therefore this stock will be analyzed in the non-territorial water section.

Based on best available science, the Navy concludes that exposure to bottlenose dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to bottlenose dolphins. In accordance with NEPA, there will be no significant impact to bottlenose dolphins in territorial waters under the No Action Alternative, Alternative 1, and Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Non-territorial Waters

The following subsections present the summary for species with potential to be exposed to sound based on the previous acoustic analysis. Information is presented for only those species with the potential to be exposed. In accordance with EO 12114, there will be no significant harm from detonations to any of the other marine mammal species that may occur in the non-territorial waters of the NSWC PCD Study Area. Furthermore, no live detonations will occur in non-territorial waters under the No Action Alternative. Further discussion is not required on this alternative. The Navy sought an LOA from NMFS in accordance with the MMPA.

Sperm whale

Explosives analysis indicated that no sperm whales will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and one under Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. In the northern GOM, the best abundance estimate for sperm whales is 1,665 (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, it is estimated that 0.060 percent of the northern GOM stock of sperm whales will potentially be exposed to levels of sound likely to result in Level B harassment under Alternative 2.

Based on best available science, the Navy concludes that exposure to sperm whales due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to sperm whales. Therefore, in accordance with the ESA, the Navy finds the NSWC PCD RDT&E activities involving detonations may affect sperm whales under the No Action Alternative, Alternative 1, or Alternative 2. Further, in accordance with EO 12114, there will be no significant harm to sperm whales under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA and initiated consultation under Section 7 of the ESA for concurrence.

Melon-headed whale

Explosives analysis indicated that no melon-headed whales will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and one under Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for melon-headed whales in the northern GOM is 2,283 individuals, with a minimum population estimate of 2,238 whales (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, it is estimated that 0.045 percent of the northern GOM stock of melon-headed whales will potentially be exposed to levels of sound likely to result in Level B harassment under Alternative 2.

Based on best available science, the Navy concludes that exposure to melon-headed whales due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to melon-headed whales. Therefore, in accordance with EO 12114, there will be no significant harm to melon-headed whales under Alternative 1 or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA and initiated consultation under Section 7 of the ESA for concurrence.

Risso's dolphin

Explosives analysis indicated that no Risso's dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and one under Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate for the northern GOM stock of Risso's dolphin is 1,589 (Waring et al., 2008). Therefore, based on the exposure data and the best estimate of abundance, it is estimated that 0.063 percent of the northern GOM stock of Risso's dolphin may be exposed to levels of sound likely to result in Level B harassment under Alternative 2.

Based on best available science, the Navy concludes that exposure to Risso's dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Risso's dolphins. Therefore, in accordance with EO 12114, the Navy concludes that there will be no significant harm to Risso's dolphins from the use of detonations in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Atlantic spotted dolphin

Explosive analysis indicated that up to four Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and eighteen under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of Atlantic spotted dolphins experiencing harassment may be fewer than previously stated. Up to one Atlantic spotted dolphin may be exposed to sound likely to result in slight lung injury under Alternative 1 and Alternative 2. In addition, up to one Atlantic spotted dolphin may be exposed to sound likely to result in severe lung injury under Alternative 2.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. As previously stated, the best estimate of abundance for Atlantic spotted dolphins in the northern GOM is 37,611 (Waring et al., 2008). Based on the analysis and the best estimate of abundance, 0.011 percent of the northern GOM stock of Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.048 percent under Alternative 2. In addition, 0.0027 percent of the northern GOM stock of Atlantic spotted dolphins will be exposed to levels of sound likely to result in Level A slight lung injury under Alternative 1 and Alternative 2, and 0.0027 percent may be exposed to sound likely to result in Level A severe lung injury under Alternative 2.

Based on best available science, the Navy concludes that exposure to Atlantic spotted dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. Given the small number of exposures and the implementation of mitigation and protective measures as described in Chapter 5, in accordance with EO 12114, there will be no significant harm to Atlantic spotted dolphins under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Pantropical spotted dolphin

Explosive analysis indicated that up to two pantropical spotted dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and six under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of pantropical spotted dolphins experiencing harassment may be fewer than previously stated. In addition, up to one pantropical spotted dolphin may be exposed to sound likely to result in Level A slight lung injury under Alternative 2. Thus, the estimated number of pantropical and Atlantic spotted dolphins experiencing harassment may be fewer than previously stated.

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for pantropical spotted dolphins in the northern GOM is 34,067 (Waring et al., 2008). Therefore, based on the exposure data and the best estimate of abundance, it is estimated that 0.0059 percent of the northern GOM stock of pantropical spotted dolphins will potentially be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.018 percent under Alternative 2.

Furthermore, 0.0029 percent of the northern GOM stock of pantropical spotted dolphins will potentially be exposed to levels of sound like to result in Level A slight lung injury under Alternative 2.

Based on best available science, the Navy concludes that exposure to pantropical spotted dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. Given the low number of exposures and the implementation of mitigation and protective measures as described in Chapter 5, in accordance with EO 12114, there will be no significant harm to pantropical spotted dolphin in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Bottlenose dolphin

Analysis for detonations indicated that nine bottlenose dolphin will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 38 under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated. In addition, one bottlenose dolphin may be exposed to sound likely to result in Level A slight lung injury under Alternative 1 and Alternative 2. One bottlenose dolphin may be exposed to sound likely to result in Level A severe lung injury under Alternative 2.

The Navy evaluated the potential exposures to stocks based on the best estimate for each stock of marine mammal species. As previously mentioned, two stocks of bottlenose dolphins occur in the non-territorial waters of the NSWC PCD Study Area. The continental shelf and oceanic stocks are thought to overlap in some areas (Waring et al., 2008). For this analysis the best estimates of abundance for the continental shelf stock and the oceanic stock were combined to calculate the effects to GOM stocks of bottlenose dolphins in non-territorial waters. Therefore, the best estimate of abundance for the GOM continental shelf and oceanic stocks of bottlenose dolphins is 25,239 (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, 0.036 percent of the northern GOM continental shelf and oceanic stocks of bottlenose dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.15 percent under Alternative 2. Furthermore, 0.0040 percent of the northern GOM continental shelf and oceanic stocks of bottlenose dolphins will be exposed to levels of sound likely to result in Level A slight lung injury under Alternative 1 and Alternative 2, and 0.0040 percent will be exposed to levels of sound likely to result in Level A severe lung injury under Alternative 2.

Based on best available science, the Navy concludes that exposure to bottlenose dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. Given the low number of exposures and the implementation of the mitigation and protective measures described in Chapter 5, in accordance with EO 12114, there will be no significant harm to bottlenose dolphins under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Spinner dolphin

Explosives analysis indicated that up to three spinner dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and ten under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of spinner dolphins experiencing harassment may be fewer than previously stated. In addition, one spinner dolphin may be exposed to sound likely to result in Level A slight lung injury under Alternative 2.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. This best estimate for the northern GOM stock of spinner dolphins is 1,989 (Waring et al., 2008). Therefore, based on the exposure data and the best estimate of abundance, it is estimated that 0.15 percent of the northern GOM stock of spinner dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.50 percent under Alternative 2. Furthermore, 0.050 percent of the northern GOM stock of spinner dolphins will be exposed to levels of sound likely to result in Level A slight lung injury under Alternative 2.

Based on best available science, the Navy concludes that exposure to spinner dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. Given the small number of potentially affected animals, in accordance with EO 12114, there will be no significant harm to spinner dolphins from detonations in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Striped dolphin

Explosives analysis indicated that no striped dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and two under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best abundance estimate for striped dolphins in the northern GOM is 3,325 (Waring et al., 2008). Therefore, based on the exposure data and the best estimate of abundance, it is estimated that 0.060 percent of the northern GOM stock of striped dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 2.

Based on best available science, the Navy concludes that exposure to striped dolphins due to NSWC PCD RDT&E activities involving detonations would generally result in only short-term effects to individuals exposed and would likely not affect rates of recruitment or survival. Given the small number of potentially affected animals, in accordance with EO 12114, there will be no significant harm to striped dolphins from detonations in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

4.3.6.7 Projectile Firing – Marine Mammals

4.3.6.7.1 Introduction and Approach to Analysis – Marine Mammals

Projectile firing includes the use of inert rounds of ammunition as well as high explosive 5-inch gun-rounds. The primary concern with respect to projectile firing and marine mammals encompasses the potential sound effects associated with their expenditures. Therefore, the following analysis focuses on the live 5-inch gun rounds. The same thresholds were used to analyze projectile firing as the previous section on ordnance operations. Modeling took into account the firing of single shots separated in time.

4.3.6.7.2 Territorial Waters – Marine Mammals (Projectile Firing Operations)

Live projectile firing operations will not occur in territorial waters.

4.3.6.7.3 Non-Territorial Waters – Marine Mammals (Projectile Firing Operations)

No Action Alternative– Marine Mammals (Projectile Firing Operations, Non Territorial)

With the No Action Alternative there will be no projectile firing occurring within non-territorial waters.

Alternative 1 – Marine Mammals (Projectile Firing Operations, Non Territorial)

Alternative 1 provides for up to 20 high explosive 5-inch rounds to be expended (tested). Other calibers of munitions will not contain HE. Rounds from a 5-inch caliber will be expended singularly over the course of the year. Projectile firing under Alternative 1 in non-territorial waters will expose one bottlenose dolphin to sound likely to result in Level B harassment (Table 4-47). The only potential impacts to marine mammals will occur at Level B harassment.

Alternative 2 – Marine Mammals (Projectile Firing Operations, Non-Territorial)

With Alternative 2, 5-inch round testing will increase to 60 live projectiles annually. Projectile firing under Alternative 2 in non-territorial waters may expose up to three species of marine mammals to sound likely to result in Level B harassment (Table 4-48). They include the bottlenose dolphin, Atlantic spotted dolphin, and pantropical spotted dolphin. The only potential impacts to marine mammals will occur at Level B harassment.

Table 4-47. Alternative 1: Estimates of Marine Mammal Exposures from Live 5-inch Round Detonations in Non-Territorial Waters Per Year

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bryde's whale	0	0	0
Sperm whale	0	0	0
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	0
Short-finned pilot whale	0	0	0
Risso's dolphin	0	0	0
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	0	0	1
Atlantic spotted dolphin	0	0	0
Pantropical spotted dolphin	0	0	0
Striped dolphin	0	0	0
Spinner dolphin	0	0	0
Clymene dolphin	0	0	0
Fraser's dolphin	0	0	0

Table 4-48. Alternative 2: Estimates of Marine Mammal Exposures from 5-inch Round Detonations in Non-Territorial Waters

Marine Mammal Species	Level A (Severe Lung Injury)	Level A (Slight Lung Injury)	Level B (Non-Injury)
Bryde's whale	0	0	0
Sperm whale	0	0	0
Dwarf/Pygmy sperm whale	0	0	0
All beaked whales	0	0	0
Killer whale	0	0	0
False killer whale	0	0	0
Pygmy killer whale	0	0	0
Melon-headed whale	0	0	0
Short-finned pilot whale	0	0	0
Risso's dolphin	0	0	0
Rough-toothed dolphin	0	0	0
Bottlenose dolphin	0	0	2
Atlantic spotted dolphin	0	0	1
Pantropical spotted dolphin	0	0	1
Striped dolphin	0	0	0
Spinner dolphin	0	0	0
Clymene dolphin	0	0	0
Fraser's dolphin	0	0	0

4.3.6.7.4 Summary of Potential Acoustic Effects from Projectile Firing by Marine Mammal Species

In accordance with MMPA requirements, NSWC PCD has requested take authorizations. Acoustical modeling provides an estimate of the actual exposures. In an effort to reduce the potential exposures associated with live projectile firing, the mitigation and protective measures listed in Chapter 5 will be implemented.

Non-territorial Waters

Atlantic spotted dolphin

Analysis for projectile firing indicated that up to one Atlantic spotted dolphin may be exposed to levels of sound likely to result in Level B harassment under Alternative 2. The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. As previously mentioned, the best estimate of abundance for Atlantic spotted dolphins in the northern GOM is 37,611 (Waring et al., 2008). Based on the analysis and the best estimate of abundance, 0.0027 percent of animals will be exposed to levels of sound likely to result in Level B harassment under Alternative 2.

Based on best available science, the Navy concludes that exposures to Atlantic spotted dolphins due to NSWC PCD RDT&E activities involving projectile firing would generally result in only short-term effects to individuals exposed and would not likely affect annual rates of recruitment or survival. Given the small number of exposures and the implementation of mitigation and protective measures as described in Chapter 5, in accordance with EO 12114, there will be no significant harm to Atlantic spotted dolphins in non-territorial waters. The Navy sought an LOA from NMFS in accordance with the MMPA.

Bottlenose dolphin

Analysis for projectile firing indicated that one bottlenose dolphin will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and two under Alternative 2. These exposures will not necessarily occur to different individuals as the same individuals could be exposed multiple times over the duration of the RDT&E activities. Thus, the estimated number of bottlenose dolphins experiencing harassment may be fewer than previously stated.

The Navy evaluated the potential exposures to stocks based on the best estimate for each stock of marine mammal species. As previously mentioned, two stocks of bottlenose dolphins occur in the non-territorial waters of the NSWC PCD Study Area. The continental shelf and oceanic stocks are thought to overlap in some areas (Waring et al., 2008). For this analysis the best estimates of abundance for the continental shelf stock and the oceanic stock were combined to calculate the effects to GOM stocks of bottlenose dolphins in non-territorial waters. Therefore, the best estimate of abundance for the GOM continental shelf and oceanic stocks of bottlenose dolphins is 25,239 (Waring et al., 2008). Based on the exposure data and the best estimate of abundance, 0.0040 percent of the northern GOM continental shelf and oceanic stocks of bottlenose dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and 0.0079 percent under Alternative 2.

Based on best available science, the Navy concludes that exposures to bottlenose dolphins due to NSWC PCD RDT&E activities involving projectile firing would generally result in only short-term effects to individuals exposed and would not likely affect annual rates of recruitment or survival. Given the low number of exposures and the implementation of the mitigation and protective measures described in Chapter 5, in accordance with EO 12114, there will be no significant harm to bottlenose dolphins under Alternative 1 or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

Pantropical spotted dolphin

Acoustic analysis indicated that no pantropical spotted dolphins will be exposed to levels of sound likely to result in Level B harassment under Alternative 1 and one under Alternative 2. In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species. The best estimate of abundance for pantropical spotted dolphins in the northern GOM is 34,067 (Waring et al., 2008). Therefore, based on the exposure data and the best estimate of abundance, it is estimated that 0.0029 percent of the northern GOM stock of pantropical spotted dolphins will potentially be exposed to levels of sound likely to result in Level B harassment under Alternative 2.

Based on best available science, the Navy concludes that exposures pantropical spotted dolphins due to NSWC PCD RDT&E activities involving projectile firing would generally result in only short-term effects to individuals exposed and would not likely affect annual rates of recruitment or survival. Given the low number of exposures and the implementation of mitigation and protective measures as described in Chapter 5, in accordance with EO 12114, there will be no significant harm to pantropical spotted dolphin in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy sought an LOA from NMFS in accordance with the MMPA.

4.3.6.7.5 Potential Non-Acoustic Effects from Projectile Firing

NSWC PCD RDT&E activities include projectile firing, which has the potential to directly strike marine mammals. Small arms rounds are tested through firing at a fixed target. Firing will occur at close range in relation to the target.

Territorial Waters – Marine Mammals (Projectile Firing)

No projectile firing will occur in territorial waters of the NSWC PCD Study Area.

Non-territorial Waters – Marine Mammals (Projectile Firing)

As previously described, tests involving projectile firing are conducted at close range. The likelihood is low that a marine mammal will enter the firing area directly adjacent to the target undetected simultaneous to projectile firing. The noise associated with the firing and the support aircraft and/or surface vessels would likely cause animals to avoid the area. Furthermore, the mitigation and clearance procedures identified in Chapter 5 will be implemented. Large groups of cetaceans such as schools of dolphin species and large species of whales such as sperm whales and Bryde's whales will be sighted at the surface during standard clearance procedures and avoided. Therefore, in accordance with EO 12114, there will be no significant harm to marine mammals from projectile firing during NSWC PCD RDT&E activities in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy also finds that projectile firing will have no effect on sperm whales.

4.3.6.8 Comparison of Potential Marine Mammal Effects by Alternative

The acoustic analysis models for sonar and explosives are useful for producing rough estimates of physiological and behavioral impacts to marine species, but should not be relied upon solely as a final assessment for the effects to marine mammals. Table 4-49 gives a summary of total exposures to marine mammals for each Alternative.

Table 4-49. Summary of Exposure Estimates by Alternative

Alternative	Effect	
	Level A Harassment	Level B Harassment
No Action Alternative	0	531
Alternative 1	2	1038
Alternative 2	6	1148

This information is useful as a means to measure the level of impact NSWC PCD RDT&E activities will have on marine mammals, however a qualitative analysis is also important. Comparing each Alternative, the No Action Alternative has significantly less exposures than Alternatives 1 and 2, however employing the No Action Alternative will not meet the increasing demands for NSWC PCD. Alternatives 1 and 2 do not differ much in the number of total exposures for all marine mammal species in the NSWC PCD Study Area. Even though Alternative 2 analyzed for up to a threefold increase in operations over the baseline level, there was not a threefold increase in Level B exposures to marine mammals. Level A exposures for Alternative 2 are three times higher than for Alternative 1, however both of these exposure numbers are small and insignificant, accounting for less than one percent of the stock of the marine mammal species in the GOM. Only two marine mammals are expected to incur a severe lung injury from NSWC PCD RDT&E activities, however no mortalities are anticipated and the mitigation and protective measures in Chapter 5 will likely mitigate the exposure down to zero.

4.3.7 Sea Turtles

4.3.7.1 Surface Operations – Sea Turtles

4.3.7.1.1 Introduction and Approach to Analysis (Surface Operations)

The potential exists for a ship to strike a sea turtle while conducting Surface Operations. Typical operations occurring at the surface includes the deployment or towing of MCM equipment, retrieval of equipment, and clearing and monitoring for non-participating vessels. NSWC PCD will implement the protective measures described in Chapter 5 to reduce the likelihood of a ship strike. The following sections will discuss the potential for ship strikes relative to the three alternatives occurring in territorial and non-territorial waters.

Territorial Waters – Sea Turtles (Surface Operations)

Boat strikes are known to affect sea turtles. Turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to a vessel strike. According to the Florida Fish and Wildlife Conservation Commission (unpublished data), there has been a significantly increasing trend in the percent occurrence of propeller wounds among the loggerheads found dead or debilitated each year in Florida during 1986 through 2004. In addition, sound from surface vessel traffic may cause behavioral responses to sea turtles.

Accordingly, the U.S. Navy has adopted standard operating procedures and protective measures to reduce the potential for collisions with surfaced sea turtles (for more details refer to Chapter 5). These protective measures include:

- Implementing reasonable and prudent actions to avoid the close interaction of Navy assets and sea turtles.
- Maneuvering to keep away from any observed sea turtle.

Based on the implementation of general protective measures described above for sea turtles (refer to Chapter 5 for additional details), the likelihood that a ship strike will occur during NSWC PCD RDT&E activities is low. Therefore, in accordance with NEPA, there will be no significant impact to sea turtles from vessel interactions within territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy also finds that surface operations will have no effect on sea turtles.

Non-Territorial Waters – Sea Turtles (Surface Operations)

The U.S. Navy will maneuver to avoid sea turtles and will implement reasonable and prudent measures to avoid interactions between surface vessels and these animals. Therefore, in accordance with EO 12114, there will be no significant harm to sea turtles from vessel interactions during NSWC PCD RDT&E activities in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy also finds that surface operations will have no effect on sea turtles.

4.3.7.2 Sonar Operations – Sea Turtles

4.3.7.2.1 Introduction and Approach to Analysis

Five species of sea turtles (Atlantic loggerhead, Atlantic green, leatherback, hawksbill, and Kemp's ridley) occur in the GOM. All but the loggerhead are classified as endangered. The loggerhead is classified as threatened. Refer to Section 3.4.8.1 for a more detailed description of sea turtle species occurrence within the NSWC PCD Study Area.

Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized tympanum (eardrum). Instead, they have a cutaneous layer and underlying subcutaneous fatty layer that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extracolumella, a cartilaginous disk, located at the entrance to the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway et al., 1969). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull.

Sea turtle auditory capabilities and sensitivity is not well studied, though a few investigations suggest that it is limited to low-frequency bandwidths, such as the sounds of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green turtle, and concluded that they have a useful hearing span of perhaps 60-1,000 Hz, but hear best from about 200 Hz up to 700 Hz, with their sensitivity falling off considerably below 200 Hz. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the turtle's hearing measurement was about 64 dB in air. At 70 Hz, it was about 70 dB in air. These values probably apply to all four of the hard-shell turtles (i.e., the green, loggerhead, hawksbill, and Kemp's ridley turtles). No audiometric data are available for the leatherback sea turtle, but based on other sea turtle hearing capabilities, they probably also hear best in the low frequencies.

Lenhardt et al. (1983) also applied audio-frequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli (250 Hz, 500 Hz) were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever, 1978). At the maximum upper limit of the vibratory delivery system, the turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt et al. (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces.

A recent study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds. The pressure level is measured at a standard reference point such as 1 meter with a reference pressure of 1 µPa at 1 m (i.e., re 1 µPa-m). Green and loggerhead sea turtles will avoid air-gun arrays at 2 km and at 1 km, with received levels of 166 dB re 1 µPa at 1 m and 175 dB re 1 µPa, respectively (McCauley et al., 2000). The sea turtles' response was consistent: above a level of about 166 dB re 1 µPa, the turtles noticeably increased their swimming activity. Above 175 dB re 1 µPa, their behavior became more erratic, possibly indicating that the turtles were agitated.

Territorial Waters – Sea Turtles (Sonar Operations)

Extrapolation from human and marine mammal data to turtles may be inappropriate given the morphological differences between the auditory systems of mammals and turtles. Currently it is believed that the range of maximum sensitivity for sea turtles is 0.1 to 0.8 kHz, with an upper limit of about 2.0 kHz (Lenhardt, 1994). Hearing below 0.08 kHz is less sensitive but still potentially usable to the animal. Green turtles are most sensitive to sounds between 0.2 and 0.7 kHz, with peak sensitivity at 0.3 to 0.4 kHz (Ridgway et al., 1997). They possess an overall hearing range of approximately 0.1 to 1.0 kHz (Ridgway et al., 1969). Juvenile loggerhead turtles hear sounds between 0.25 and 1.0 kHz and, therefore, often avoid these low frequency sounds (Bartol et al., 1999). Finally, sensitivity even within the optimal hearing range is apparently low—threshold detection levels in water are relatively high at 160 to 200 dB re 1 μPa-m (Lenhardt, 1994). Given the lack of audiometric information, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown but would likely follow those of other sea turtles. In terms of sound emission, nesting leatherback turtles produce sounds in the 0.3 to 0.5 kHz range (Mrosovsky, 1972).

Any potential role of long-range acoustical perception in sea turtles has not been studied and is unclear at this time. The concept of sound masking is difficult, if not impossible, to apply to sea turtles. Although mid-frequency hearing has not been studied in many sea turtle species, most of those that have been tested, exhibit low audiometric and behavioral sensitivity to low-frequency sound. It appears that if there were the potential for the mid and high frequency sonars to increase masking effects for any sea turtle species, it is expected to be minimal.

Additionally, although little data exists on sea turtle hearing and past studies are limited, sea turtle navigation has been relatively well studied. Unlike marine mammals, researchers have found that sea turtles use non-acoustic cues in migration and particularly in movement related to hatchling activity, nesting, and long-distance migrations. Hatchlings primarily use magnetic fields to navigate (Lohmann, 1991; Lohmann and Lohmann, 1996). Recent studies have found that they supplement this navigation technique with a secondary method based on the sun or skylight (Avens and Lohman, 2003). Studies recently have focused on juvenile and adult navigation in addition to the previous concentrated focus on hatchlings. Avens and Lohmann (2004) captured data consistent with a conclusion that juvenile and adult sea turtles have a map-based navigation capability (or they are able to home to specific locations). Sea turtles of these age classes may use other indicators such as chemical cues and magnetic fields to navigate to specific areas (Avens and Lohmann, 2004). Since sea turtles rely on sensory systems other than hearing to navigate and because the sonar systems used during NSWC PCD RDT&E activities are at frequency ranges higher than the optimal hearing capabilities of sea turtles, mid- and high-frequency active sonar would not affect sea turtle navigation.

Therefore, based on the best available scientific data including low audiometric and behavioral sensitivity by sea turtles to low-frequency sound and their navigation techniques through sensory systems other than hearing, in accordance with NEPA, no significant impacts are anticipated to sea turtles from sonar operations under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy finds that sonar operations in territorial waters will have no effect on sea turtles.

Non-Territorial Waters – Sea Turtles (Sonar Operations)

The potential effects to sea turtles in non-territorial waters would be similar to the effects associated with the No Action Alternative in territorial waters. The knowledge of sea turtle hearing shows that the maximum sensitivity of the five species to underwater sound occurs in the low-frequency spectrum. NSWC PCD will use systems in the mid- and high-frequency ranges. Therefore, based on the best available scientific data including low audiometric and behavioral sensitivity by sea turtles to low-frequency sound and their navigation techniques through sensory systems other than hearing, in accordance with EO 12114, there will be no significant harm to sea turtles from sonar operations in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. Further, in accordance with the ESA, the Navy finds that sonar operations in non-territorial waters will have no effect on sea turtles.

4.3.7.3 Electromagnetic Operations – Sea Turtles

The current predominant system tested is the Organic Airborne and Surface Influence Sweep (OASIS), which generates an EMF down the length of a cable. NSWC PCD has also experimented with deploying magnetic sensors onboard unmanned underwater swimming and crawling vehicles and has conducted tests to evaluate individual sensor capabilities during high-speed operations.

4.3.7.3.1 Introduction and Approach to Analysis

Potential effects by the generation of EMFs were analyzed for sea turtles. Neither regulations nor scientific literature provide threshold criteria to determine the significance of the potential effects from the NSWC PCD RDT&E activities that involve the use of EMF. Sea turtles are found in the waters of the NSWC PCD Study Area and nest on nearby beaches. Studies have shown that hatchling sea turtle behavior is affected by changes in the magnetic field (Irwin and Lohmann, 2003). Goff et al. (1998) indicate that hatchling sea turtles use geomagnetic fields to navigate once they are out of the influence of land. During the first 30 minutes after leaving the nest, hatchlings are susceptible to changes in the magnetic field. After 30 minutes of swimming against the waves, changes in the magnetic field do not appear to have any influence on the hatchlings' behavior (Goff et al., 1998). Based on research conducted on the distribution and predation of nearshore hatchlings, the average hatchling is capable of swimming 786 m (2,579 ft) in about 39 minutes (Pitcher et al., 2001). Sea turtles are able to use multiple cues to determine direction and may switch between cues as needed (Papi et al., 2000; Goff et al., 1998).

4.3.7.3.2 Territorial Waters – Sea Turtles (Electromagnetic Operations)

Although a small number of sea turtles in territorial waters will be exposed to EMFs, exposure does not equate to harm. EMFs have not been linked to any serious injury or mortality in marine species. The EMF events associated with NSWC PCD RDT&E activities will be spread out over time and location and will be short in duration. The EMF field generated will dissipate quickly within the saltwater environment, and any influence it may have on the surrounding environment will be temporary and localized. The levels generated above the earth's magnetic field will only extend out to a 4 m (13.12 ft) radius from the cable (DON, 2005a).

Magnetic fields have been shown to affect the navigational ability of hatchling sea turtles during the first 30 minutes after entering the water. However, the RDT&E activities generating EMF will occur at a minimum of 5.5 km (3.4 mi) off the beach. Based on the research conducted in the Nearshore Turtle Hatchling Distribution and Predation Study of 2001, the average sea turtle hatchling is capable of swimming 786 m (2,579 ft, or 0.48 mi) in about 39 minutes (Pitcher et al., 2001). Thus, it is unlikely that any sea turtle hatchlings will be affected within their first 30 minutes in the water. Furthermore, sea turtles will be exposed to magnetic fields above that of the Earth's field only if they swim within 4 m (13.12 ft) of the cable's surface. Additionally, the proposed protective measures outlined in Chapter 5 will be implemented. Thus, in accordance with the ESA, the Navy finds that the proposed action will have no effect on sea turtles in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. Further, based on the best available scientific information coupled with the small amount of area affected (4 m [13.12 ft]) and implementation of protective measures, in accordance with NEPA, there will be no significant impact to sea turtles from NSWC PCD activities in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.3.7.3.3 Non-Territorial Waters – Sea Turtles (Electromagnetic Operations)

The effects to sea turtles from electromagnetic operations are the same in non-territorial waters as territorial waters. The EMF events will be spread out over time and location with short testing periods. Furthermore, the field will dissipate quickly with in the saltwater environment. The level generated above the earth's magnetic field will only extend out to a 4 m (13.12 ft) radius from the cable of the OASIS system. Effects to the navigational ability of hatchling sea turtles during the first 30 minutes after entering the water. Hatchlings will be in the water longer than 30 minutes in order to reach the non-territorial waters of the NSWC PCD Study Area. Therefore, in accordance with ESA, the Navy finds that electromagnetic operations will have no effect on threatened and endangered sea turtles in non-territorial waters with the No Action Alternative, Alternative 1, or Alternative 2. Additionally, based on the best available scientific information discounting the influence of EMF on hatchling navigation outside the territorial waters and the small amount of area affected (4 m [13.12 ft)], in accordance with EO 12114, there will be no significant harm to sea turtles in non-territorial waters.

4.3.7.4 Laser Operations – Sea Turtles

4.3.7.4.1 Introduction and Approach to Analysis

The greatest potential for laser exposure is at the ocean's surface, where laser intensity is greatest. As the laser penetrates the water, 96 percent of a laser beam is absorbed, scattered, or otherwise lost (Ulrich, 2004). As with humans, the greatest laser-related concern for marine species is visual damage. Lasers may also cause burns to the skin, but the threshold energy for eye damage is considerably lower and is considered the threshold of concern. Effects to an animal's skin, scales, and/or carapace are not addressed because the necessary laser power to cause damage is much greater than that which will cause damage to the eyes (Ulrich, 2004). While all points on an animal's body have roughly the same probability of laser exposure, only eye exposure is of concern. Exposure to lasers does not imply harm. Any heat that the laser generates will rapidly dissipate due to the large heat capacity of water and the large volume of water in which the laser is used (Churnside, 2004). There is no suspected effect due to heat loss from the laser beam. The information below will focus on the potential for eye damage only.

Eye damage to sea turtles is unlikely because ocular damage is not dependent on wavelength with exposures of less than 10 seconds. Thus, an animal's eye will have to be exposed to a direct beam for at least 10 seconds or longer to sustain damage. With pulse durations less than 10 seconds combined with the laser platform movement and animal motion, exposures of more than 10 seconds will be very unlikely. LIDAR systems will be deployed in the air by helicopter. A sea turtle will have to surface and turn its head skyward at the exact moment that the helicopter is overhead to be exposed to a LIDAR laser. Similarly, a sea turtle will have to be looking directly into the underwater laser exit port for 10 seconds or more to be affected by LLS or directional laser systems. Furthermore, 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Ulrich, 2004). Therefore, species underwater will not be harmed. In addition, the protective measures listed in Chapter 5 will be implemented.

4.3.7.4.2 Territorial Waters – Sea Turtles (Laser Operations)

Based on the previous information, in accordance with NEPA, there will be no significant impact to sea turtles in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. Also, in accordance with the ESA, the Navy has determined that the proposed action will have no effect on threatened or endangered species.

4.3.7.4.3 Non-Territorial Waters – Sea Turtles (Laser Operations)

Based on the introductory information, in accordance with EO 12114, there will be no significant harm to sea turtles in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, the Navy has determined that the proposed action will have no effect on threatened or endangered species.

4.3.7.5 Ordnance Operations – Sea Turtles

4.3.7.5.1 Introduction and Approach to Analysis – Sea Turtles

Thresholds are not available for sea turtles. However, using the approach applied in Record of Decision for the Seawolf EIS, the thresholds used for marine mammals will be applied to sea turtles since it is reasonable to assume sea turtle lungs and other gas-containing organs will be similarly affected by shock waves (DON, 1995). As was the case for Seawolf and Churchill, criteria and thresholds for effects on protected sea turtles' TTS are the same as those for toothed whales. Calculations for potential exposures of sea turtles to sound were conducted as described for marine mammals, which is presented in Section 4.3.6.

Sea Turtle Density

As discussed in Section 4.3.6.3.2 Calculation Methods for Sonar Sound, the density estimates used in the acoustic analysis come from the updated density estimates presented in the *NODE for the GOMEX OPAREA* report (DON, 2007h). Density estimate calculations for sea turtles were derived from aerial survey data provided by NMFS-Southeast East Fishery Science Center. Estimates were generated for the leatherback turtle, loggerhead turtle, Kemp's ridley turtle, and the group Hardshell Turtles in the same manner as marine mammal species (see Section 4.3.6.3.2 Calculation Methods for Sonar Sound and DON, 2007h). The species incorporated into the Hardshell Turtles category include green, hawksbill, Kemp's ridley, unidentified hardshell turtles, and possible occurrence of the Olive ridley sea turtle. These species were pooled together since the numbers of sightings for each species or group did not allow spatial modeling. This category did not include leatherback turtles since identification is not difficult. The sea turtle estimates produced are for continental shelf waters only, since only this portion was covered by aerial surveys.

Depth Distribution

Sea turtles are generally tagged while on the beach during nesting activities, although some researchers capture turtles at-sea for tag emplacement. There are a few different methodologies/techniques that can be used to determine depth distribution percentages, but by far the most widely used technique currently is the time-depth recorder. These instruments are attached to the animal for a fairly short period of time (several hours to a few days) via a suction cup or glue, and then retrieved when the sea turtle returns to the beach. Depth information is also collected via satellite tags, sonic tags, and digital tags.

There are somewhat suitable depth distribution data for some marine mammal and sea turtle species. Sample sizes are usually extremely small, nearly always fewer than 10 animals total and often only one or two animals. Depth distribution information can also be interpreted from other dive and/or preferred prey characteristics, and from methods including behavioral observations, stomach content analysis and habitat preference analysis. Depth distributions for species for which no data are available are extrapolated from similar species.

Density and Depth Distribution Combined

Density is nearly always reported for an area (e.g., animals/km^2). Analyses of survey results using Distance Sampling techniques include correction factors for animals at the surface but not seen as well as animals below the surface and not seen. Therefore, although the area (e.g., km^2) appears to represent only the surface of the water (two-dimensional), density actually implicitly includes animals anywhere within the water column under that surface area. Density assumes that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Sea turtles are often clumped in areas of greater importance, for example, areas of high productivity, lower predation, basking, etc. Density can occasionally be calculated for smaller areas that are used regularly by sea turtles, but more often than not there are insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the norm.

Assuming that all species are evenly distributed from surface to bottom is almost never appropriate and can present a distorted view of sea turtle distribution in any region. By combining sea turtle density with depth distribution information, a 3-D density estimate is possible. These 3-D estimates allow more accurate modeling of sea turtle exposures from explosive sources.

4.3.7.5.2 Territorial Waters – Sea Turtles (Ordnance Operations)

No Action Alternative – Sea Turtles (Ordnance Operations, Territorial)

The No Action Alternative includes detonations in territorial waters of small C4 charges associated with mine warfare, recovery operations, and line charges and could potentially affect sea turtles. Detonations under the No Action Alternative in territorial waters will not expose any species of sea turtles to sound likely to result in TTS or TM/lung injury (Table 4-50).

Table 4-50. No Action Alternative: Estimates of Sea Turtle Exposures from Live Detonations (0.45 to 4.5 kg [1 to 10 lbs]) in Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	0
Loggerhead	0	0
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill, and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys. .

The No Action Alternative provides for the detonation of one line charge per year in shallow surf zone water. The maximum NEW will be 794 kg (1,750 lbs). The use of line charges under the No Action Alternative will not expose any species to sound likely to result in TTS or injury (Table 4-51).

Table 4-51. No Action Alternative: Estimates of Sea Turtle Exposures from a Line Charge Detonation (794 kg [1,750 lbs] NEW) in Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	0
Loggerhead	0	0
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

Alternative 1 – Sea Turtles (Ordnance Operations, Territorial)

Detonations under Alternative 1 in territorial waters will expose one species of sea turtle that occur in the NSWC PCD Study Area to sound likely to result in TTS (Table 4-52).

Table 4-52. Alternative 1: Estimates of Sea Turtle Exposures from Detonations (0.45 to 34 kg [1 to 75 lbs]) in Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	0
Loggerhead	0	1
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

The use of line charges under Alternative 1 will expose one hardshell sea turtle to sound likely to result in harassment (Table 4-53). No exposures will occur at the TM/lung injury level.

Table 4-53. Alternative 1: Estimates of Sea Turtle Exposures from a Line Charge Detonation (794 kg [1,750 lbs] NEW) in Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	1
Loggerhead	0	0
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

Alternative 2 – Sea Turtles (Ordnance Operations, Territorial)

Detonations under Alternative 2 in territorial waters will expose three species of sea turtles to sound likely to result in TTS and sound likely to result in injury (Table 4-54). They include a hardshell sea turtle, which include any hard-shelled turtle that are difficult to differentiate at sea, as well as a loggerhead and a leatherback sea turtle.

Table 4-54. Alternative 2: Estimates of Sea Turtle Exposures from Detonations (0.45 to 34 kg [1 to 75 lbs]) in Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	1
Loggerhead	0	1
Leatherback	0	1

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

Alternative 2 provides for a maximum of three line detonations. The use of line charges under Alternative 2 will expose one loggerhead sea turtle and one hardshell sea turtle to sound likely to result in TTS (Table 4-55). No exposures will occur at the TM/lung injury level.

Table 4-55. Alternative 2: Estimates of Sea Turtle Exposures from Line Charge Detonations (794 kg [1,750 lbs] NEW) in Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	1
Loggerhead	0	1
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

4.3.7.5.3 Non-Territorial Waters – Sea Turtles (Ordnance Operations)

No Action Alternative– Sea Turtles (Ordnance Operations, Non Territorial)

With the No Action Alternative there will be no live detonations occurring within non-territorial waters.

Alternative 1 – Sea Turtles (Ordnance Operations, Non Territorial)

Detonations under Alternative 1 in non-territorial waters will expose one loggerhead sea turtle to sound likely to result in TTS (Table 4-56). No exposures will occur at the TM/lung injury level.

Table 4-56. Alternative 1: Estimates of Sea Turtle Exposures from Live Detonations (34 to 272 kg [76 to 600 lbs]) in Non-Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	0
Loggerhead	0	1
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys .

Alternative 2 – Sea Turtles (Ordnance Operations, Non-Territorial)

Detonations under Alternative 1 in non-territorial waters will expose one individual of each species, except for leatherback sea turtles, to levels of sound likely to result in TTS (Table 4-57).

Table 4-57. Alternative 2: Estimates of Sea Turtle Exposures from Detonations (34 to 272 kg [76 to 600 lbs]) in Non-Territorial Waters

Sea Turtle Species	Injury (TM/lung)	TTS
Hardshell*	0	1
Loggerhead	0	1
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys**.**

4.3.7.5.4 Summary of Potential Acoustic Effects from Detonations by Sea Turtle Species

NSWC PCD initiated the consultation process in accordance with ESA requirements. NSWC PCD requested an incidental take statement (ITS) from NMFS for ordnance operations. Acoustical modeling provides an estimate of the actual exposures.

Territorial Waters

The following subsections present the summary for species with potential to be exposed to sound based on the previous acoustic analysis. Analysis indicated that all species occurring in the NSWC PCD Study Area have the potential to be exposed to levels of sound likely to result in TTS in territorial waters and up to two species, hardshell and loggerhead sea turtles, in non-territorial waters. All line charge testing occurs on Santa Rosa Island (SRI), which is property of Eglin Air Force Base. Eglin's Natural Resources Branch reviews all activities proposed for SRI and ensures that required mitigation measures are implemented for sea turtles. The implementation of these measures identified in Chapter 5 will ensure avoidance of effects to sea turtles during nesting season and when hatchlings are present (May through October).

Hardshell Sea Turtles

Explosive analysis indicated that one unidentified hardshell sea turtle will be exposed to levels of sound likely to result in TTS under Alternative 1 and two unidentified hardshell sea turtles under Alternative 2. The mitigations presented in Chapter 5 will reduce the potential for exposures to occur to individual unidentified hardshell sea turtles. In accordance with NEPA, there will be no significant impact to unidentified hardshell sea turtles in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect hardshell sea turtles in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

Loggerhead

Explosive analysis indicated that one loggerhead sea turtle will be exposed to levels of sound likely to result in TTS under Alternative 1 and two loggerhead sea turtles under Alternative 2. The mitigations presented in Chapter 5 will reduce the potential for exposures to occur to individual loggerhead sea turtles. In accordance with NEPA, there will be no significant impact to loggerhead sea turtle in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect loggerhead sea turtles in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

Non-territorial Waters

The following subsections present the summary for species with potential to be exposed to sound based on the previous acoustic analysis. The results of this analysis indicate that no sea turtles will be exposed to levels of sound likely to result in injury under the No Action Alternative, Alternative 1, or Alternative 2. Information is presented for only those species with the potential to be exposed to levels of sound likely to result in TTS.

Hardshell Sea Turtles

Explosive analysis indicated that one hardshell sea turtles will be exposed to levels of sound likely to result in TTS under Alternative 2. Even though these species may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual hardshell sea turtles.

In accordance with EO 12114, there will be no significant harm to hardshell sea turtles in non-territorial waters under the Alternative 1 or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect hardshell sea turtles in non-territorial waters under Alternative 1 or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

Loggerhead

Explosive analysis indicated that one loggerhead sea turtles will be exposed to levels of sound likely to result in TTS under Alternative 2. Even though these species may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual loggerhead sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual loggerhead sea turtles.

In accordance with EO 12114, there will be no significant harm to loggerhead sea turtle in non-territorial waters under Alternative 1 or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect loggerhead sea turtles in non-territorial waters under Alternative 1 or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

Leatherback

Acoustic analysis indicates that no leatherback sea turtles may be exposed to levels of sound from detonations likely to result in TTS under the No Action Alternative, none under Alternative 1, and one under Alternative 2. Even though leatherback sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual leatherback sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual leatherback sea turtles.

In accordance with EO 12114, there will be no significant harm to leatherback sea turtle in non-territorial waters under Alternative 1 or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect leatherback sea turtles in non-territorial waters under Alternative 1 or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

4.3.7.6 Projectile Firing – Sea Turtles

4.3.7.6.1 Introduction and Approach to Analysis – Sea Turtles

Projectile firing includes the use of inert rounds of ammunition as well as high explosive 5-inch gun-rounds. The primary concern with respect to projectile firing and sea turtles encompasses the potential sound effects associated with their expenditures. Therefore, the following analysis focuses on the live 5-inch gun rounds.

4.3.7.6.2 Territorial Waters – Sea Turtles (Projectile Firing Operations)

Projectile firing operations will not occur in territorial waters.

4.3.7.6.3 Non-Territorial Waters –Sea Turtles (Projectile Firing Operations)

No Action Alternative– Sea Turtles (Projectile Firing, Non Territorial)

With the No Action Alternative there will be no live detonations occurring within non-territorial waters.

Alternative 1 – Sea Turtles (Projectile Firing Operations, Non Territorial)

The use of projectile firing under Alternative 1 will expose one loggerhead sea turtle to sound likely to result in harassment (Table 4-58). No exposures will occur at the TM/lung injury level.

Table 4-58. Alternative 1: Estimates of Sea Turtle Exposures from 5-inch Round Detonations in Non-Territorial Waters

Sea Turtle Species	TM/lung	TTS
Hardshell*	0	0
Loggerhead	0	1
Leatherback	0	0

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

Alternative 2 – Sea Turtles (Projectile Firing Operations, Non-Territorial)

The use of projectile firing under Alternative 2 will expose one loggerhead sea turtle and one leatherback sea turtle to sound likely to result in harassment (Table 4-59). No exposures will occur at the TM/lung injury level.

Table 4-59. Alternative 2: Estimates of Sea Turtle Exposures from 5-inch Round Detonations in Non-Territorial Waters

Sea Turtle Species	TM/lung	TTS
Hardshell*	0	0
Loggerhead	0	1
Leatherback	0	1

*Hardshell sea turtles include Kemp's ridley, hawksbill and unidentified *chelonid* sea turtles that could not be differentiated during scientific surveys.

4.3.7.6.4 Summary of Potential Acoustic Effects from Projectile Firing by Sea Turtle Species

NSWC PCD initiated the consultation process in accordance with ESA requirements. NSWC PCD requested an incidental take statement (ITS) from NMFS for projectile firing. Acoustical modeling provides an estimate of the actual exposures.

The following subsections present the summary for species with potential to be exposed to sound based on the previous acoustic analysis. Analysis indicated that two species occurring in the

NSWC PCD Study Area have the potential to be exposed to levels of sound likely to result in TTS.

Loggerhead

Acoustic analysis indicated that no loggerhead sea turtles will be exposed to levels of sound from projectile firing likely to result in TTS under Alternative 1 and one under Alternative 2. Even though these species may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual loggerhead sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual loggerhead sea turtles.

In accordance with EO 12114, there will be no significant harm to loggerhead sea turtle in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect loggerhead sea turtles in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

Leatherback

Acoustic analysis indicates that no leatherback sea turtles may be exposed to levels of sound from projectile firing likely to result in TTS under Alternative 1 and one under Alternative 2. Even though leatherback sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual leatherback sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual leatherback sea turtles.

In accordance with EO 12114, there will be no significant harm to leatherback sea turtle in non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In accordance with the ESA, NSWC PCD RDT&E activities may affect leatherback sea turtles in non-territorial waters under Alternative 1 or Alternative 2. The Navy initiated consultation with NMFS in accordance with the Section 7 of the ESA for concurrence.

4.3.7.6.5 Potential Non-Acoustic Effects from Projectile Firing

NSWC PCD RDT&E activities include projectile firing, which has the potential to directly impact sea turtles. Tests will be conducted through the firing of small arms rounds at a fixed target. Firing will occur at close range in relation to the target.

Territorial Waters – Sea Turtles (Projectile Firing)

No projectile firing will occur in territorial waters of the NSWC PCD Study Area.

Non-territorial Waters – Sea turtles (Projectile Firing)

As previously described, tests involving projectile firing are conducted at close range. The likelihood is low that a sea turtle will enter the firing area directly adjacent to the target undetected simultaneous to projectile firing. The noise associated with the firing and the support aircraft and/or surface vessels will likely cause animals to avoid the area. Furthermore, the mitigation and clearance procedures identified in Chapter 5 will be implemented. Sea turtles, in particular juvenile and hatchling sea turtles, have been known to associate with surface debris and floating algae such as *Sargassum*. Floating rafts of *Sargassum* will be avoided during tests. Juvenile and hatchling sea turtles have a greater likelihood to occur within test waters during the late summer months, when they enter coastal waters after hatching from nests on nearby beaches. No sea turtles are expected to be impacted directly from rounds entering the water, particularly due to clearance procedures for the NSWC PCD Study Area during these months. Therefore, in accordance with EO 12114, there will be no significant harm to sea turtles from projectile firing during NSWC PCD RDT&E activities in non-territorial waters under Alternative 1 or Alternative 2. In accordance with the ESA, the Navy also finds that projectile firing will have no effect on sea turtles.

4.4 ANTHROPOGENIC (MAN-MADE) ENVIRONMENT

4.4.1 Socioeconomics

Introduction and Approach to Analysis

NSWC PCD RDT&E activities will occur in and over the waters present in the NSWC PCD Study Area (W-151, W-155, W-470, and SAB). The test activities associated with all three alternatives addressed in this EIS/OEIS will not require any additional personnel, support equipment, or facilities to accommodate the associated increase in proposed testing. Therefore, no significant changes in the population or economy of the surrounding area are anticipated. Furthermore, nearshore operations that take place along the coast in the surf zone will occur in front of DoD-owned property. These operations will not have a visual or physical effect to the public. The primary focus of this section is to address the potential direct and indirect effects associated with temporary closures of areas out in the GOM.

It is assumed that a test area equivalent to a 5.6 km by 5.6 km (3.48 mi by 3.48 mi) box within the NSWC PCD Study Area will be temporarily restricted for an estimated six hours per test event. In addition, it has also been assumed that under normal conditions no more than two individual test events will occur on the same day. Therefore, a maximum of two separate areas equaling a total of 62 km^2 (24mi^2) within the NSWC PCD Study Area will be restricted on any given day. Thus, with a total 5,444 km^2 (2,102 mi^2) area inside the territorial line and a total of 72,125 km^2 (27,848 mi^2) area outside of the territorial line available within the Study Area, the potential closure of 62 km^2 (24 mi^2) per day will be a minimal segment of the available area open to the public.

It is expected that temporary closures related to nearshore areas (e.g., surf zone) could have a greater effect on public recreation, whereas those farther offshore will affect commercial trawlers to a greater extent. However, the availability of such a large study area provides NSWC PCD the flexibility to effectively schedule testing events in locations that avoid shipping lanes and areas of high volume commercial and recreational activities. In addition, NSWC PCD will avoid areas with known presence of artificial reefs and hardbottom areas. Therefore, minimal disruption to popular fishing and recreational diving areas is expected. Moreover, it is anticipated that fish may temporarily swim away from the test area based on human activity near the area. However, all tests are short in duration; therefore, fish are expected to repopulate the area following the test event.

NSWC PCD will continue to follow standard operating procedures associated with test planning and will release a Notice to Mariners (NOTMAR) 24 hours prior to a scheduled test event that required a secured test area. This notice will provide recreational and commercial fisherman and divers ample time to plan accordingly. Based on the small area (62 km^2 [24 mi^2]) potentially affected by temporary closures and the advance public release of NOTMARs, in accordance with NEPA, the impact on socioeconomic resources within or adjacent to the NSWC PCD Study Area will not be significant. Given these factors, in accordance with EO 12114, there will be no significant harm to socioeconomic resources within or adjacent to the NSWC PCD Study Area. Therefore, no additional analysis associated with socioeconomic resources is required

4.4.2 Airspace Management

4.4.2.1 Airspace Operations

4.4.2.1.1 Introduction and Approach to Analysis

The potential direct and indirect effects of the proposed action and alternatives on the regional air traffic environment were assessed by considering the changes in aircraft operations and airspace uses that could occur relative to current conditions under each. If required, measures that could minimize potential effects on air traffic and the Air Traffic Control (ATC) system were considered.

The type, size, shape, and configuration of individual airspace elements in a region are based on, and are intended to satisfy, competing aviation requirements. Potential effects could occur if air traffic in the region and/or the ATC systems were encumbered by changed flight activities associated with any of the alternative actions. When any significant change is planned, such as new or revised defense-related activities within an airspace area or a change in the complexity or density of aircraft movements, the FAA reassesses the airspace configuration to determine if such changes could adversely affect:

- ATC systems and/or facilities.
- Movement of other air traffic in the area.
- Airspace already designated and used for other purposes supporting military, commercial, or civil aviation.

4.4.2.1.2 Territorial Waters – Airspace Management (Air Operations)

Air operations will range from 239 hours under the No Action Alternative to 774 hours under Alternative 2. Applicable unit airspace managers schedule the use of these airspace elements, and pilots using the airspace are under the control of the FAA at Jacksonville ARTCC. The potential for conflicting use of this airspace is avoided through this scheduling and control.

Military use of this airspace will not be expected to adversely affect other civil or commercial aviation. Jacksonville ARTCC controls air traffic in the airspace, and all pilots using the airspace are required to use "see-and-avoid" standards of flight safety. Thus, in accordance with NEPA the impact to air space management from air operations will not be significant over territorial waters with the No Action Alternative, Alternative 1, or Alternative 2.

4.4.2.1.3 Non-Territorial Waters – Airspace Management (Air Operations)

NSWC PCD RDT&E activities will include up to 342 hours of helicopter and fixed-wing operations over non-territorial waters. However, the potential for conflicts in airspace utilization is avoided through FAA scheduling and control; effects will not differ between the non-territorial and territorial waters for this alternative. Therefore, in accordance with EO 12114, there will be no significant harm to airspace management over non-territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.4.3 Artificial Reefs

Artificial reefs and shipwrecks typically attract large numbers of fish; thus, these areas are frequented by fishermen and recreational divers. The locations of reef permit areas, individual reefs, and known shipwrecks are shown in Figure 3-8 in Chapter 3. All operations that occur on or near the sea floor (i.e., tow tests, mine placement, detonations, crawler operations), or have the potential to physically damage the structural integrity of an artificial reef (i.e., ordnance operations) will not be conducted near the location of artificial reefs or known shipwrecks in accordance with the protective measures described in Chapter 5. If a test requires a secured test area that prohibits public access to a nearby artificial reef, NSWC PCD will release a NOTMAR 24 hours prior the scheduled test event. This notice will provide recreational and commercial fisherman and divers ample time to plan accordingly. Furthermore, the locations of the popular diving spots have been well documented (as shown in Figure 3-8) and dive boats are typically well marked and include diver-down flags that will be visible from a reasonable distance. This will help the Navy to avoid conducting operations in areas where recreational divers are present.

Based on the avoidance of artificial reefs and known shipwrecks and the advance public release of NOTMARs, in accordance with NEPA, there will be no significant impact to artificial reefs from NSWC PCD RDT&E activities conducted in territorial waters of the NSWC PCD Study Area under the No Action Alternative, Alternative 1, or Alternative 2. Furthermore, in accordance with EO 12114, there will be no significant harm to artificial reefs from RDT&E activities conducted in non-territorial waters of the NSWC PCD Study Area under the No Action Alternative, Alternative 1, or Alternative 2.

4.4.4 Cultural and Historical Resources

4.4.4.1 Introduction and Approach to Analysis

This section discusses potential direct and indirect effects to cultural resources within the NSWC PCD Study Area, which includes portions of SAB and the GOM. Potential issues for cultural resources relate to potential disturbance of submerged cultural resources during RDT&E activities. Analysis focused on assessing the potential for effects to submerged cultural resources from sonar, laser, electromagnetic, ordnance, air, surface, and subsurface operations.

A number of federal regulations and guidelines have been established for the management of cultural resources. Section 106 of the National Historic Preservation Act (NHPA), as amended, requires federal agencies to take into account the effects of their undertakings within territorial waters on historic properties. Historic properties are cultural resources that are listed in, or are eligible for listing in the National Register of Historic Places (NRHP). Effects to cultural resources are considered adverse if the resources have been determined to be eligible for listing or are listed in the NRHP or have religious or cultural significance for federally recognized Indian Tribes.

Operations that possess the potential to disturb submerged cultural resources will not be conducted in areas that are expected to contain known cultural resources, such as historic shipwrecks in accordance with the protective measures described in Chapter 5. If avoidance is not possible, consultation with the applicable agencies will be initiated. For potential effects in State of Florida waters, mitigation measures will be identified through consultation with the Florida State Historic Preservation Officer (SHPO). If an unknown cultural resource is discovered during an operation, the Navy will cease activities and notify the SHPO. Therefore, based on the implementation of avoidance measures for cultural resources and the notification of the SHPO for newly discovered resources, in accordance with NEPA, there will be no significant impact to known cultural resources from sonar, laser, electromagnetic, ordnance, projectile firing, air, surface, and subsurface operations in territorial waters with the No Action Alternative, Alternative 1, or Alternative 2. In addition, in accordance with EO 12114, there will be no significant harm to known cultural resources from sonar, laser, electromagnetic, ordnance, air, surface, and subsurface operations in non-territorial waters with the No Action Alternative, Alternative 1, or Alternative 2.

4.4.5 Environmental Justice and Risks to Children

The CEQ's *Environmental Justice Guidance under the National Environmental Policy Act* (1997) identifies factors that are to be considered to the extent practicable when determining whether environmental effects on minority populations and low-income populations are disproportionately high and adverse. These factors include whether there is or will be an effect on the natural or physical environment that significantly (as delineated in NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social effects when those effects are interrelated to effects on the natural or physical environment. Other factors to be considered if significant and adverse effects are projected include: (1) whether they would appreciably exceed those same effects on the general population or other appropriate comparison group, and (2) whether these populations have been affected by cumulative or multiple exposures from environmental hazards. NSWC PCD RDT&E activities will occur in areas with no land-based effects.

4.4.5.1 Introduction and Approach to Analysis

The methods to conduct the effects analysis for environmental justice for the NSWC PCD EIS/OEIS included a review of conclusions for the following resources: geology, air quality, water quality, sound, biological resources including marine habitat and others, socioeconomics, airspace management, artificial reefs, and safety. If the EIS/OEIS identified significant effects or otherwise identified effects considered to be disproportionately high and adverse for the purposes of the environmental justice analysis (i.e., effects that exceeded an accepted threshold or standard and would potentially affect the public), an evaluation would be conducted to determine if further analysis was needed to determine if effects could disproportionately fall on minority populations or low-income populations. It should be noted that all the NSWC PCD RDT&E activities addressed in this EIS/OEIS will be conducted either on or over waters within the NSWC PCD Study Area. Flight operations required to support such activities will also be occurring offshore. Since NSWC PCD is located adjacent to the SAB, even takeoffs and landings will not often require flight patterns over highly populated areas.

4.4.5.2 Territorial Waters – Environmental Justice and Risks to Children

Although neither significant or disproportionately high and adverse impacts to the public were identified for the No Action Alternative, Alternative 1, or Alternative 2, the potential impact to each environmental justice resource area are discussed below:

- ***Geology*** – No significant impact to the geology will occur within the territorial waters of the NSWC PCD Study Area, in accordance with NEPA.
- ***Water Quality*** – No regulatory thresholds will be exceeded, and the water quality within the NSWC PCD Study Area territorial waters will not degrade below existing conditions.
- ***In-Air Sound*** – No significant impact to sound level averages will occur over the territorial waters of the NSWC PCD Study Area, in accordance with NEPA.
- ***Air Quality*** – No regulatory thresholds will be exceeded over the territorial waters of the NSWC PCD Study Area.
- ***Biological Resources*** – Potential impacts to marine mammals and sea turtles is likely. However, these effects will not affect the public outside the NSWC PCD Study Area. In accordance with the ESA requirements, a formal consultation with NMFS will be conducted and a BE package will be submitted. Additionally, a LOA package will be prepared and submitted to NMFS to meet the associated MMPA requirements.
- ***Cultural Resources*** – No significant impact to historic architectural or traditional resources will occur in the territorial waters of the NSWC PCD Study Area, in accordance with NEPA.
- ***Airspace Management*** – No significant impact to airspace management will occur over the territorial waters of the NSWC PCD Study Area, in accordance with NEPA.
- ***Artificial Reefs*** – No significant impact to artificial reefs will occur within the territorial waters of the NSWC PCD Study Area, in accordance with NEPA.
- ***Socioeconomics*** – No significant impact to socioeconomics will occur within the territorial waters of the NSWC PCD Study Area, in accordance with NEPA.

Based on the conclusions of the effects analyses for the aforementioned resources, conditions regarding minority populations, low-income populations, and children will be unaffected. The NSWC PCD RDT&E activities associated under the No Action Alternative, Alternative 1, or Alternative 2 will occur on and over water within the NSWC PCD Study Area. Project activities will occur in areas with no land-based effects, thus avoiding conflicts with minority and low-income populations and facilities serving children, such as schools, day-care centers, and playgrounds. Minimal changes to Navy personnel will be expected.

It has been assumed that a test area equivalent to a 5.6 km by 5.6 km (3.48 mi by 3.48 mi) box within the NSWC PCD Study Area will be temporarily restricted for an estimated six hours per test event. In addition, it has also been assumed that under normal conditions no more than two individual test events will occur on the same day. Therefore, a maximum of two separate areas equaling a total of 62 km^2 (24.7 mi^2) within the NSWC PCD Study Area will be restricted on any given day. Thus, a total 5,382-km^2 (2,077 mi^2) area inside the territorial line will remain available to the public. The availability of such a large study area provides NSWC PCD the flexibility to effectively schedule testing events in locations that avoid shipping lanes and areas of high volume recreational activities. In addition, any potential displacement of fish populations is expected to be temporary; therefore, fish will repopulate a test area following the test.

Two potential socioeconomic effects, recreational and commercial fishing, are discussed in greater detail below, due to public interest in the local region. There were no significant effects identified for the remaining resource areas.

- ***Socioeconomics: Direct Effects* –** Existing test and evaluation resources will be capable of accommodating additional missions. Therefore, additional tests will be accomplished without changes in personnel and equipment levels. In addition, any changes in expenditures will not be expected to result in long-term changes in population or employment in the area.
- Socioeconomics: Indirect Effects –
- Recreational and Commercial Fishing – Operations could occur anywhere from 0 to 22 km (0 to 12 NM) offshore which will result in temporary closures of portions of three military warning areas in W-151 (includes Panama City Operating Area), W-155 (includes Pensacola Operating Area), and W-470, and SAB within the territorial waters. Depending on the locations selected for various operations (e.g., sonar, laser, electromagnetic, ordnance), these closures will periodically limit public recreation and commercial fishing in some offshore areas. It is expected that temporary closures related to nearshore areas (e.g., surf zone) could have a greater effect on public recreation, whereas those farther offshore will affect commercial trawlers to a greater extent. Notices to Mariners will be issued 24 hours ahead of time when areas will be closed. The overall size of the NSWC PCD Study Area provides NSWC PCD schedulers the flexibility needed to schedule test events in areas that will have the least amount of effect on recreational and commercial activities.

The potential to cause disproportionately high and adverse effects on minority populations, low-income populations, or risks to children is highly unlikely. Therefore, there will be no significant impact to environmental justice or children from RDT&E activities in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2.

4.4.5.3 Non-Territorial Waters – Environmental Justice and Risks to Children

Environmental justice and risks to children are not applicable outside the U.S. territory; therefore, no further discussion is required.

4.5 COASTAL ZONE MANAGEMENT

Federal agency activities affecting a state's coastal zone must be consistent to the maximum extent practicable with the enforceable policies of the state's coastal management program. The Navy has prepared a Coastal Consistency Determination (CCD) and has concluded that the Proposed Action is consistent to the maximum extent practicable with the enforceable policies of the coastal zone management programs of Florida and Alabama. The Navy received a letter from the Florida State Clearinghouse which provided concurrence with this Consistency Determination. The Alabama Department of Environmental Management, however, did not respond to or request an extension after the 90th day from receipt of the determination. Therefore the Navy concludes that Alabama concurred with the Consistency Determination. Appendix J (Florida) and Appendix K (Alabama) of this EIS/OEIS contain the Navy's CCD for the Proposed Action within the NSWC PCD Study Area. Appendix J (Florida) also contains the letter NSWC PCD received from the Florida State Clearinghouse.

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5. MITIGATION AND PROTECTIVE MEASURES

To meet current and future national and global defense challenges, the Navy must develop a robust capability using realistic conditions to research, develop, test, and evaluate systems within the Naval Surface Warfare Center Panama City Division (NSWC PCD) Study Area. The Navy recognizes that such developments have the potential to create serious injury and/or mortality and to cause behavioral disruption of some marine mammal species in the vicinity of research, development, test, and evaluation (RDT&E) activities, as discussed in Chapter 4. This chapter presents the Navy's mitigation measures that would be implemented to protect marine mammals, federally listed species, and other aspects of the marine environment during RDT&E activities. Several of these mitigation measures align with mitigation measures in the training arena for the United States (U.S.) Navy, which have been in place since 2004. For NSWC PCD RDT&E activities, NSWC PCD used appropriate mitigation measures derived from the NDE. For 53-C operations aboard Navy ships, NSWC PCD used mitigation measures appropriate for Navy ships.

Title 16 of USC, Section 1371(f) of the MMPA, provides that the Secretary of Defense, after conferring with the Secretary of Commerce, the Secretary of the Interior, or both as appropriate, may exempt any action or category of actions undertaken by the Department of Defense or its components from compliance with any requirement of this chapter, if the Secretary determines that it is necessary for national defense (Section 1371[f][1]). An exemption is effective for the period specified by the Secretary of Defense, not to exceed two years. In accordance with Section 1371(f)(2), compliance with the MMPA for the use of mid-frequency active sonar (MFA) in the NSWC PCD Study Area was implemented for a two-year period beginning with the 23 January 2007 issuance of a "National Defense Exemption [NDE] from the Requirements of the MMPA for Certain DoD Military Readiness Activities that Employ Mid-Frequency Active Sonar of Improved Extended Echo Ranging Sonobuoys." The NDE expired in January 2009.

The Navy coordinated with NMFS on the "Mid-Frequency Active Sonar Mitigation Measures During Major Training Exercises or Within Established DoD Maritime Ranges and Established Operating Areas." Those mitigations for mid-frequency active (MFA) sonar were incorporated into this EIS/OEIS and are detailed below. This chapter also presents a discussion of other measures that have been considered and rejected because they: (1) are not feasible, (2) present a safety concern, (3) provide no known or ambiguous protective benefit; or (4) impact the effectiveness of the required military readiness activity.

To make the findings necessary to issue the Marine Mammal Protection Act (MMPA) authorization, it may be necessary for NMFS to require additional mitigation or monitoring measures beyond those addressed in this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS). These could include measures considered, but eliminated in this EIS/OEIS, or measures yet to be developed. In addition to commenting on this document, the public had an opportunity to provide information to NMFS through the MMPA process, both during the comment period following NMFS' Notice of Receipt of the application for a LOA, and during the comment period following NMFS' publication of the proposed rule. NMFS may propose additional mitigation or monitoring measures in the proposed rule. Any measures not considered in the Draft EIS/OEIS, but required through the MMPA consultation, were evaluated in accordance with the National Environmental Policy Act (NEPA) and are included in this Chapter 5.

In addition to the proposed mitigation and protective measures, NSWC PCD is implementing a formalized Environmental Review Process to monitor and track activity tempos associated with the effects addressed in this NSWC PCD EIS/OEIS. The following subsections outline the key elements and components of the proposed NSWC PCD Environmental Review Process and the mitigation and protective measures. All proposed measures will be discussed with NMFS.

5.1 ENVIRONMENTAL REVIEW PROCESS

The NSWC PCD Environmental Review Process, as implemented by the revised NSWC PCD Instruction 5100.30D, requires that all draft test plans be submitted to the NSWC PCD Environmental Help Desk six months prior to the proposed start date. The test plan is assigned to an environmental analyst from the Help Desk to review the proposed testing.

Upon completing the review of the test plan, the assigned analyst would make a determination as to whether the proposed testing falls within the overall scope of the NSWC PCD EIS/OEIS or has sufficient environmental documentation to cover the Proposed Action. If it is determined that the proposed testing is either covered under the scope of the NSWC PCD EIS/OEIS or has sufficient independent environmental planning documentation, the analyst would prepare a Record of Environmental Consideration (REC), which would serve as documentation that the plan successfully completed the Environmental Review Process and would not require any further environmental review. The REC would contain required mitigation measures identified in this EIS/OEIS.

However, if it is determined that the proposed testing falls outside of the scope of the NSWC PCD EIS/OEIS, does not have current environmental planning documentation, and does not meet the criteria for utilizing one of the Navy's Categorical Exclusions (CATEXs), the Help Desk analyst would contact the test planner immediately. The Help Desk analyst would request that the test planner present a short informational briefing on the proposed testing to the Environmental Review Board. The Environmental Review Board serves as the official forum for determining what actions would be required if a proposed test falls outside the scope of the NSWC PCD EIS/OEIS. A REC would be provided to the test planner describing the level of environmental compliance documentation required and outlining any specific mitigation, agency coordination, or recommended safety procedures. The mitigations and recommendations would be incorporated into the individual test plans to ensure compliance. The Environmental Review Process would incorporate these mitigations and recommendations based on the nature of the test event such as the test platforms (i.e. aircraft, surface vessel) and the acoustic sources (i.e., sonars, explosives, and projectiles) and their associated environmental effects addressed in this EIS/OEIS. Each of the mitigations outlined in this chapter would be applied appropriately to each test event.

In an effort to track and monitor the activity tempos associated with the effects addressed in this EIS/OEIS, test directors would be required to submit a Post-test Summary to the NSWC PCD Environmental Help Desk upon the completion of each test event. The Post-test Summary would summarize the test events, any mitigation and protective measures used, an overview of marine mammal and sea turtle observations and capture the actual hours, intensity, and number of events conducted. The data captured would be used to populate a living database that would be used to compare NSWC PCD's current operational tempo and intensity to that which has been analyzed in this EIS/OEIS. Thus, this data would serve as a means of projecting if and when NSWC PCD operations might exceed the allotment of hours utilized in the analysis performed within the NSWC PCD EIS/OEIS. This data would also be used to determine the number of marine mammal takes under the LOA.

5.2 SAFETY

This section addresses safety associated with RDT&E activities within the NSWC PCD Study Area and includes a discussion of the current safety planning process at NSWC PCD, as well as a discussion of safety requirements/procedures associated with specific hazards, such as the use of ordnance and lasers. This section provides the existing standard operating procedures and safety procedures.

5.2.1 Safety Planning Process

NSWC PCD has established a comprehensive safety planning process designed to minimize hazards associated with its RDT&E activities. The purpose of this process is to:

1. **Identify the hazards.** Personnel involved with the test or activity act as a team to identify all potential hazards.
2. **Assess the potential risk.** Assess the probability and severity of loss from exposure to the identified hazard.
3. **Analyze risk control measures.** Investigate specific strategies and tools that reduce, mitigate, or eliminate the risk.
4. **Implement risk controls.** Once procedures to minimize identified hazards have been determined and approved at the appropriate level, those procedures are implemented during the proposed testing.
5. **Supervise and review.** Continue the process throughout each and every test event.

The primary regulations that establish safety policy and define requirements and procedures for activities conducted within the NSWC PCD Study Area are found in NSWC, Coastal System Station Instruction 5100.30C (NSWCCSSINST 5100.30C), *Field Test And Safety Planning*, dated 1 September 1999. This guidance is implemented by the Test Engineering Branch and supporting organizations (NSWC, 1999) who are in the process of revising this instruction. It affects all NSWC PCD RDT&E activities and includes ground, waterborne, and airborne testing activities involving personnel, aircraft, inert minefields, equipment, and/or airspace. The guidance applies to system program managers, program engineers, test engineers, test directors, and aircrews that are responsible for incorporating safety planning and review into the conduct of test programs.

Safety planning requirements of NSWCCSSINST 5100.30C are implemented through a Test Safety Review Committee (TSRC). This committee consists of knowledgeable and experienced individuals from Test Engineering Branch, Environmental Office, Meteorology and Oceanography (METOC)/Disaster Preparedness Office, Safety and Security Division, as well as the Explosive Safety Officer and Ordnance Officer. In addition, applicable NSWC PCD functions and tenant activities are consulted to provide expertise in their mission areas as needed (NSWC, 1999).

The safety planning process begins when a test organization requests the use of a NSWC PCD test asset. The requesting organization is required to submit a written test/safety plan to the TSRC, which includes a detailed description of the methods to be used to accomplish the test as well as detailed information regarding the control of potential test-related hazards (explosives, lasers, etc.). The TSRC then thoroughly reviews the test/safety plan for test implementation, conduct, and safety considerations, and either recommends approval or rejection. At least five TSRC members must be present for a formal TSRC to convene. A unanimous vote of the TSRC is required for approval of any test/activity (NSWC, 1999).

A test safety officer is appointed within the test team to monitor safety during the event. A daily test and safety briefing is conducted prior to the commencement of each day's test(s). This briefing addresses the test safety issues, the safety checklist, the communication frequencies, the security protocol, the call signs, and any other related items that may be of concern to the test team. To help all test participants anticipate the occurrence of any unusual, unexpected, or hazardous situations, specific test responsibilities and required actions are clearly defined and prioritized as part of the daily briefing (NSWC, 1999).

5.2.2 Standard Safety Procedures

A number of standard safety procedures exist at NSWC PCD to ensure limited public access to active operational areas during test implementation. These procedures require that participants employ every practical effort to keep the designated operational areas clear of all nonparticipating personnel, aircraft, and surface vessels.

For example, NSWC PCD may provide local media with advance notice of upcoming tests by issuing releases for publication in local newspapers and/or recorded messages for radio stations. Verbal and written warnings may also be transmitted for surface vessels (via Notices to Mariners [NOTMARs]) to clear the area or to provide notification of specific hazards in designated areas. These warnings are transmitted prior to the test over specific Marine very high frequency (VHF) radio channels. The airspace or coastal areas to be utilized for tests that pose a potential safety risk are visually surveyed to ensure that unauthorized aircraft or boats are not in the operational area at the time of the scheduled test. After verifying the operational area is clear, the scheduled test would be allowed to proceed. If any unauthorized personnel, aircraft, or surface vessels were detected within the operational area following these procedures, the test activity would be temporarily halted until the area is again cleared and secured.

5.2.3 Test-specific Safety Hazards

NSWC PCD also applies specific and standardized safety procedures associated with the operation of potentially hazardous sources, such as explosives, sonar or lasers, as discussed in the mitigation and protective measures for these areas in Sections 5.3, 5.8, and 5.9. (Note: Safety procedures associated with routine flying operations, operation of boats or seagoing vessels, or diving operations are implemented through the individual organization, based on its specific testing protocols/guidance and standard operating procedures.)

5.3 MITIGATION MEASURES RELATED TO SONAR EFFECTS

The Navy must develop a robust capability using realistic conditions to research, develop, test, and evaluate systems to meet current and future national and global defense challenges. The Navy recognizes that such developments may create serious injury and/or mortality and cause behavioral disruption of some marine mammal species (as outlined in Chapter 4) in the NSWC PCD Study Area and has sought a request for a Letter of Authorization (LOA), a Biological Opinion (BO) and incidental take statement from NMFS. This subsection describes the suite of mitigation measures developed based on the results of the consultations with NMFS that would be implemented to protect marine mammals and sea turtles, as well as other aspects of the marine environment during the proposed RDT&E activities related to sonar. This section does not address mitigation measures related to the 53-C sonar system. Refer to Section 5.12 for mitigation measures related to this system. The requirements for each specific event would be identified and documented during the Environmental Review Process and would be incorporated into the individual test plans as part of the protocol.

5.3.1 Personnel Training

NSWC PCD has used RDT&E marine species observers in previous RDT&E test activities that have the potential to affect protected marine species. Depending on the level of activity and the projected potential effects, the observers are required to sight and report to the Test Director any marine mammal or sea turtle species within 1,829 m (2,000 yd) of the sonar system. Marine species observers also keep detailed records about the time and duration of sonar use, the location of testing, and any species observed during the sonar activities. These RDT&E marine species observers either undergo extensive Navy training to qualify or have educational and professional experience as biologists, typically specializing in marine mammal biology or marine biology in general.

Marine mammal mitigation training for those who participate in the active sonar activities is a key element of the mitigation measures. The goal of this training is for key personnel onboard platforms in the NSWC PCD Study Area to understand the mitigation measures and be competent to carry them out. The Marine Species Awareness Training (MSAT), developed and implemented Navy-wide, is provided to all applicable participants, where appropriate. The program addresses environmental protection, laws governing the protection of marine species, Navy stewardship, and general observation information including more detailed information for spotting marine mammals. MSAT has been reviewed by NMFS and acknowledged it as suitable training. MSAT would be provided to participants, as deemed necessary and appropriate during the Environmental Review Process. Furthermore, NSWC PCD has prepared a training presentation that includes the governing laws and policies, the potential causes of NSWC PCD activities' impact, an overview of the specific Gulf of Mexico species, the role of the observer and hands-on practice with the observer tools to be used during test events. Upon completing this training, marine species observers would be aware of the specific actions to be taken based on the RDT&E platform if a marine mammal or sea turtle is observed.

5.3.2 Range Operating Procedures

The following procedures would be implemented to maximize the ability of Navy personnel to recognize instances when marine mammals are in the vicinity.

5.3.2.1 General Maritime Mitigation Measures: Personnel Training

- Marine species observers would be trained to quickly and effectively communicate within the command structure to facilitate implementation of mitigation measures if marine species are spotted.

5.3.2.2 General Maritime Mitigation Measures: Observer Responsibilities

- On the bridge of surface vessels, there shall always be at least one to three marine species awareness trained observer(s) on watch whose duties include observing the water surface around the vessel.
  a) For vessels with length under 65 ft (20 m), there would be at least one marine species observer on watch.
  b) For vessels with length between 65 – 200 ft (20 – 61 m), there would be at least two marine species observers on watch.
  c) For vessels with length above 200 ft (61 m), there would be at least three marine species observers on watch.
- Marine species observers would have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- Marine species observers would scan the water from the ship to the horizon and be responsible for all observations in their sector. In searching the assigned sector, the marine species observer would always start at the forward part of the sector and search aft (toward the back). To search and scan, the marine species observer would hold the binoculars steady so the horizon is in the top third of the field of vision and direct the eyes just below the horizon. The marine species observer would scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They would search the entire sector in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the marine species observer would search back across the sector with the naked eye.
- After sunset and prior to sunrise, marine species observers would employ Night Lookout Techniques in accordance with the Lookout Training Handbook (Naval Education and Training Command Manual [NAVEDTRA] 12968-D).
- At night, marine species observers would scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually

searching at night, marine species observers would look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision.

- Marine species observers would be responsible for informing the Test Director of any marine mammal or sea turtle that may need to be avoided, as warranted.

5.3.2.3 Operating Procedures

Section 5.10 presents detailed information on visual clearance procedures. The following gives a general overview of the requirements of monitoring during RDT&E activities that involve sonar.

- The Test Director or the Test Director's designee would maintain the logs and records documenting RDT&E activities should they be required for event reconstruction purposes.

- A Record of Environmental Consideration would be included in the Test Plan prior to the test event to further disseminate the personnel testing requirement and general marine mammal mitigation measures.

- Test Directors would, as appropriate to the event, make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible, consistent with the safety of the ship.
- During operations involving high frequency active (HFA) and mid-frequency active (MFA) sonar, personnel would use all available sensor and optical systems (such as binoculars or night vision goggles to aid in the detection of marine mammals).
- Navy aircraft participating in RDT&E activities would conduct and maintain, when operationally feasible, required, and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Marine mammal detections by aircraft would be immediately reported to the Test Director. This action would occur when it is reasonable to conclude that the course of the ship would likely close the distance between the ship and the detected marine mammal.
- Safety zones – For tests that require the use of safety zones, when marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 914 m (1,000 yd) of the sonar system, the platform would limit active transmission levels to at least 6 decibels (dB) below normal operating levels for those systems that this capability is available.
- Vessels would continue to limit maximum transmission levels by this 6-dB factor for those systems that this capability is available until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.
- Should a marine mammal be detected within or closing to inside 457 m (500 yd) of the sonar system, active sonar transmissions would be limited to at least 10 dB below the equipment's normal operating level for those systems that this capability is available.

Platforms would continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.

- Should the marine mammal be detected within or closing to inside 183 m (200 yd) of the sonar system, active sonar transmissions would cease. Sonar would not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.
- If the need for power-down should arise, as detailed in "Safety Zones" above, Navy staff would follow the requirements as though they were operating at 235 dB—the normal operating level (i.e., the first power-down would be to 229 dB, regardless of the level above 235 dB the sonar was being operated).
- Prior to start up or restart of active sonar, operators would check that the safety zone radius around the sound system is clear of marine mammals.
- Sonar levels (generally) – the Navy would operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet RDT&E objectives.
- These procedures would also apply as much as possible during AUV/UUV operations. An observer would be located on the support vessel or platform to observe the area, depending on the test event. When an AUV/UUV is operating and shows potential to expose, it is impossible to follow and observe it during the entire path but they would visualize the general area or modify the plan specific to the nature of the system. If the system is undergoing a small track close to the support platform, then observers would be used.

5.3.2.4 Special Conditions Applicable for Bow-Riding Dolphins

- If, after conducting an initial maneuver to avoid close quarters with dolphins, the ship concludes that dolphins are deliberately closing in on the ship to ride the vessel's bow wave, no further mitigation actions would be necessary because dolphins are out of the main transmission axis of the active sonar while in the shallow-wave area of the vessel bow.

5.3.2.5 Other Considerations for Sonar Safety

- Safe standoff distances for swimmers and divers are detailed in the Navy Dive Manual, Appendix 1A (DON, 1999). These distances would be used as the standard sonar safety buffer for operations occurring within the NSWC PCD Study Area.

5.4 PROTECTIVE MEASURES RELATED TO OPERATIONAL AND ENVIRONMENTAL PLANNING AND COORDINATION

- Test areas would not be sited in areas of seagrass.
- The most favorable temporal-spatial (seasonal and geographical) province that satisfies all operational requirements would be utilized.

- Local Notices to Mariners would be issued at least 24 hours ahead of time when areas would be used for testing.
- The Navy would follow established procedures designed to avoid conflicts with mariners, such as avoidance of shipping lanes and artificial reefs, where feasible.
- Consultation with the appropriate agencies would be conducted when avoidance of historic properties in territorial waters is not possible. Furthermore, unexpected finds of historical properties would be reported to the State Historic Preservation Officer (SHPO).

5.5 PROTECTIVE MEASURES RELATED TO SURFACE OPERATIONS

- Surface vessels would not operate over areas of seagrass. Marine vehicle operators would observe idle speed limits, channel markers, and other aids to navigation to avoid any effects to nearby seagrass.
- Visual surveys would be conducted for all test operations to reduce the potential for vessel collisions with a protected species. If necessary, the ship's course and speed could be adjusted.
- Vessels underway use safety observers during all hours of underway activities. Safety observer duties include looking for any and all objects in the water, including marine mammals. While these observers have other duties and are not necessarily looking only for marine mammals, they will be MSAT trained. All sightings are reported to the Test Director or the Test Director designee in charge of overseeing the activity.
- While in transit, naval vessels would be alert at all times, use extreme caution, and proceed at the minimum speed that would not compromise mission goals or safety so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.
- When marine mammals have been sighted in the area, Navy vessels would increase vigilance and implement measures to avoid collisions with marine mammals and avoid activities that might result in close interaction of naval assets and marine mammals. Actions would include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).
- Naval vessels would maneuver to keep at least 460 m (500 yd) away from any observed whale and avoid approaching whales head-on. This requirement does not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Vessels would take reasonable steps to alert other vessels in the vicinity of the whale.
- Where operationally feasible and safe, vessels would avoid closing to within 183 m (200 yd) of marine mammals other than whales.

5.6 PROTECTIVE MEASURES RELATED TO SUBSURFACE OPERATIONS

- No mine-like object (MLO) and versatile exercise mine (VEM) placement or crawler operations would occur within areas of seagrass.
- No MLO and VEM placement or crawler operations would occur within areas of known hardbottom.
- Activities such as mine placement and crawler operations that cause bottom disturbance would not be conducted in Marine Managed Areas.
- Mine placement and anchoring would not be conducted in areas that could damage hardbottom or seagrass habitats.
- Activities such as mine placement and crawler operations that cause bottom disturbance would not occur over artificial reefs or known shipwrecks. If an unknown shipwreck is uncovered, the SHPO would be notified and all activities would cease.

5.7 PROTECTIVE MEASURES RELATED TO ELECTROMAGNETIC OPERATIONS

- When operationally feasible, electromagnetic operations and tests would not be conducted within 0.03 kilometer (km) (approximately 0.02 nautical mile [NM]) of shore during sea turtle nesting and hatching season, which is considered to be 01 May through 30 September.
- RDT&E marine species observers would monitor the system for contact with marine mammals or sea turtles during all test operations involving electromagnetic field generation.

5.8 PROTECTIVE MEASURES RELATED TO LASERS

- Lasers would be operated at or below human unaided eye safety levels.
- Visual surveys would be conducted for all test operations involving laser line scan, light imaging detection, and ranging lasers.
- A test/safety plan must be developed for operations involving laser systems and must include a laser hazard analysis, which includes the distance in which exposure or irradiance falls below the applicable exposure limit (nominal ocular hazard distance [NOHD]), wavelength, energy, optical density of goggles, etc.; a description of the required safety buffer zone and procedures for securing the safety buffer during testing; a description of laser safety features (beam shutters, beam stops, roll/pitch limits, etc.) and other potential laser-related hazards (high voltage, liquid cooling, etc.); and documentation of laser safety training for test personnel. The test/safety plan must also indicate that the Range Laser Safety Officer has the authority to shut down the laser test if he/she observes any unsafe conditions related to firing the laser.

5.9 MITIGATION AND PROTECTIVE MEASURES RELATED TO DETONATIONS AND PROJECTILES

- No detonations over 34 kilograms (kg) (75 pounds [lbs]) would be conducted in territorial waters. This does not apply to the line charge detonation, which is not considered to be a single detonation but a series of 2.3 kg (5 lbs) detonations occurring more or less simultaneously.
- The number of live mine detonations would be minimized and the smallest amount of explosive material possible to achieve test objectives would be used.
- Ammunition casings would be collected when possible. Some of the casings from the rounds would be expected to fall within the test platform. They should be collected when possible and not swept into the water.
- Activities would be coordinated through the Environmental Help Desk to allow potential concentrations of detonations in a particular area over a short time to be identified and avoided.
- No detonations would occur within areas of seagrass or where they could damage seagrass habitat.
- No detonations would occur within hardbottom areas or where they could damage hardbottom habitat.
- Detonations that cause bottom disturbance would not occur over artificial reefs or known shipwrecks. If an unknown shipwreck is uncovered, the SHPO would be notified and all activities would cease.
- No detonations would occur in estuarine areas.
- Line charge tests would not be conducted during the nighttime.
- Detonations would not occur if flocks of birds are rafting on the water's surface inside a test area or if flocks of birds are migrating directly above the proposed test site.
- Gulf sturgeon critical habitat occurs from the shoreline to 1.9 km (1 NM) offshore throughout the NSWC PCD Study Area. During the months of October and November, many of these fish move from fresh water into the Gulf of Mexico (GOM) and may be found in the marine portion of critical habitat. They generally remain in the GOM until March. Therefore, when operationally feasible, surf zone line charge detonations would not be conducted between October and March.
- Visual surveys and aerial surveys would be conducted for all test operations that involve detonation events with large net explosive weight (NEW) and projectile firing. Any protected species sighted would be avoided. For additional information regarding clearance procedures, refer to Section 5.10.
- If a Gulf sturgeon was sighted close to the line charge detonation point, tests would be postponed until the animal is over 0.8 km (0.5 mi) from the detonation point.
- No surf zone line charge detonations would be conducted during sea turtle nesting season.

- No surf zone line charge detonations would be conducted within 24 hours of any turtle nest hatching on U.S. Air Force property within 5 km (3 mi) in either direction of the detonation site.
- Mitigations would be determined through the Environmental Review Process based on test activities including the size of detonations, test platforms, and environmental effects documented in this EIS/OEIS. Clearance zones would be determined based on the environmental criteria and explosive safety guidance (DON, 2007). The most conservative requirements in comparing the criteria with the guidance would be used.
- NSWC PCD would follow established Navy safety guidance documents for operations involving live ammunition or explosives, including OPNAVINST 8020.14, *Department Of The Navy Explosives Safety Policy*, *Naval Sea Systems Command Operating Procedures (NAVSEA OP)* 5, Volume 1, *Ammunition and Explosives Ashore, Safety Regulations for Handling, Storing, Production, Renovation, and Shipping*, and Naval Ordnance, Safety, and Security Activity Instruction (*NOSSAINST*) *8023.11A Standard Operating Procedures Development, Implementation, Maintenance for Ammunition and Explosives* (Naval Support Activity Panama City Instruction [NSAPCINST], 2007).
- Departments at NSWC PCD would develop written standard operating procedures (SOPs), which clearly identify and minimize existing and potential hazards inherent in processing explosive components. These standard procedures provide NSWC PCD personnel with detailed, step-by-step instructions for conducting safe processing of explosive ordnance or components and integrate technical requirements; explosive safety standards; Naval Occupational Safety and Health (NAVOSH) standards; federal, state, local environmental protection standards; security and physical security directives; and other factors as determined by the activity (U.S. Navy, 2001 and 1999). Elements of an SOP include a flow chart of step-by-step test procedures, a Hazard Control Brief detailing hazard control measures, and an Emergency Response and Contingency Plan. NSAPCINST 8023.4A Explosive Safety Policies, Requirements and Procedures, dated 22 January 2007, provides guidance and direction for developing and using SOPs at NSWC PCD.
- All SOPs would be reviewed and validated by the facility Explosive Safety Office and Ordnance Officer to ensure that they are correct and would result in a safe, effective, and efficient operation (NSAPCINST, 2007).

5.10 CLEARANCE PROCEDURES

Visual surveys would be conducted from vessels and/or aircraft, when the Environmental Review Process desk determines that they are required. Aerial surveys would be used for detonations involving large amounts of the NEW, since the impact range could be too large to be effectively surveyed from a surface vessel only. The Environmental Review Process desk would evaluate the proposed type of test activities and determine the appropriate mitigation requirements including pre- and post- mitigation times, number of observers, and any other specifics for the required mitigation activities.

A visual survey would consist of searching the water 360 degrees around the detonation point and out to the Level B behavioral harassment zone for the presence or indicators of protected species. If a protected species is sighted within 914 m (1,000 yd) of the detonation point, all efforts would be made to avoid these sighted species. Since the effectiveness of visual surveys depends on not only on observer training and experience, but also on sea state and observer fatigue, operations requiring visual surveys would be carried out only in sea states of 3.5 or lower as described in Table 5-1. Higher winds typically increase wave height and create "white cap" conditions, thus limiting an observer's ability to locate surfacing marine mammals and sea turtles. The Environmental Review Process personnel would also provide suggestions based on the hours of operation, the type of RDT&E activity, and the level of mitigation requirements to reduce observer fatigue.

When the test platform (surface vessel or aircraft) arrives at the test site, an initial evaluation of environmental suitability would be made. This evaluation would include an assessment of sea state and verification that the area is clear of visually detectable marine mammals, sea turtles, and indicators of their presence. Large *Sargassum* rafts and large concentrations of jellyfish are considered indicators of potential sea turtle presence. Large flocks of birds and large schools of fish are considered indicators of potential marine mammal presence.

Table 5-1. Pierson-Moskowitz Sea Spectrum - Sea State Scale for Marine Mammal and Sea Turtle Observation

Wind Speed (Kts)	Sea State	Significant Wave (m) (Ft)	Significant Range of Periods (Sec)	Average Period (Sec)	Average Length of Waves (m) (Ft)
3	0	< 0.15 (<0.5)	<0.5 - 1	0.5	0.46 (1.5)
4	0	< 0.15 (<0.5)	0.5 - 1	1	0.61 (2)
5	1	0.15 (0.5)	1 - 2.5	1.5	2.90 (9.5)
7	1	0.30 (1)	1 - 3.5	2	3.96 (13)
8	1	0.30 (1)	1 - 4	2	4.88 (16)
9	2	0.46 (1.5)	1.5 - 4	2.5	6.10 (20)
10	2	0.61 (2)	1.5 - 5	3	7.92 (26)
11	2.5	0.76 (2.5)	1.5 - 5.5	3	10.06 (33)
13	2.5	0.91 (3)	2 - 6	3.5	12.04 (39.5)
14	3	1.07 (3.5)	2 - 6.5	3.5	14.02 (46)
15	3	1.22 (4)	2 - 7	4	16.0 (52.5)
16	3.5	1.37 (4.5)	2.5 - 7	4	17.98 (59)
17	3.5	1.52 (5)	2.5 - 7.5	4.5	19.96 (65.5)
18	4	1.83 (6)	2.5 - 8.5	5	24.08 (79)
19	4	2.13 (7)	3 - 9	5	28.04 (92)
20	4	2.29 (7.5)	3 - 9.5	5.5	30.18 (99)
21	5	2.4 (8)	3 - 10	5.5	32.0 (105)

m = Meters; Ft = Feet; Kts = Knots; Sec = Seconds

If the initial evaluation indicates that the area is clear, visual surveying would begin. The area around the center of the noise source, with a radius equal to 914 m (1,000 yd), would be visually surveyed for the presence of protected species and protected species indicators. Visual surveys would be conducted from the test platform before test activities begin. If the platform is a surface vessel, no additional aerial surveys would be required except for events involving large detonations. For surveys requiring only surface vessels, aerial surveys may be opportunistically conducted by aircraft participating in the test. If surface vessels were participating in activities with large detonations, shipboard surveys on these vessels would be required as well.

Shipboard monitoring would be staged from the highest point possible on the vessel. The observer(s) would be experienced in shipboard surveys, familiar with the marine life of the area, and equipped with binoculars of sufficient magnification. Each observer would be provided with a two-way radio that would be dedicated to the survey, and would have direct radio contact with the Test Director. Observers would report to the Test Director any sightings of marine mammals, sea turtles, or indicators of these species, as described previously. Distance and bearing would be provided when available. Observers may recommend a “Go”/“No Go” decision, but the final decision would be the responsibility of the Test Director.

If one or more aircraft participate in visual surveys, the area to be surveyed would extend from the noise source out to 914 m (1,000 yd). The pilots would employ standard flight patterns. In addition to the previous requirements for boat-based observers, aerial observers would be experienced in aerial surveys. If operational constraints permit, it would be preferable that aerial surveys be conducted at an altitude of 152 to 229 m (about 500 to 750 ft). Each observer would have direct radio contact with the Test Director. Observers would report to the Test Director any sightings of marine mammals, sea turtles, or indicators of these species, as described previously. Distance and bearing would be provided when available. Observers may recommend a “Go”/“No Go” decision, but the final decision would be the responsibility of the Test Director.

The mission would be postponed if any marine mammal, sea turtle, *Sargassum* raft, jellyfish concentration, large flock of birds, or large school of fish were visually detected within 914 m (3,000 yd) of the detonation point. The delay would continue until the animal or animal indicator has voluntarily moved or drifted out of the impact range (i.e., greater than 914 m [1,000 yd] from the detonation point). At that point, visual surveys would be restarted before test activities begin.

Post-mission surveys would be conducted from the surface vessel(s) and aircraft used for pre-test surveys. Observation of the impact range would be carried out to verify the presence of dead or injured marine mammals or sea turtles. Any such affected marine species would be documented and reported to NMFS. The report would include the date, time, location, test activities, species (to the lowest taxonomic level possible), behavior, and number of animals.

5.11 AVOIDANCE AREAS

As stated previously, the most favorable temporal-spatial (seasonal and geographical) province that satisfies all operational requirements would be utilized. Additionally, other identified areas would be avoided due to potential effects to biological, economic, or social resources. Figure 5-1 shows the composite of these individual areas. Figure 5-2 depicts the composite of areas that must be avoided for only activities affecting the sea surface. These two types of areas are differentiated because activities that involve only surface operations (i.e., operations occurring just under the surface) may still be conducted over areas of sensitive bottom habitat. Conversely, operations that affect the sea floor require the presence of surface vessels. Therefore, submerged operations directly affect the sea surface.

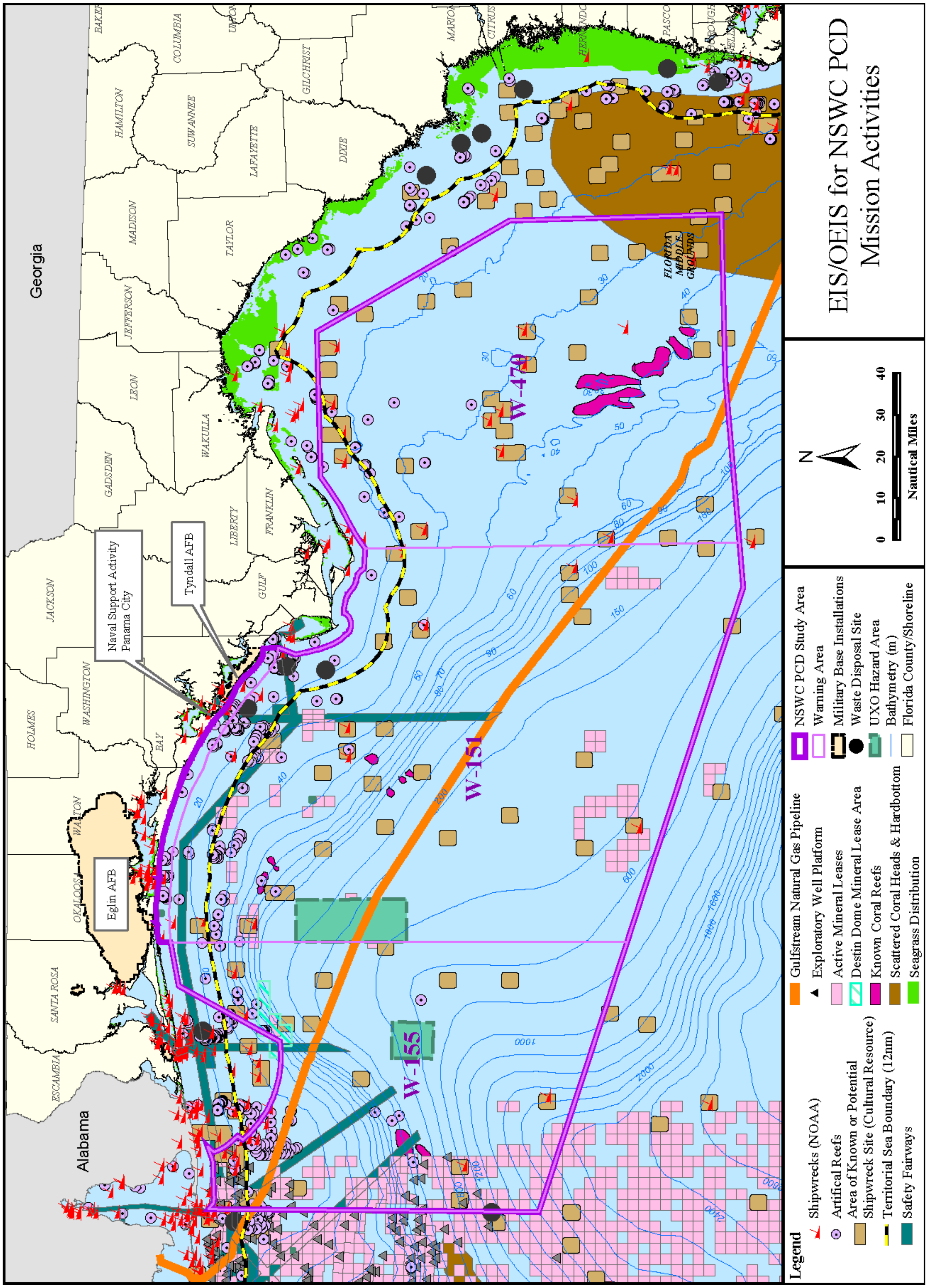

Figure 5-1. Constraint Areas for All Activities Combined

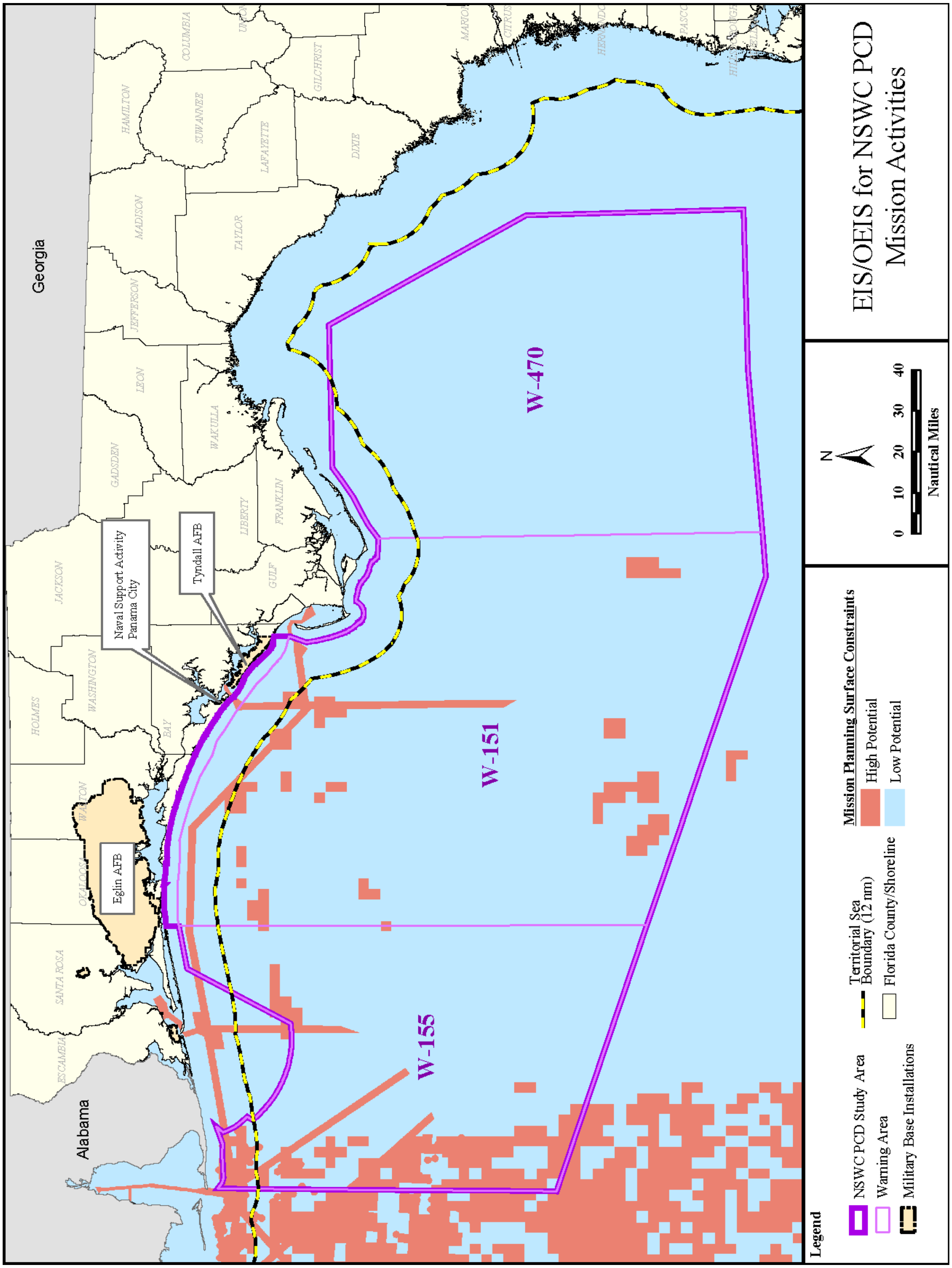

Figure 5-2. Constraint Areas for Activities Conducted On or Near the Surface

5.12 MITIGATION MEASURES ASSOCIATED WITH THE AN/SQS-53C

5.12.1 Personnel Training

Navy shipboard lookouts are highly qualified and experienced marine observers. At all times, shipboard lookouts are required to sight and report all objects found in the water to the Officer of the Deck. Objects (e.g., trash, periscope) or disturbances (e.g., surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew. Navy lookouts undergo extensive training to qualify as a watchstander. This training includes on-the-job instruction under the supervision of an experienced watchstander, followed by completion of the Personal Qualification Standard (PQS) program, certifying that they have demonstrated the necessary skills to detect and report partially submerged objects. In addition to these requirements, many watchstanders periodically undergo a two-day refresher training course.

Marine mammal mitigation training for those who participate in the NSWC PCD RDT&E activities involving the use of the AN/SQS-53C is a key element of the mitigation measures. The goal of this training is twofold: (1) that active sonar operators understand the details of the mitigation measures and are competent to carry out the mitigation measures, and (2) that key personnel onboard platforms in the NSWC PCD Study Area understand the mitigation measures and are competent to carry them out.

For the past few years, the Navy has implemented marine mammal spotter training for its bridge lookout personnel on ships and submarines. This training has been revamped and updated as the Marine Species Awareness Training (MSAT) and is provided to all applicable units. The lookout training program incorporates MSAT, which addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information, including more detailed information for spotting marine mammals. MSAT has been reviewed by NMFS and acknowledged as suitable training. MSAT would also be provided to the following personnel:

- **Bridge personnel on ships** – Personnel would continue to use the current marine mammal spotting training and any updates.
- **Sonar personnel on ships** – Sonar operators aboard ships who are participating in NSWC PCD RDT&E activities would be trained in the details of the mitigation measures relative to their platform. Training would also target the specific actions to be taken if a marine mammal is observed.

5.12.2 Procedures

The following procedures would be implemented to maximize the ability of operators to recognize instances when marine mammals are in the vicinity.

5.12.2.1 General Maritime Mitigation Measures: Personnel Training

- All lookouts aboard platforms involved in NSWC PCD RDT&E activities involving the AN/SQS-53C would review NMFS-approved MSAT material prior to using mid-frequency active sonar.
- All Commanding Officers, Executive Officers, officers standing watch on the bridge, and Mine Warfare (MIW) helicopter crews would complete MSAT prior to a training activity that employs the use of sonar.
- Navy lookouts would undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).
- Lookout training would include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts would complete the PQS program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from inclusion in previous measures as long as supervisors monitor their progress and performance.
- Lookouts would be trained to quickly and effectively communicate within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

5.12.2.2 General Maritime Mitigation measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there would always be at least three personnel on watch whose duties include observing the water surface around the vessel.
- In addition to the three personnel on watch, all surface ships participating in NWC PCD RDT&E activities involving the AN/SQS-53C would have at least two additional personnel on watch as lookouts at all times during the activities.
- Personnel on lookout and officers on watch on the bridge would have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- On surface vessels equipped with mid-frequency active sonar, pedestal-mounted "Big Eye" (20 x 110) binoculars would be present and would be maintained in good working order to assist in the detection of marine mammals near the vessel.
- Personnel on lookout would follow visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).
- Surface lookouts would scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout would always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout would hold the binoculars steady so the horizon is in the top third of the field of vision and direct their eyes just below the horizon. The lookout would scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They would search the entire sector through the binoculars in approximately five-degree steps, pausing between steps for approximately five seconds to

scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the lookout would search back across the sector with the naked eye.

- After sunset and prior to sunrise, lookouts would employ Night Lookout Techniques in accordance with the Lookout Training Handbook.
- At night, lookouts would not sweep the horizon with their eyes, because eyes do not see well when they are moving. Lookouts would scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they would look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision. Lookouts would also have night vision devices available for use.
- Personnel on lookout would be responsible for informing the Officer of the Deck of all objects or anomalies sighted in the water (regardless of the distance from the vessel), since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew or the presence of a marine species that may need to be avoided, as warranted.

5.12.2.3 Operating Procedures

- Commanding Officers would make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible, consistent with the safety of the ship.
- All personnel engaged in passive acoustic sonar operation would monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action. The Navy can detect sounds within the human hearing range due to an operator listening to the incoming sounds. Passive acoustic detection systems are used during all NWC PCD RDT&E activities involving the AN/SQS-53C.
- During NWC PCD RDT&E activities involving the AN/SQS-53C, personnel would use all available sensor and optical systems (such as night vision goggles to aid in the detection of marine mammals).
- When marine mammals are detected by any means (shipboard lookout or acoustically) within 914 m (1,000 yd) of the sonar dome (the bow), the ship would limit active transmission levels to at least 6 decibels (dB) below normal operating levels.
- Ships would continue to limit maximum transmission levels by this 6 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.
- Should a marine mammal be detected within 457 m (500 yd) of the sonar dome, active sonar transmissions would be limited to at least 10 dB below the equipment's normal operating level. Ships would continue to limit maximum ping levels by this 10 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.

- Should the marine mammal be detected within 183 m (200 yd) of the sonar dome, active sonar transmissions would cease. Sonar would not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.
- If the need for power-down should arise, as detailed in "Safety Zones" above, Navy staff would follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down would be to 229 dB, regardless of the level above 235 db the sonar was being operated).
- Prior to start up or restart of active sonar, operators would check that the safety zone radius around the sound source is clear of marine mammals.
- Sonar levels (generally) – The Navy would operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

5.13 MONITORING

The NSWC PCD Monitoring Plan (Monitoring Plan) is being developed in cooperation with NMFS Office of Protected Resources to provide marine mammal and sea turtle monitoring as required under the MMPA and the Endangered Species Act (ESA). Further refinement of the NSWC PCD Monitoring Plan would occur through the Environmental Review Process desk. When finalized, the Monitoring Plan is expected to contain the framework for research on the effectiveness of the Navy's suite of mitigation measures and analyze behavioral responses of marine mammals to MFA sonar and explosives. The Monitoring Plan would use vessel and aerial surveys, along with passive acoustics to accomplish its goals. The following subsections provide an overview of the Monitoring Plan, as well as the associated Integrated Comprehensive Monitoring Plan (ICMP) and the Navy-NMFS 2011 Monitoring Workshop.

5.13.1.1 NSWC PCD Monitoring Plan

NSWC PCD would conduct a combination of individual elements including vessel and aerial surveys, passive acoustic monitoring, and marine mammal observers on platforms. The Monitoring Plan is designed as a series of focused "studies" to gather data that would address behavioral responses of marine mammal and sea turtles exposed to specific levels of explosives and the effectiveness of the Navy's mitigations measures for explosives.

NSWC PCD proposes to visually survey four test events per year. The primary goal would be to visually survey two high-frequency/mid-frequency active sonar activities and two different types of explosive events per year. If the AN/SQS-53C sonar is to be operated, it would be monitored as one of the high-frequency/mid-frequency active sonar activities. If a multiple detonation event occurs, it would be monitored as one of the explosive events. The variation in the number of days after the event allows for the detection of animals that gradually return to an area, if they change their distribution in response to events that emit sound underwater. Surveys would include any specified exclusion zone around a particular detonation point plus 1,829 meters (2,000 yards) beyond the exclusion zone For vessel-based surveys a passive acoustic system (hydrophone or towed array) could be used to determine if marine mammals are in the area before and/or after a detonation event. Depending on animals sighted, it may be possible to conduct focal surveys of animals outside of the exclusion zone (detonations and sonar use could be delayed if marine mammals are observed within the exclusion zone) to record behavioral responses to underwater sound. When conducting a particular survey, the team would collect detailed information about the species present, group and behavior characteristics, and environmental and test event conditions. When practicable, NSWC PCD would also use passive acoustic monitoring to augment visual surveys. The hydrophone or hydrophone array would be used to detect low frequency vocalizations (less than 1,000 Hertz) for baleen whales and relatively high frequency vocalizations (up to 30 kilohertz) for odontocetes such as sperm whales.

NSWC PCD may also use marine mammal observers (MMOs) on ships during one of the test events being monitored per year. MMOs would not be placed aboard platforms for every Navy testing event, but during specifically identified opportunities deemed appropriate for data collection efforts. The events selected for MMO participation would take into account safety, logistics, and operational concerns. As part of the Integrated Comprehensive Monitoring Plan (ICMP), knowledge gained from other Navy MMO monitored events would be incorporated into NSWC PCD monitoring/mitigations as part of the adaptive management approach.

The Navy would submit a report annually describing the implementation and results of the required monitoring. The Navy would submit a comprehensive draft report for the NSWC PCD Study Area that summarizes all of the marine mammal observations and data gathered during test events through February 1, 2014.

5.13.1.2 Integrated Comprehensive Monitoring Plan (ICMP)

The primary goals of the ICMP as relevant to NSWC PCD RDT&E activities are:

- To monitor Navy events, particularly those involving MFA sonar and underwater detonations, for compliance with the terms and conditions of the ESA Section 7 consultations or MMPA authorizations.
- To collect data to support estimating the number of individuals exposed to sound levels above current regulatory thresholds.
- To assess the efficacy of the Navy's current marine species mitigation.
- To add to the knowledge base on potential behavioral and physiological effects to marine species from mid-frequency active sonar and underwater detonations.
- To assess the practicality and effectiveness of a number of mitigation tools and techniques (some not yet in use).

The analysis protocols that would be used for the ICMP are still in the development phase at this time (2009). However, data collection methods would be standardized to allow for comparison from range-specific monitoring plans. The sampling scheme for the program would be developed so that the results are scientifically defensible (e.g. statistically significant). A data management system would be developed to assure that standardized, quality data are collected towards meeting the goals. The ICMP would be evaluated yearly by the Navy to provide a matrix for research progress and goals for the following year. The ICMP reports and the range specific monitoring plan reports would be used by the Navy and NMFS for refinement and analysis of the monitoring methods, which can be used in annual LOA applications.

5.13.1.3 Navy-NMFS Monitoring Workshop

The Navy in conjunction with NMFS will convene a Monitoring Workshop in 2011. This forum will bring together interested parties including marine mammal and acoustic experts to review results from the previous two years of monitoring in the NSWC PCD Study Area, as well as monitoring results from other Navy rules and LOAs (e.g., the Southern California Range Complex [SOCAL], Hawaii Range Complex [HRC], and other rules). The participants will provide their individual recommendations to the Navy and NMFS on the monitoring plans considering the current science, resource availability, and implementation feasibility. Then, NMFS and the Navy will analyze input from the Monitoring Workshop participants and determine the best way forward from a national perspective. Subsequent to the Monitoring Workshop, appropriate modifications may be applied to monitoring plans.

5.13.2 Research

The Navy provides a significant amount of funding and support to marine research through a variety of organizations. From FY04 to FY08, the Navy provided over $94 million to universities, research institutions, federal laboratories, private companies, and independent researchers around the world for marine mammal research. During this same time period, the DoD contributed nearly $6 million for a total of $100 million in marine mammal research projects. These projects include basic science efforts, such as baseline surveys, but do not include monitoring surveys or environmental planning document preparation (DON 2008). In FY08 alone, the Navy will spend over $26 million and the DoD almost $1 million towards this effort (DON 2008). Currently, the Navy has budgeted nearly $22 million and the DoD has budgeted a half a million dollars for continued marine mammal research in FY09 (DON 2008). Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to NSWC PCD RDT&E activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed NSWC PCD RDT&E activities employ sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

1. Environmental Consequences of Underwater Sound,
2. Non-Auditory Biological Effects of Sound on Marine Mammals,
3. Effects of Sound on the Marine Environment,
4. Sensors and Models for Marine Environmental Monitoring,
5. Effects of Sound on Hearing of Marine Animals, and
6. Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resource Assessments and the Navy OPAREA Density Estimates (NODE) reports. Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. Navy. For instance, the ONR contributed financially to the Sperm Whale Seismic Survey (SWSS) in the Gulf of Mexico, coordinated by Texas A&M. The goals of the SWSS are to examine effects of the oil and gas industry on sperm whales and what mitigations would be employed to minimize adverse effects to the species. All of this research helps in understanding the marine environment and the effects that may arise from the use of underwater noise in the Gulf of Mexico and western North Atlantic Ocean.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

A workshop was held in April 2007 at Duke University to discuss the research required to understand the impact of tactical mid-frequency sonar transmission on fish, fisheries and fisheries habitat. Workshop participants included personnel from the Navy, academic universities, and NOAA Fisheries Service, who were selected based on their expertise in acoustics, fish hearing and fisheries biology. The objective of the workshop was to describe the range of scientific concerns regarding the effects of Navy training activities using tactical mid-frequency active sonar on fish and fisheries resources and to distill these concerns into a long-term research and development plan. The priorities of the workshop included larval fish effects, hearing capabilities, small pelagic and soniferous fish behavior and potential effects to fisheries.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

5.13.3 Coordination and Reporting

The Navy would coordinate with NMFS Stranding Coordinators for any unusual marine mammal behavior. This includes any stranding, beached live/dead, or floating marine mammals that may occur coincidentally with Navy RDT&E activities.

The MFA sonar mitigation measures, in particular, have been developed in full consideration of the recommendations of the joint National Oceanic and Atmospheric Administration / Navy report on the Bahamas marine mammal stranding event (Department of Commerce and Department of the Navy [DON], 2001).

5.14 ALTERNATIVE MITIGATION MEASURES CONSIDERED BUT ELIMINATED

As described in Chapter 4, proposed active sonar activities and projectile firing would not result in levels of sound likely to cause injury. The vast majority of estimated sound exposures of marine mammals during proposed detonation operations would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described above. Therefore, the Navy concludes the Proposed Action and mitigation measures would achieve the least practicable adverse impact on marine mammal species or stocks.

A determination of "least practicable adverse impacts" includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the NSWC PCD RDT&E activities. A number of possible alternative and/or additional mitigation measures have been reviewed in the past in the development of the current measures or have been suggested during the public comment periods. This section presents measures and an evaluation based on known science, likely effectiveness, impact to NSWC PCD RDT&E activities, personnel safety, and implementation practicality. Alternative measures in addition to those currently in use include:

- Reducing NSWC PCD RDT&E testing activities.
- Using non-Navy observers for visual surveillance.
- Surveying before, during, and after all test events.
- Suspending tests at night and during low visibility when marine mammals are not readily visible.
- Reducing vessel speed.
- Using larger shut-down zones.
- Avoiding active sonar use within (1) 22.2 km (12 NM) from shore; (2) 25 km (13.5 NM) from the 200-m (656-ft) isobath; or (3) 46.3 km (25 NM) from shore.
- Using active sonar with output levels as low as possible consistent with test requirements.

- Using active sonar only when necessary.
- Expanding exclusion area delineated for explosive detonation use.
- Reporting marine mammal sightings to augment scientific data collection.

5.14.1 Evaluation of Alternative and/or Additional Mitigation Measures

There is a distinction between effective and feasible monitoring procedures for data collection and measures employed to prevent impacts or otherwise serve as mitigation. The discussion below is in reference to those procedures meant to serve as mitigation measures.

- Reducing testing. The requirements to test systems prior to their implementation in military activities are identified in Department of Defense (DoD) Directive 5000.1. This directive states that test and evaluation support is to be integrated throughout the defense acquisition process. The Navy used a rigorous effort during the developmental stages of the EIS/OEIS to accurately quantify test activities necessary to meet requirements of DoD Directive 5000.1. These testing requirements are designed to determine whether systems perform as expected and are operationally effective, suitable, survivable, and safe for their intended use. Any reduction of testing activities would not allow the Navy to meet its purpose and need to achieve requirements set forth in DoD Directive 5000.1.
- Conducting visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained marine species observers.
    - Use of trained RDT&E marine species observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted.
    - Vessels used during NSWC PCD RDT&E activities have limited passenger capacity. As test planning includes careful consideration of this limited capacity in the placement of test directors, data collection personnel, and other personnel on ships involved in the test events.
    - Some of the test events take place far from land, limiting both the time available for civilian aircraft to be at the test site and presenting a concern should aircraft mechanical problems arise.
    - Scheduling civilian vessels or aircraft to coincide with test events may impact testing effectiveness, since test event timetables cannot always be precisely fixed and are instead based on dynamic situations related to the testing environment.
- Reducing or securing power during either adverse weather conditions or at night.
    - The Navy must test its systems in the same way they would be used for military readiness activities. Reducing or securing power in adverse weather conditions or at night would affect the ability to determine whether systems are operationally effective, suitable, survivable, and safe. Additionally, some systems have a nighttime testing requirement. Therefore, NSWC PCD personnel cannot operate only in daylight hours or wait for the weather to clear before or during all test events.
- Reducing vessel speed: Establish and implement a set vessel speed.

  - ○ As discussed in Chapter 5, Navy personnel are already required to use extreme caution and operate at a slow, safe speed consistent with safety. Vessels need to be able to reach their test site and sometimes multiple test sites efficiently. Placing arbitrary speed restrictions may not allow them to test systems in a reasonable amount of time.

- Extending safety zone requirements.
  - ○ The current safety zones requirement to power down mid-frequency active sonar at 457 and 914 m (500 and 1,000 yd), as well as shut down at 183 m (200 yd) were developed to minimize exposing marine mammals to sound levels that could cause temporary threshold shift (TTS) or permanent threshold shift (PTS), levels that are supported by the scientific community. Implementation of the safety zones discussed above would prevent exposure to sound levels greater than 195 dB re 1µPa-m for animals sighted. The safety range the Navy has developed is also within a range that test operators can realistically maintain situational awareness and achieve visually during most conditions at sea. Requirements to implement procedures when marine mammals are present well beyond 914 m (1,000 yd) require that marine species observers sight marine mammals at distances that, in reality, they cannot. These increased distances also greatly increase the area that must be monitored to implement these procedures.
- Limiting the active sonar use to a few specific locations.
  - ○ RDT&E testing activities are scheduled to occur in areas carefully chosen based on system characteristics and test objectives. NSWC PCD would use the most favorable temporal-spatial (seasonal and geographical) province that satisfies all operational requirements. Limiting the site selection to a few areas would impact the effectiveness of the NSWC PCD RDT&E testing activities.
- Avoiding active sonar use within (1) 22.2 km (12 NM) from shore; (2) 25 km (13 NM) from the 200-m (656-ft) isobath; or (3) 46 km (25 NM) from shore.
  - ○ The measure requiring avoidance of mid-frequency active sonar within 25 km (13 NM) of the 200-m (656-ft) isobaths was part of the RIMPAC 2006 authorization by NMFS. This measure lacks any scientific basis when applied to the context in the NSWC PCD Study Area (i.e. the bathymetry, sound propagation, width of channels).
  - ○ The other distances from shore (i.e., 22.2 km [12 NM] and 46 km [25 NM]) have been identified in previous Navy documents as potential mitigation measures. No biological or ecological significance is connected with the environments located at these distances from shore in the NSWC PCD Study Area. Furthermore, no scientific evidence exists that any set distance from the coast is more protective of marine mammals than any other distance.
- Using active sonar with output levels as low as possible consistent with test requirements and use of active sonar only when necessary.
  - Test directors and operators of sonar equipment are cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment output

levels are consistent with test requirements. Furthermore, not all tested systems have variable output levels.

- Expanding exclusion area delineated for explosive detonation use.
  - NSWC PCD RDT&E activities would use range clearance procedures that encompass a radius of 914 m (1,000 yd). Increasing the size could potentially result in less focus on the center area that is more critical for survey efforts. More severe effects are expected closer to the source where the received level would be louder.
  - Increasing the number of marine species observers for detonation events is not practicable considering the limited anticipated protective value of this measure and available personnel space on vessels.
- Reporting marine mammal sightings to augment scientific data collection.
  - Personnel engaged in NSWC PCD RDT&E testing activities are intensively employed throughout the duration of the test events. Their primary duty is accomplishment of the test objectives and any additional workload unrelated to their primary duty would impact test event effectiveness.

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6. CUMULATIVE IMPACTS AND OTHER NATIONAL ENVIRONMENTAL POLICY ACT CONSIDERATIONS

6.1 CUMULATIVE IMPACTS

The Navy's past experience in preparing cumulative impacts analyses and the National Environmental Policy Act of 1969 (NEPA) to determine the scope and format of the cumulative impacts analysis is presented in this chapter of the Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). The approach taken in the analysis of cumulative effects follows the objectives of NEPA, Council on Environmental Quality (CEQ) regulations and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define cumulative effects as:

> "[T]he impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

> "To determine the scope of environmental impact statements, agencies shall consider ….[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement."

In addition, the CEQ has published guidance addressing implementation of cumulative impact analyses under NEPA. The CEQ guidance publication entitled *Considering Cumulative Impacts Under the National Environmental Policy Act, January 1997* states that the analyses should:

> "…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions ... identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Based on the guidance provided within this CEQ publication, the Navy has determined the types of potential cumulative impacts that need to be analyzed:

- "additive" (the total loss of a resource from more than one incident),
- "countervailing" (adverse impacts that are compensated for by beneficial effects), and
- "synergistic" (when the total effect is greater than the sum of the effects taken independently).

However, the analysis of cumulative effects may go beyond the scope of project-specific direct and indirect effects to include expanded geographic and time boundaries and a focus on broad resource sustainability. The true geographic range of an action's effect may not be limited to an arbitrary political or administrative boundary. Similarly, the effects of an action may continue beyond the time the action ceases. This "big picture" approach is becoming increasingly important as growing evidence suggests that the most significant effects result not from the direct effects of a particular action, but from the combination of individual, often minor, effects of multiple actions over time. The underlying issue is whether or not a resource can adequately recover from the effect of an action before the environment is exposed to a subsequent action or actions.

For the purposes of determining cumulative effects in this chapter, the Navy reviewed all environmental documentation regarding known current and past federal and non-federal actions (Section 6.2) associated with the resources analyzed in Chapter 4. Additionally, projects in the planning phase were considered, including reasonably foreseeable (rather than speculative) actions that have the potential to interact with the proposed Navy action (see Section 6.3). The level of information available for the different projects varies. The best available science is used in this analysis. The cumulative analysis incorporates specific numbers and values for potential effects, where available; descriptive information is used in place of quantitative measures where they are unavailable. Additionally, the National Marine Fisheries Service (NMFS) reviews the status of listed species and the environmental baseline of these species, as well as considering cumulative effects, in their issuance of the Biological Opinion (BO) that will result from the Navy's consultation under Section 7 of the Endangered Species Act (ESA). In accordance with NEPA, the cumulative impacts analysis includes past, present, and reasonably foreseeable future activities in the NSWC PCD Study Area.

The incremental contribution of the proposed action is relatively small and would most likely continue to reduce in size as non-military activities increase within the NSWC PCD Study Area. Overall, it is more difficult to analyze cumulative impacts versus project-specific effects. The Navy recognizes the need to identify and quantify the factors causing the environmental change and the threshold triggers associated with the potential environmental response.

6.2 PAST AND PRESENT ACTIONS

A number of actions unrelated to the Proposed Action, occurring historically and up to the present time, have the potential to affect the resources identified in Chapter 4. A brief description of these actions follows, with an emphasis on components of the activity that are relevant to the effects previously identified. When determining whether a particular activity may contribute cumulatively and significantly to the effects identified in Chapter 4, the following attributes are considered: geographical distribution, intensity, duration, and the historical effects of similar activities. The conclusions given in Subsections 6.2.1 through 6.2.14 were determined through the respective agency's environmental planning processes. The Navy provided conclusions for Subsections 6.2.15 through 6.2.18.

6.2.1 Navy Pre-Deployment Training at Eglin Air Force Base (AFB), Florida: Composite Training Unit Exercises (COMPTUEX) and Joint Task Force Exercises (JTFEX)

This Navy pre-deployment training consists of air-to-ground delivery of live weapons onto the Eglin Range Complex, Eglin AFB, Florida. Aircraft launch from carrier ships, either in the GOM or the Atlantic Ocean off Florida's east coast, fly to target, deliver ordnance, and return to the carrier (U.S. Navy, 2004a). In these exercises, Opposing Forces (OPFOR) aircraft launch from Naval Air Station (NAS) Pensacola to provide simulated opposition to strike fighters. Other components of the exercise include the use of helicopters to simulate evacuation of military personnel, to conduct gunnery exercises, and to conduct low-level flight training from carriers in the GOM. Most of these activities take place in warning area 151 (W-151), which includes the Panama City Operating Area. One training component, involving simulated ordnance delivery against targets in developed landscapes and flyover video of the attacks, occurs in the Tyndall Military Operations Area at altitudes of 3,048 to 5,486 meters (m) (10,000 to 18,000 feet [ft]). The Navy will conduct up to two COMPTUEXs and three JTFEXs at Eglin AFB per year. The COMPTUEX and JTFEX would not necessarily be conducted concurrently. COMPTUEX training requires nine days of Eglin Range operations over a 10-calendar-day period, with the majority of operations occurring during the second week. JTFEX requires three days of Eglin Range operations over a three-calendar-day period. The airspace proposed for use includes W-151 (includes Panama City Operating Area) and W-155 (includes Pensacola Operating Area) (U.S. Navy, 2004a).

Potential effects associated with COMPTUEX/JTFEX activities include air quality, noise, and airspace management (U.S. Navy, 2004a). For each COMPTUEX, up to 696 sorties could be flown over the GOM within a 10-day period. This could occur twice per year. For each JTFEX, up to 30 sorties could be flown over the GOM within a three-day period. This could occur three times per year. The total potential number of annual sorties per year is therefore 1,482. Air pollutant emissions would result from these flights. Because the emissions generated by the training exercises are considered temporary, emission analysis was performed to estimate the amount of combustive emissions emitted from aircraft and from the expenditure of explosive ordnance. Emissions were compared to that of the three counties that encompass the Eglin Range Complex. Emissions resulting from ordnance explosions were determined to be negligible (U.S. Navy, 2004a). Table 6-1 shows the amount of air emissions associated with all Eglin AFB activities, COMPTUEX/JTFEX aircraft activities, and the surrounding counties. Air emissions were determined to be not significant (U.S. Navy, 2004a).

Table 6-1. Air Emissions Associated with COMPTUEX/JTFEX Activities

Pollutant Emission Source	Pollutants (tons/year)				
	CO	NO_X	PM_{10}	SO_X	VOCs
Eglin AFB Stationary Emissions (CY2001)	72	96	101	11	109
Eglin AFB Mobile Source Emissions (CY2001)	16,935	80,823	6,143	12,672	5,752
Eglin AFB Totals	**17,007**	**80,919**	**6,244**	**12,683**	**5,861**
Santa Rosa County (CY2001)*	68,684	14,157	12,537	6,434	16,390
Okaloosa County (CY2001)*	71,952	8,296	7,363	698	11,135
Walton County Total Emissions (CY2001)*	21,368	3,475	3,508	230	3,573
County Totals	**162,004**	**25,928**	**23,408**	**7,362**	**31,098**
COMPTUEX/JTFEX Explosive Ordnance Emissions	0.27	0.29	1.3	N/A	0.04
Percent of Eglin AFB Total Emissions	0.0016	0.0004	0.02	N/A	0.0007
Percent of County Total Emissions	0.00017	0.0011	0.0055	N/A	0.00013

CO = carbon monoxide; COMPTUEX = Composite Training Unit Exercise; CY = calendar year; JTFEX = Joint Task Force Exercises; N/A = not applicable; NO_x = nitrogen oxides; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides; VOCs = volatile organic compounds; * = Includes mobile sources
Source: U.S. Navy, 2004a

Noise from both fixed- and rotary- wing aircraft could enter the water, potentially disturbing marine species (U.S. Navy, 2004a). In the large-scale COMPTUEX, approximately 1,100 rotary and fixed-wing aircraft sorties would be flown. While the number of daily sorties would be somewhat higher than what is usually flown, modeling has shown that the contribution to noise would not be significant. Another mitigating factor is the fact that the sorties occur over a small amount of time. Therefore, although the noise effects could be relatively intense and concentrated, primarily in W-151 (includes Panama City Operating Area), the duration would be short (U.S. Navy, 2004a).

The increased number of sorties flown during a COMPTUEX would require additional management of military and commercial airspace. However, these activities are expected to fall well within the management capabilities of airspace controllers (U.S. Navy, 2004a; 2006b).

6.2.2 Amphibious Ready Group/Marine Expeditionary Unit (ARG/MEU) Readiness Training

The Navy and Marine Corps conducted one readiness training exercise at Eglin AFB. The training occurred in 2003 and Fleet Forces Command does not plan to conduct this training at Eglin AFB in the near future. Only the components potentially affecting the Naval Surface Warfare Center Panama City Division (NSWC PCD) Study Area are considered.

Transport of the MEU was conducted by naval ships from various locations throughout the United States to the GOM. ARG operations took place within the Inner Transport Area, which covers an 8 kilometers (km) by 32 km (5 miles [mi] by 20 mi) rectangular box approximately 1.9 to 11 km (1 mi to 7 mi) from the beach. During the 10-day exercise, ARG ships remained in the assigned box at slow speed (5 knots to 10 knots [5.8 to 11.5 miles per hour]) or at anchor (U.S. Marine Corps and U.S. Air Force, 2003). Operations included launch/recovery of aircraft, and launch/recovery of Landing Craft Air Cushion (LCAC), Landing Craft Utility (LCU), and Amphibious Assault Vehicles (AAVs). The ARG consisted of three amphibious ships that were augmented by two or three cruisers/destroyers. No ship-to-shore movements of ground forces occurred from cruisers and destroyers. No more than seven aircraft typically operated during a single event (U.S. Marine Corps and U.S. Air Force, 2003).

Potential effects from ARG/MEU operations included noise, socioeconomic effects, and effects to biological resources, particularly sensitive species (U.S. Marine Corps and U.S. Air Force, 2003). During the 10-day period of exercises, there were approximately 130 crossings of LCACs between Navy ships and shore, 78 crossings by AAVs, and 42 transits by LCUs. The crossings and transits occurred in the Gulf of Mexico as well as Santa Rosa Sound. These crossings had the potential to transmit noise into the marine environment, potentially disturbing marine species such as sea turtles and marine mammals (U.S. Marine Corps and U.S. Air Force, 2003). In addition, there was a potential for vessels to physically strike some animals. The number of sea turtles potentially affected by surface vessels was evaluated in the Environmental Assessment (EA) for ARG/MEU activities and is listed in Table 6-2.

Table 6-2 indicates that the expected maximum number of sea turtles within the vessel transit area is less than 35. Realistically, any effects from ARG/MEU operations that included, for example, vessel transit and troop movements would be limited to turtles at the surface. Thus, some number less than nine turtles would occupy the surface of the transit area over the 10-day exercise. Some percentage of these nine individuals may be affected through direct contact with a vessel, but the likelihood is considered low. Adult turtles could probably avoid collision because the LCUs move very slowly and the LCACs produce loud noise. Thus, the greatest potential risk would be to hatchlings during nesting season (U.S. Marine Corps and U.S. Air Force, 2003). An additional potential effect to sea turtles is the possibility of surface vessels physically disturbing large *Sargassum* mats. These mats are considered likely habitat for juvenile turtles as well as habitat for a number of fish species during various life stages. Large *Sargassum* mats, however, are distributed in a very patchy manner and are usually associated with ocean current convergence lines. Effects to *Sargassum* therefore were not considered likely (U.S. Marine Corps and U.S. Air Force, 2003).

Table 6-2. Sea Turtles Potentially Affected by ARG/MEU Activities

Species	Number of Sea Turtles at the Surface	Number of Surface and Submerged Sea Turtles	Number of Hatchlings
Loggerhead	3.9	26.0	2.0
Leatherback	0.5	2.2	0.1
Kemp's ridley	0.2	0.7	0
Unidentified	0.4	2.2	N/A
Green	*	*	1.3
Total	**5**	**31**	**3.4**

ARG/MEU = Amphibious Ready Group/Marine Expeditionary Unit; N/A = not applicable
* Turtles listed as unidentified by GulfCet II are assumed to include green sea turtles
Source: U.S. Marine Corps and U.S. Air Force, 2003

The USFWS issued a BO in 2003 in response to a BA submitted by the U.S. Navy and the U.S. Air Force. The USFWS anticipated incidental takes of the four species of sea turtles and the flatwoods salamander that occur on Eglin AFB and issued an incidental take statement (ITS), pursuant to Section 7 of the ESA. The ITS contains reasonable and prudent measures with implementing terms and conditions to help minimize takes (USFWS, 2003).

The vessels transiting between naval ships and shore would introduce noise into the water, which could disturb protected species such as sea turtles or marine mammals. The noise characteristics (frequency, energy level, etc.) are not quantified, but are considered inconsequential when compared to the baseline level of noise produced by surface vessels in the GOM (U.S. Marine Corps and U.S. Air Force, 2003). The EA concluded that there would be no effect to sea turtles and Gulf sturgeon as regulated by NMFS and no ESA consultation or MMPA authorization was required with this agency (U.S. Marine Corps and U.S. Air Force, 2003).

In addition to these potential impacts, impact analyses also focused on Santa Rosa Sound. Temporary, localized impacts to water quality were projected from possible increased turbidity (due to erosion), changes in dissolved oxygen, and the disturbance of bottom sediments. The implementation of best management practices (BMPs) coupled with the rapid (one-day) settling of sediments resulted in a conclusion of no significant impact to water quality (U.S. Marine Corps and U.S. Air Force, 2003). There was no potential to affect seagrasses because no emergent vegetation or seagrasses occur along the transit corridor within Santa Rosa Sound (U.S. Marine Corps and U.S. Air Force, 2003).

The magnitude and intensity of vessels, materials, and troops moving to and from shore necessitates the closing of the operation area to commercial and recreational fishing. However, considering the small size of the operating areas and the short time duration required for each landing event, MEU training and operations were not expected to interfere with commercial and recreational fishing activities, and the effect is considered minimal (U.S. Marine Corps and U.S. Air Force, 2003).

6.2.3 Eglin Gulf Test and Training Range Operations

Eglin AFB supported nearly 39,000 sorties during the timeframe of fiscal years (FY) 1995 through 1999 (U.S. Air Force, 2002b). Most of the sorties were flown in the Eglin Gulf Test and Training Range (EGTTR) over the GOM. The three most northern warning areas (W-155 [includes Pensacola Operating Area], W-151 [includes Panama City Operating Area], and W-470) of the EGTTR (airspace above the NSWC PCD Study Area) coincide with and comprise the Panama City Military Operating Area described in the NSWC PCD Study Area (Figure 3-1). Mission activities conducted within the EGTTR can be summarized as Air Operations and Ordnance Testing and Training. Air Operations include all manned and unmanned aircraft flights through the EGTTR. Ordnance Testing and Training involves the release of expendables, which are defined as items that are deployed, released, or consumed (or potentially consumed) while performing an activity. Examples of expendables include bombs, missiles, bullets, chaff, flares, and other miscellaneous items. Test and training missions are described below.

EGTTR activities may include effects to air quality, water quality, sensitive species and habitats, non-protected species, airspace management, and effects due to noise (U.S. Air Force, 2002b). Mission generated air emissions were analyzed to enable comparison to compare with National Ambient Air Quality Standards (NAAQS). The results are summarized in Table 6-3.

Table 6-3. Air Emissions Associated with EGTTR Missions in the NSWC PCD Study Area

Criteria Pollutant	Averaging Time	NAAQS	W-155A	W-155B	W-470A	W-470B	W-470C
CO	1-hour	40 mg/m^3	1.62E-06	1.08E-06	2.41E-05	2.17E-05	3.94E-05
	8-hour	10 mg/m^3	1.13E-06	7.42E-07	1.69E-05	1.52E-05	2.76E-05
NO_2	Annual	100 µg/m^3	4.30E-03	3.81E-03	1.23E-01	1.10E-01	2.02E-01
SO_2	3-hour	1300 µg/m^3	2.95E-04	2.52E-04	6.06E-03	5.30E-03	9.71E-03
	24-hour	365 µg/m^3	2.06E-04	1.76E-04	4.23E-03	3.71E-03	6.79E-03
	Annual	80 µg/m^3	7.60E-05	6.51E-05	1.56E-03	1.37E-03	2.50E-03
PM_{10}	24-hour	150 µg/m^3	2.92E-04	3.38E-04	6.15E-03	5.63E-03	1.03E-02
	Annual	50 µg/m^3	1.08E-04	1.25E-04	2.27E-03	2.08E-03	3.81E-03

CO = carbon monoxide; µg/m^3 = micrograms per cubic meter; mg/m^3 = milligrams per cubic meter; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide
*Units of measurement for the criteria pollutants in each of the Warning Areas of the EGTTR are the same as those given for the NAAQS column
Source: U.S. Air Force, 2002b

Water quality may be negatively affected from the introduction of chemical materials from jet fuel, munitions, chaff, and flares. Fuel may be introduced into the water by the occasional downing of a target drone and by emergency in-flight fuel release (U.S. Air Force, 2002b). Table 6-4 and Table 6-5 show the maximum amount of fuel deposited by these actions between 1995 and 2000. In reality, the amount is far less because the extreme volatility of the substance results in a significant amount (approximately 99 percent) of evaporation during descent. The remainder would disperse through the action of waves and currents.

Table 6-4. Estimated Volume of Fuel Released by Drones During EGTTR Missions

Drone Type	Quantity	Average Fuel Amount (gallons/drone)	Total Fuel Released (gallons)	Fuel (gallons) Reaching Surface*
QF-4	21	1,030	21,630	216
QF-106/4	35	735	25,725	257
BQM-34	20	40	800	8
MQM-107	23	30	690	7
		TOTAL	**48,845**	**488**

Source: U.S. Air Force, 2002b
*Calculated by NSWC PCD on the assumption of 1 percent of fuel reaches surface.

Table 6-5. Estimated Fuel Release from In-Flight Emergencies (IFE) during EGTTR Missions

Aircraft Type	IFE Sorties that Released Fuel	Average Released Fuel (gallons/sortie)	Total Fuel Released (gallons)	Fuel (gallons) Reaching Surface
F-15/F-15E	220	735	161700	1,620
F-18	4	735	2940	30
F-111	2	735	1470	20
F-117	0.2	735	150	2
AC/MC/C-130	0.5	1,470	700	10
		TOTAL	**166,960**	**1,682**

Source: U.S. Air Force, 2002b

Chaff is primarily used as a defense mechanism and is released from engaged aircraft. Discharge of chaff results in the release of millions of aluminum dipoles (short fibers similar in appearance to human hair) that create an electromagnetic cloud around the aircraft, shrouding the plane from enemy radar and defense systems. The main chemical component of concern in chaff is aluminum. Due to the wide dispersion over large areas of the eastern GOM, chaff dispersion would vary for each of the water ranges (U.S. Air Force, 2002b). A small portion of the chaff may dissolve over time. An assessment suggests that approximately 0.06 percent of the initial aluminum weight would dissolve in seawater. Although no criteria exist for aluminum in oceanic waters, it is a naturally occurring trace element (river input) in seawater and found at variable concentrations. Effects are therefore considered negligible (U.S. Air Force, 2002b).
Flares are high-temperature heat sources that are ejected from aircraft to confuse and divert enemy heat-seeking or heat-sensitive missiles. Flares are also used to illuminate surface areas during nighttime operations. The principle chemical element of concern is magnesium. The total amounts of magnesium added to the GOM surface waters would be less than 0.0002 percent (W-151, which includes the Panama City Operating Area) and 0.0005 (W-470) percent of the background concentration (1.35 grams per liter [g/L]) of magnesium in the GOM surface waters. Due to this extremely small amount, no adverse effects are anticipated (U.S. Air Force, 2002b).

Test and training missions conducted by Eglin AFB result in numerous flight activities in the EGTTR involving a variety of aircraft and missiles flying at a wide range of altitudes and traveling at speeds ranging from slow subsonic to supersonic. Subsonic and supersonic aircraft noise is basically continuous over the EGTTR while missions are in progress. Supersonic noise from EGTTR missions was determined to be not likely to adversely affect dolphins or other biological resources, or socioeconomic (human) resources (U.S. Air Force, 2002b).

Underwater noise resulting from gunnery missions has been calculated. Noise results from 25 millimeter (mm), 40 mm, and/or 105 mm rounds being fired at the water surface. Various noise levels were found to be pertinent in their effects on protected species. The distance from an exploding shell that these noise levels would reach was determined, and then the number of animals potentially affected was calculated. Generally, for the purposes of the EGTTR Programmatic EA, noise levels above 205 decibels referenced to 1 micropascal squared second (dB re 1 μPa^2 s) are considered injurious, levels above 182 dB re 1 μPa^2 s are considered non-injurious harassment, and levels above 176 dB re 1 μPa^2 s are considered behavioral harassment. This 176 dB re 1 μPa^2 value was employed by the U.S. Air Force for behavioral takes of marine mammal species and was based on the *EA for the Use of the AN/SSQ-110 Sonobuoys in Deep Ocean Waters*. The harassment level is now set at 177 dB for all Air Force activities.

Table 6-6 and Table 6-7 show the number of protected species potentially affected. All gunnery missions used in these calculations occur in W-151 (includes Panama City Operating Area).

Table 6-6. Yearly Estimated Number of Marine Mammals Affected by the Gunnery Mission Noise

Species	Adjusted Density (#/km)	Level A Harassment Injurious 205 dB* EFD for Ear Rupture	Level B Harassment Non-Injurious 182 dB* EFD for TTS	Level B Harassment Non-Injurious 176 dB* EFD for Behavior
Bryde's whale	0.007	<0.001	0.010	0.041
Sperm whale	0.011	<0.001	0.016	0.064
Dwarf/pygmy sperm whale	0.024	<0.001	0.035	0.139
Cuvier's beaked whale	0.10	<0.001	0.015	0.058
Mesoplodon spp.	0.019	<0.001	0.028	0.110
Pygmy killer whale	0.030	<0.001	0.044	0.174
False killer whale	0.026	<0.001	0.038	0.151
Short-finned pilot whale	0.027	<0.001	0.039	0.157
Rough-toothed dolphin	0.028	<0.001	0.041	0.163
Bottlenose dolphin	0.810	0.006	1.177	4.706
Risso's dolphin	0.113	0.001	0.164	0.657
Atlantic spotted dolphin	0.677	0.005	0.984	3.934
Pantropical spotted dolphin	1.077	0.008	1.565	6.258
Striped dolphin	0.237	0.002	0.344	1.377
Spinner dolphin	0.915	0.007	1.330	5.316
Clymene dolphin	0.253	0.002	0.368	1.470
Unidentified dolphin**	0.053	<0.001	0.077	0.308
Unidentified whale	0.008	<0.001	0.012	0.046
All marine mammals	4.325	0.032	6.29	25.13

$\#/km^2$ = number per square kilometer; NA = not applicable; TTS = temporary threshold shift
*dB= Decibels referenced to 1 micropascal squared second (dB re 1 μPa^2 s)
**Bottlenose dolphin/Atlantic spotted dolphin
Source: U.S. Air Force, 2002b

Table 6-7. Yearly Estimated Number of Sea Turtles Affected by the Gunnery Mission Noise

Species	160 dB	170 dB	180 dB	190 dB	200 dB
Sea Turtles (#)	215	20.2	2.1	0.2	0.02

dB = dB re 1 μPa^2 s
Source: U.S. Air Force, 2002b

Underwater noise may also affect non-protected resources such as fish. Impulsive noise at sufficient intensity is known to cause injury to the swim bladder and other air spaces inside fish.

However, the intermittent nature of both the EGTTR missions and the presence of large schools of fish make significant impacts unlikely (U.S. Air Force, 2002b).

Direct physical effects to sensitive species and habitat (sea turtles, marine mammals, and *Sargassum* mats) may occur when the surface of the water is physically struck by gunnery ordnance or other falling objects. The possibilities of an animal being struck by a falling object are extremely remote, however, given the large area within which an item may land. Specifically, it was determined an average of 0.21 cetaceans and 0.04 sea turtles could potentially be injured or killed by projectiles and falling debris per year (U.S. Air Force, 2002b).

The large number of sorties flown over the EGTTR over the course of a year requires dedicated management of military and commercial airspace. However, these activities have been occurring for years, and control of the airspace is well established. Therefore, no additional effects are anticipated (U.S. Air Force, 2002b).

6.2.4 Cape San Blas Activities

Eglin AFB maintains property on Cape San Blas (CSB), Florida. Air Force facilities on CSB indirectly support nearly all air operations within the EGTTR warning area W-151 (includes Panama City Operating Area), as well as some of the air operations in W-470. Additionally, CSB facilities directly support some air missions (5,415 during FY 1994 through 1997), including surface-to-air missile launches. Up to 26 surface-to-air missiles may be launched per year (4 Patriot, 16 Caesar Trumpet, and 6 VIPER). Some smaller, portable missiles are also fired at QF-4 drones, with up to two drones potentially downed in the GOM per year. In addition, CSB may support limited surf zone testing and training activities in the nearshore shallow waters. Although no specific test or training missions are identified, typical activities include underwater navigation and reconnaissance missions, as well as small inert munitions activities as performed by the Navy Explosive Ordnance Disposal School (NEODS) (U.S. Air Force, 1999).CSB activities may include effects to air quality, water quality, sensitive species and habitats, airspace management, and effects due to noise. The CSB Programmatic EA identified issues associated with restricted access, noise, habitat alteration, debris, electromagnetic radiation, chemical materials, and direct physical effects (U.S. Air Force, 1999).

For the purpose of public safety and the security of test and training operations, use of land and water areas and airspace beyond Air Force property boundaries is occasionally and briefly restricted for some Surface-to-Air Missile activities. It is expected that water access will be restricted for approximately 69 hours per year (U.S. Air Force, 1999).

Expended material from CSB missions results primarily from the surface-to-air missile launch missions. Missile components and drones from missile tests typically consist of aluminum and steel housing assemblies, optical sensors, guidance and control electronics, radio transmitters and receivers, and a power supply that may include lithium or nickel-cadmium batteries. Although most typical missions do not plan for the intentional downing of drones, surface-to-air missiles and drone targets that potentially fall on land have relatively benign environmental effects. Debris falling into nearshore waters has the potential to physically strike a boat, person, marine animal, or other receptor at the surface. Calculations predict, however, that the likelihood is extremely remote as estimated at 0.0000334 direct potential impacts per square meters (m^2), for example, in the Cape San Blas Final Programmatic EA (U.S. Air Force, 1999).

The introduction of chemical materials into the CSB environment occurs primarily from missile and rocket exhaust emissions as a result of the surface-to-air missile launch activities. The amount of chemical materials released into the air and water is summarized in Table 6-8.

The number of aircraft and missile flights in the CSB vicinity requires management of military and commercial airspace. However, these activities are expected to fall well within the management capabilities of airspace controllers (U.S. Air Force, 1999).

Table 6-8. Chemical Materials Associated with Missile Launch Activities

Environmental Receptor	Chemical Material	Maximum Exposure (mg/m^3)
Air	Al_2O_3	0.021
	CO	39.11
	HCl	0.012
	NO_x	0.009
Water	JP-8 Fuel	0.023

Al_2O_3 = alumina ; CO = carbon monoxide; HCl = hydrochloric acid; JP-8 = Jet Propulsion fuel, type 8; mg/m^3 = milligrams per cubic meter; NO_x = nitrogen oxides
Source: U.S. Air Force, 1999

6.2.5 Santa Rosa Island Activities

Eglin AFB controls 19.3 square kilometers (km^2) (7.4 square miles [mi^2]) of Santa Rosa Island (SRI), which includes 15 Air Force test sites. In addition to the SRI land mass, the surf zone is also considered part of the zone of exposure (ZOE). The surf zone is a shallow area covering the continental shelf seaward of SRI to a depth of approximately 9 m (30 ft). The distance from the SRI shoreline that corresponds to this depth varies from approximately 0.8 km (0.4 NM) at the western side of the Air Force property to 2.4 km (1.3 NM) at the eastern side (U.S. Air Force, 2005a). Several activities conducted on SRI and in the surf zone have the potential to affect the resources analyzed in Chapter 4.

Electronic Countermeasures (ECM) and Electronic Systems Testing are conducted in the vicinity of SRI (U.S. Air Force, 2005a). Training is routinely done aircraft-against-aircraft or aircraft-against-ground/surface ship systems. Any part of the Eglin Range Complex can be used for this type of training, but it is mostly done over the water. Surface-to-air missile tests launch missiles from a variety of locations, including A-15 on SRI and surface vessels, at target aircraft in the EGTTR. A variety of surf zone testing/training activities may occur as needed and include mine clearance testing and explosive ordnance disposal training (U.S. Air Force, 2005a).

Although the number of missile and aircraft flights is not quantified, air pollutant emission is a potential effect issue, as is airspace management. Air sorties associated with SRI lack the intensity and frequency of those associated with other activities, and the effects are considered minimal (U.S. Air Force, 2005a).

If increased use of the surf zone occurs, the potential for effects to geology, water quality, cultural resources, marine life, and sensitive species and habitats exists (U.S. Air Force, 2005a). Mine clearance and ordnance disposal could result in underwater detonations on or close to the sediment. This could cause turbidity and damage to essential fish habitat (such as natural or artificial reefs) and cultural resources. Turbidity would be very brief and localized, as wave and current action would disperse the sediments (U.S. Air Force, 2005a). Environmental regulations would require that such training not be undertaken in the vicinity of cultural resources, essential fish habitat, or other sensitive habitats. A small amount of chemical materials would be added to the water column, but would be diluted to the point of insignificance (U.S. Air Force, 2005a). Detonations could cause injury to sensitive species such as sea turtles and marine mammals, and to non-protected resources such as fish. However, surveys for the presence of protected species would be required before such activities. Therefore, effects are considered unlikely (U.S. Air Force, 2005a).

6.2.6 Naval Explosive Ordnance Disposal School (NEODS) Training

The mission of the NEODS is to detect, recover, identify, evaluate, render safe, and dispose of unexploded ordnance (UXO) that constitutes a threat to people, material, installations, ships, aircraft, and operations. The NEODS facilities are located at Eglin AFB, Florida. The training at Eglin AFB involves recognizing ordnance, reconnaissance, measurement, basic understanding of demolition charges, and neutralization of conventional and chemical ordnance. Mine countermeasures (MCM) detonation is one important function of the NEODS, which involves mine-hunting and mine-clearance operations (U.S. Air Force, 2004b).

The NEODS proposes to use the GOM waters off of SRI for a portion of the class. The NEODS would utilize areas approximately 2 to 6 km (1.1 to 3.2 NM) offshore of SRI (i.e., Test Sites A-15, A-10, or A-3) for MCM training. The students would be taught techniques for neutralizing mines by diving and hand-placing charges adjacent to the mines. The detonation of small, live explosive charges adjacent to the mine disables the mine function. Inert mines are utilized for training purposes. This training would occur offshore of SRI six times annually, at varying times within the year (U.S. Air Force, 2004b).

During training, five charges packed with C-4 explosive material will be set up adjacent to the mines. A charge contains a total net explosive weight (NEW) of 2.7 kilograms (kg) (6.0 pounds [lbs]), with C-4 comprising 2.3 kg (5.0 lbs) of the total. No more than five charges will be utilized over the two-day period. The five 2.3 kg (5.0-lb) C-4 charges will be detonated individually with a maximum separation time of 20 minutes between each detonation. The time of detonation will be limited to an hour after sunrise and an hour before sunset. Inert mines and debris will be recovered and removed from the GOM waters when training is completed (U.S. Air Force, 2004b).

NEODS activities could potentially cause effects to geology, water quality, noise, biological and cultural resources, and artificial reefs. Detonations will likely disturb sediments and produce turbidity, but the effects are temporary and not considered significant. Activities conducted on or in the vicinity of sensitive habitats, such as natural or artificial reefs, could negatively affect the function of such structures as fish habitat. Cultural resources could also be damaged by the detonation or associated activities. However, environmental regulations require surveys for such resources, which should result in no effects.

C-4 is a common variety of military plastic explosive, and the explosive material RDX (also known as cyclonite or hexogen) makes up around 90 percent of C-4 by weight. According to the Biological Opinion (BO) prepared by NMFS concerning NEODS activities, bioaccumulation of

RDX does not appear to be of concern in aquatic organisms, and there are no data to indicate biomagnification of RDX in fish and other animal tissues. RDX and any other chemical resulting from detonations would occur in extremely low concentrations and would be dispersed by wave and current action. The BO concludes that, although data is lacking, there appears to be no effects on sea turtles, marine mammals, or the marine environment in general (NMFS, 2004a).

Detonations would result in both pressure waves and noise in the marine environment. Effects to sea turtles and marine mammals could result from exposure to these metrics (U.S. Air Force, 2004b; U.S. Air Force, 2004c). The BO included calculations of sea turtles potentially affected before and after mitigation measures. After the implementation of the required measures, a total of six sea turtles are expected to be affected (lethal and non-lethal) over a five-year period (NMFS, 2004a). The number of marine mammals potentially affected as estimated by Eglin AFB is summarized in Table 6-9. NMFS issued authorization for incidental harassment of marine mammals and concluded that takes are expected to be limited to short-term and localized TTS-related behavioral changes (NMFS, 2007d).

Table 6-9. Number of Marine Mammals Exposed to Noise Due to NEODS Activities

Species	Density (km^2)	Number of Animals Exposed to Level A Harassment from 30 Detonations per Year	Number of Animals Exposed to Level B Harassment from 30 Detonations per Year
Summer			
Bottlenose dolphin	0.81	0.21	3.96
Atlantic spotted dolphin	0.677	0.18	3.30
T. truncatus/S. frontalis	0.053	0.01	0.27
TOTAL		**0.40**	**7.53**
Winter			
Bottlenose dolphin	0.81	0.21	4.02
Atlantic spotted dolphin	0.677	0.18	3.36
T. truncatus/S. frontalis	0.053	0.01	0.27
TOTAL		**0.40**	**7.65**

km^2 = square kilometers
Source: U.S. Air Force, 2004b

6.2.7 Precision Strike Weapons (PSW) Test

The U.S. Air Force Air Armament Center (AAC) and U.S. Navy, in cooperation with the 46th Test Wing Precision Strike Division (46 OG/OGMTP), proposes to conduct a series of Precision Strike Weapons (PSW) test missions during the next five years utilizing resources within the Eglin Military Complex, including two sites in the EGTTR (U.S. Air Force, 2005b). The weapons to be tested are the Joint Air-to-Surface Stand-off Missile (JASSM) AGM-158 A and B, and the Small-Diameter Bomb (SDB) GBU-39/B. The JASSM is a precision cruise missile designed for launch from outside area defenses to kill hard, medium-hardened, soft, and area-type (or object related such as a barge) targets. The SDB weapon is a 113-kg (250-lb) class, air-to-surface, precision-guided munition. As many as two live and four inert JASSM missiles per year would be launched from an aircraft above the GOM at a target located approximately 28 to 44 km (15 to 23.7 NM) offshore of Eglin AFB (U.S. Air Force, 2005b). Detonation of the JASSM would occur under one of three scenarios.

- Detonation upon impact with the target, about 1.5 m (5 ft) above the GOM surface.

- Detonation upon impact with a barge target at the surface of the GOM.
- Detonation at 120 milliseconds (msec) after contact with the surface of the GOM.

In addition to the JASSM explosive, as many as six live and 12 inert SDBs per year would also be dropped on the target. Targets would be located in less than 61 m (200 ft) of water and more than 22 km (12 nautical miles [NM]) offshore (U.S. Air Force, 2005b). Detonation of the SDBs would occur under one of two scenarios.

- Detonation of one or two bombs upon impact with the target, about 1.5 m (5 ft) above the GOM surface.
- Height of burst test: Detonation of one or two bombs 3 to 8 m (about 10 to 26 ft) above the GOM surface.

Activities associated with PSW testing may potentially affect water quality, biological resources, and the anthropogenic (man-made) environment (U.S. Air Force, 2005b). Chemical products may be released into the aquatic environment during explosive detonations. The detonation of explosives usually results in the complete combustion of the original material and the emission of carbon dioxide, carbon, carbon monoxide, water, and nitrogen compounds. Residual chemical products are usually extremely dilute and are dispersed within hours by wave and current action. Although data is lacking, these compounds are not expected to persist in the marine environment, and there is expected to be no effects to sea turtles, marine mammals, or the marine environment in general (U.S. Air Force, 2005b). During the time of operations, a safety zone on the surrounding water surface would be closed to commercial and recreational fishing. However, the total closed area compared to other areas available in the GOM is not significant. In addition, the closures would be infrequent (U.S. Air Force, 2005b).

Exploding JASSM and SDB bombs will result in both pressure waves and noise in the marine environment (U.S. Air Force, 2005b). Detonations would have the potential for effects to protected and non-protected marine species (e.g., sea turtles, marine mammals, and fish). As stated before, injury can result from the shock wave interacting with air spaces in an animal's body, such as the swim bladder, inner ear, and viscera. At further distances from the detonation, noise may cause hearing impairment or behavioral modification to individuals. The BO by NMFS (2005) related to PSW activities included calculations of sea turtles potentially affected before and after mitigation measures. After the implementation of the required measures, a total of 12 sea turtles may be affected (lethal and non-lethal) over a five-year period (NMFS, 2005c). The number of marine mammals potentially impacted as estimated by Eglin AFB is summarized in Table 6-10 and Table 6-11. NMFS has approved an incidental take permit for joint U.S. Air Force and Navy activities to allow for 1 mortality, 2 injury, and 53 harassment takes of marine mammals) (NMFS, 2006b).

6.2.8 Minerals Management Service (MMS) Regulated Activities

The MMS, within the Department of the Interior, manages the mineral resources of the federal offshore lands of the Outer Continental Shelf (OCS). The MMS leases OCS lands to commercial companies for the exploration, extraction, and production of mineral resources. In the GOM, the great majority of leases are granted in the MMS Central and Western Planning Areas.

Table 6-10. Marine Mammal Densities and Risk Estimates for Level A Harassment (205 dB EFD 1/3-Octave Band) Noise Exposure During PSW Missions

Species	Density	Number of Animals Exposed from 1-ft Depth Detonations	Number of Animals Exposed from >20-ft Depth Detonations
Summer			
Dwarf/pygmy sperm whale	0.013	0.0024	0.0247
Bottlenose dolphin	0.81	0.1491	1.5417
Atlantic spotted dolphin	0.677	0.1246	1.2886
T. truncatus/S. frontalis	0.053	0.0098	0.1009
TOTAL		**0.29**	**3.0**
Winter			
Dwarf/pygmy sperm whale	0.013	0.0024	0.0285
Bottlenose dolphin	0.81	0.1491	1.7737
Atlantic spotted dolphin	0.677	0.1246	1.4824
T. truncatus/S. frontalis	0.053	0.0098	0.1161
TOTAL		**0.29**	**3.4**

Source: U.S. Air Force, 2005b
dB – decibels; EFD = energy flux density

Table 6-11. Marine Mammal Densities and Risk Estimates for Level B Harassment (182 dB EFD 1/3-Octave Band) Noise Exposure During PSW Activities

Species	Density	Number of Animals Exposed from 1-ft Depth Detonations	Number of Animals Exposed from >20-ft Depth Detonations
Summer			
Dwarf/pygmy sperm whale	0.013	0.0226	0.5070
Bottlenose dolphin	0.81	1.4089	31.5886
Atlantic spotted dolphin	0.677	1.1776	26.3735
T. truncatus/S. frontalis	0.053	0.0922	2.0669
TOTAL		**2.7**	**60.5**
Winter			
Dwarf/pygmy sperm whale	0.013	0.0280	0.8633
Bottlenose dolphin	0.81	1.7448	53.7906
Atlantic spotted dolphin	0.677	1.4583	44.9300
T. truncatus/S. frontalis	0.053	0.1142	3.5196
TOTAL		**3.3**	**103.1**

Source: U.S. Air Force, 2005b
dB – decibels; EFD = energy flux density

Two lease sales in the Eastern Gulf of Mexico Planning Area were held in 2003 and 2005 for Lease Sales 189 and 197, respectively (MMS, 2003). The lease sale area abuts the westernmost border of the Eastern Planning Area (See Section 3.4.7.1 for definition), and is composed of 256 blocks covering more than 6,000 km^2 (2,317 mi^2) in water depths of 1,600 to 3,000 m (about 5,249 to 9,843 ft). The northeast corner of the lease sale area is located in W-155B (approximately 150 km [about 80 NM] from the Alabama coast and 161 km (87 NM) from the Florida coast). The great majority (94 percent) of the area is located in Eglin Water Training Areas (EWTAs) 1 and 3. A small number of lease blocks have been drilled and/or are in gas production. The MMS Central Planning Area extends into the western portion of W-155 (includes Pensacola Operating Area) (MMS, 2003). A number of active lease blocks are present in the area, with a few additional blocks receiving lease bids in 2003. Most recently, Lease Sale 190 occurred in March 2004.

Some activities associated with offshore exploration, development, and production could potentially contribute to the cumulative effects on the air, water, and biological resources analyzed in Chapter 4. However, the vast majority of such activities are located in the Central and Western GOM, from Mississippi to Texas (MMS, 2003). Because of the distance between these activities and the NSWC PCD Study Area, it is expected that air and water movement will disperse any pollutants to the point where they will not be significant by the time they reach the NSWC PCD Study Area (MMS, 2003). Underwater noise associated with these activities is concentrated in the central and western GOM as well (MMS, 2003). Furthermore, any leases in the NSWC PCD Study Area would include a stipulation requiring coordination with military officials responsible for activities in the relevant military warning areas. These stipulations should cover any space-use conflicts between the oil and gas lease activities and the proposed Navy activities.

The potential exists for effects to occur to protected marine mammals and sea turtles, particularly from underwater noise associated with seismic airgun exploration and explosive rig removal (MMS, 2003). These species are quite mobile and may traverse large portions of the GOM during migrations or in search of prey. Therefore, they cannot be considered stationary resources that are immune to the effects of activities occurring outside the NSWC PCD Study Area. For example, a dolphin could potentially be exposed to harassing or injurious levels of noise during oil exploration activities in the central GOM, and subsequently be exposed to similar noise levels due to sonar or detonations in the NSWC PCD Study Area a short time later (MMS, 2003). NMFS has suggested that one of the criteria for behavioral effects is that the same individual animal be exposed to repeated stressors.

In February 2002, the American Petroleum Institute (API) submitted a request to NMFS to provide the oil and gas industry incidental take permits during structure decommissioning and removal. The Final Rule was published in August 2002 and allowed for the incidental taking of Atlantic spotted and bottlenose dolphins. No numbers were specified and it was determined that incidental takes resulting from structure removal activities would be in the form of harassment (NOAA, 2002c). The Final Rule expired in February 2004 and since then, no removal operations have been covered by MMPA Take-Regulations. In February 2005, MMS submitted a request for the authorization to take by harassment small numbers of marine mammals associated with explosive severance activities. On April 7, 2006, NMFS published a Proposed Rule (NOAA, 2006c), but MMS has yet to receive the Final Rule. While no incidental takes of sperm whales will be issued until the MMPA Take-Regulations are published, MMS anticipates only one take by harassment per year.

6.2.8.1 Gulf of Mexico Energy Security Act (GOMESA) of 2006

The Gulf of Mexico Energy Security Act of 2006, signed by President Bush on December 20, 2006, was passed to repeal the Congressional moratorium on certain areas within the Gulf of Mexico, place a moratorium on other areas, and increase the distribution of offshore oil as gas revenues to coastal states. Specifically, the GOMESA defines the "181 Area" and the "181 South Area." The 181 Area includes approximately two million acres (8,100 km^2) that are located in the Central Planning Area as well as approximately 500,000 acres (2,025 km^2) located in the

Eastern Planning Area. The Military Mission Line is a significant boundary in the GOM because the military practices aerial maneuvers and bombing trials to the east of this line. The line extends south from the panhandle of Florida and lies about 376.6 km (234 mi) west of Tampa Bay (National Ocean Industries Association, 2006). The 181 Area is located to the west of the Military Mission Line. As part of the environmental review process, MMS held two public meetings in Florida and Louisiana in March 2007 (MMS, 2007a). The portion of the 181 Area within the Central Planning Area was not included in the original moratorium and therefore was available for lease starting with Lease Sale 205 on October 3, 2007. The MMS published a Final Supplemental EIS (SEIS) in October 2007 for the remaining portion of the 181 Area within the Eastern Planning Area, which was offered in Lease Sale 224 on March 19, 2008 (MMS, 2007b).

The 181 South Area is also located in the Central Planning Area and is approximately 5.8 million acres (23,490 km^2). The MMS has published a Draft SEIS proposing that the sale area for the Central Planning Area Sales 208 (2009), 213 (2011), and 222 (2012) would be expanded to include 4.3 million acres (17,415 km^2) of the 181 South Area. The remaining portion of the 181 South Area is located beyond the U.S. Exclusive Economic Zone and would not be offered. The MMS held four scoping meetings in October 2007 including one in Texas, one in Alabama, and two in Louisiana (MMS, 2008a). Three public hearings were held in May 2008 including two in Louisiana and one in Alabama. The public comment period for this project closed on June 10, 2008.

On February 1, 2008, a Proposed Rule was published in the Federal Register allowing the MMS to implement an amendment to the GOMESA. This would include a provision to allow for credits to be issued to lessees for exchanging certain eligible leases within 125 miles (201 km) of the Florida coast in the Eastern Planning Area and within 100 miles (161 km) from the coast in the Central Planning Area for either a lease bonus bid or royalty from production from other leases in the GOM or a transfer of the credits to other GOM lessees. Potential credits would include over 79 active leases acquired between 1984 and 1990 (MMS, 2008b).

6.2.9 Dredging Operations

The construction and maintenance of federal navigation channels are ongoing activities in the GOM that could occur within the area of interest. NMFS has identified dredging operations as an activity that may cause sea turtle mortality (NMFS, 2004b). Hopper dredges move faster than sea turtles and can entrain them. NMFS has issued BOs with the USACOE, most recently in 2003, for the GOM and has concluded that the implementation of reasonable and prudent measures will result in no jeopardy to sea turtle species (USACOE, 2003a). Dredging activities also have the potential to affect the protected Gulf sturgeon, particularly juveniles that may not be able to avoid entrapment. This potential effect has not been quantified. Dredging operations obviously affect the geology of an area, as the floor topography is altered and turbidity occurs (USACOE, 2003a).

6.2.10 Fishing Operations

NMFS has summarized the cumulative effects of fishing in the area of interest (NMFS, 2004b). Adverse effects to protected marine species are possible due to gillnet, longline, trawl gear, and pot fisheries. The following fisheries have been considered as likely to adversely affect sea turtles: southeastern shrimp trawl and summer flounder/scup/black sea bass fisheries. Shrimp trawling is considered to have by far the greatest effect on sea turtles (Table 6-12). The use of Turtle Excluder Devices (TEDs) in the shrimp fishery has reduced mortality by up to 50 percent. The implementation of new TED regulations is expected to further decrease mortality.

Various fishing methods in state fisheries, including trawling, pot fisheries, fly nets, and gillnets, may potentially affect protected marine species. Florida has banned all but very small nets in state waters, and Alabama has placed restrictions on gillnet fisheries in state waters. Therefore, very little gillnet fishing takes place in GOM waters.

6.2.11 Endangered Species Act (ESA) Permits for Scientific Research

ESA allows the taking of listed species for the purpose of scientific research, provided the proper consultation process is followed. There are currently 11 sea turtle and five sperm whale active scientific research permits applicable to the eastern GOM (NMFS, 2004b). Under the sea turtle permits, permissible activities include photographing, weighing, and tagging sea turtles incidentally taken in fisheries, blood sampling, tissue sampling, and laparoscopy. The number of turtles taken may number in the hundreds annually (most are non-lethal). Sperm whale permits allow activities such as surveys, photo identification, tagging, biopsy sampling, and sound playback experiments. Most of the activities involve only incidental harassment, and none have resulted in injury to whales. In addition, there is currently one active permit that allows the "take" of one Gulf sturgeon per year from trawling activities. The permit is applicable to the state waters of Gulf, Franklin, and Wakulla Counties, Florida. Table 6-12 shows the annual number of sea turtle takes authorized by incidental take permits in the GOM (NMFS, 2004b; NMFS, 2003; USACOE, 2003a; USACOE, 2003b, NMFS, 2006c).

Table 6-12. Annual Number of Estimated Sea Turtle Takes

Federal Action	Annual Anticipated Incidental Take Levels in the GOM											
	Loggerhead		Leatherback		Green		Kemp's Ridley		Hawksbill		TOTAL	
	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal
USACOE Dredging in the GOM	0	40	0	0	0	14	0	20	0	4	**0**	**78**
USACOE Dredging and Spoil Deposition in Pensacola Pass*	10	2	0	0	10	2	10	2	0	0	**30**	**6**
USACOE Rig Removal	0	1	0	1	0	1	0	1	0	1	**0**	**5**
MMS Rig Removal	-	-	-	-	-	-	-	-	-	-	**3****	**84****
Shrimp	163,160	3,948	3,090	80	18,757	514	155,503	4,208	0	640	**340,510**	**9,390**

Table 6-12. Annual Number of Estimated Sea Turtle Takes (Cont'd)

Federal Action	Annual Anticipated Incidental Take Levels in the GOM											
	Loggerhead		Leatherback		Green		Kemp's Ridley		Hawksbill		TOTAL	
	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal
Fishery												
HMS – Pelagic Longline Fishery	468	7	358	6	46	2	23	1	46	2	**941**	**18**
HMS – Shark Gillnet Fishery	20	20	2	2	2	2	2	2	2	2	**28**	**28**
HMS – Bottom Longline Fishery	12	12	2	2	2	2	2	2	2	2	**20**	**20**
NRC St. Lucie, FL	1,000	10	1,000	1	1,000	10	1,000	1	1,000	1	**5,000**	**23**
NRC Crystal River, FL	55	1	55	1	55	1	55	1	55	1	**275**	**5**
Total	**164,715**	**4,049**	**4,507**	**98**	**19,872**	**553**	**156,595**	**4,243**	**1,105**	**658**	**346,807**	**9,657**

USACOE = U.S. Corps of Engineers; LNG = Liquefied Natural Gas; HMS = Highly Migratory Species; MMS = Minerals Management Service; NRC = Nuclear Regulatory Commission
Sources: USACOE, 2003a; USACOE, 2003b; NMFS, 2004b; NMFS, 2003, NMFS 2006c
*The anticipated take level may represent any combination of species and thus is tallied under each column.
** The anticipated take numbers were estimated over all species combined.

6.2.12 Marine Mammal Protection Act (MMPA) Permits

The MMPA allows for the taking of marine mammals in some circumstances. For instance, NMFS has authorized the taking of 200 bottlenose and spotted dolphins (combined) for activities associated with the oil and gas industry. Other incidental take permit requests for military operations are also being evaluated. Requests for takes of marine mammal species have been submitted to NMFS for some of the actions previously described and include activities that would be conducted under the EGTTR Programmatic EA. This permit has not been finalized and, therefore, the official "take" estimates has not been made official to date. Requests for takes have been finalized for Eglin activities under the LOA for the Precision Strike Weapons Testing at Eglin AFB (NMFS, 2006b) and under the IHA for the NEODS Training Operations (NMFS, 2007d). Some takes (by harassment only) are also authorized for scientific research activities in the GOM.

6.2.13 Seismic Survey Research

Seismic surveys occur throughout the Naval Surface Warfare Center Panama City Division (NSWC PCD) Study Area. One of the most active organizations performing oceanographic seismic surveys is the Lamont-Doherty Earth Observatory (LDEO). Seismic surveys performed by LDEO utilize airguns, sonar, and sub-bottom profilers, all of which have the possibility of harassing marine mammals. The deepwater GOM is the premier source of gas production intended to offset declines from gas fields on the shelf. Modern three-dimensional seismic surveys are the main survey method used for these efforts and sometimes cover hundreds of blocks and involve several months of acquisition time (Petzet, 1999). The Outer Continental Shelf (OCS) Deep Water Royalty Relief Act (DWRRA) provides economic incentives for operators to develop fields in water depths greater than 200 meters (m) (656.17 feet [ft]). Between 18 and 47 percent of the lease blocks in the GOM are undergoing geological surveys in any given year. During Gulf Cetaceans (GulfCet) I and II surveys, seismic exploration signals were detected 10 to 21 percent of the time, respectively (Davis et al., 2000a).

The potential exists for effects to protected marine mammals and sea turtles from underwater noise associated with seismic airgun surveys. LDEO has had Incidental Harassment Authorizations (IHAs) for surveys off the northern Yucatan Peninsula, northern GOM, southeast Caribbean Sea, and in the mid- and northwest Atlantic Ocean (NMFS, 2003b, 2003c, 2003d, 2004c, 2004d). However, these IHAs are all now expired. NMFS has determined that minor adverse behavioral effects to sea turtles may result from seismic survey activities in deeper federal waters, but these effects would be short-term and minor. Effects to sea turtles have not yet been analyzed in states where nesting beaches and important foraging areas may be present (U.S. Air Force, 2005b).

6.2.14 Panama City–Bay County International Airport

The current Panama City–Bay County International Airport, although expanded in 1995, is considered limited because of its relatively short runway length and because it is closely bordered by residential development considered incompatible with airport activities. Expansion of the existing runway would affect waters protected under state law. With support from the Florida Department of Transportation and the Federal Aviation Administration (FAA), the Panama City-Bay County International Airport Authority has decided to construct a new airport north of County Road 388. Changes in the number and types of aircraft utilizing Panama City as a result of the new airport are uncertain, but may increase. The airport authority considers the current air use underdeveloped and forecasts some level of growth in aviation demand in the Panama City-Bay County region (Bechtel, 2004).

The initial (or short-term) proposed airport configuration is very similar to the existing version, and aircraft flight tracks are not expected to change appreciably. A long-term plan has been proposed for expansion, if necessary, to include extension of the main runway, construction of a second runway, and the development of additional terminals and other infrastructure. This phase would be accomplished after 2018 and be covered by a separate NEPA document. Air emission levels are not expected to increase substantially, and the location of emissions is the same on a regional basis. By the year 2023, annual expectations are for approximately 324,000 passenger enplanements (or boardings) and 141,000 total operations (commercial and general aviation). Both these metrics fall below the threshold at which NAAQS assessment would be required (FAA, 2006).

6.2.15 Artificial Reefs

Artificial reefs consist of a variety of materials intentionally placed into the water to attract fish and benthic organisms. These artificial structures provide habitat for a number of species of invertebrates and fish attracted to a place for settlement, shelter, feeding, and refuge (Florida Fish and Wildlife Conservation Commission [FWC], 2004a; Alabama Department of Conservation and Natural Resources [ADCNR], 2004). Interest in placing artificial reefs in coastal waters is high among fishermen and divers since these structures attract marine life. For placement of artificial reef material by counties within state coastal waters, a permit must be obtained from both the state and the U.S. Army Corps of Engineers (USACOE) (FWC, 2004a; ADCNR, 2004). Individual counties may fund their own artificial reef projects or receive donations from private fishing or diving clubs or individuals. Artificial reefs are composed of a variety of materials and typically include concrete, steel, and aluminum. In Florida, reefs are sited and permitted on an individual basis, while Alabama reefs are located within five permit areas (FWC, 2004a; ADCNR, 2004). In addition, the Minerals Management Service (MMS) has a Rigs-to-Reefs program whereby retired oil and gas platforms are converted to artificial reefs. Currently there are three such reefs in Florida waters and four in Alabama waters (FWC, 2004a; ADCNR, 2004). The locations of artificial reefs in the area of interest are shown in Figure 3-8.

The State of Florida received one of the single largest artificial reefs placed to date. The retired aircraft carrier United States Ship (USS) Oriskany (which is 271 m or 889 ft long) was sunk at a depth of 64.6 m (212 ft) on 17 May 2006 approximately 39 km (21 NM) off the coast of Pensacola, Florida. The ex-Oriskany sinking site is part of the permitted Escambia East Large Area Artificial Reef site, which comprises an area of 199.4 km^2 (58.1 square nautical miles [NM^2]). The ex-Oriskany is the first vessel in a new program designed to remove excess ships from its inventory by utilizing them in artificial reef programs or as targets for military training. Other Navy and Maritime Administration vessels may be available in the future to serve as artificial reefs.

Prior to sinking the ex-Oriskany, the Navy removed oil and fuel, asbestos, certain paints, and loose debris based on the U.S. Environmental Protection Agency's (USEPA's) *Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs*. Most of this work was completed in December 2004, with final cleaning completed in Beaumont, Texas, while the ship awaited tow in February/March 2006 (U.S. Navy, 2006). USEPA granted a risk-based disposal approval to allow solid Polychlorinated Biphenyl (PCB) containing materials to remain onboard. This approval was based on the Navy's demonstration that the risks to people using the reef, as well as plants and animals living and feeding on the reef, were acceptable. The Navy was issued a risk-based PCB disposal approval from USEPA Region IV on 15 February 2006 (U.S. Navy, 2006).

6.2.16 State Oil and Gas Activities

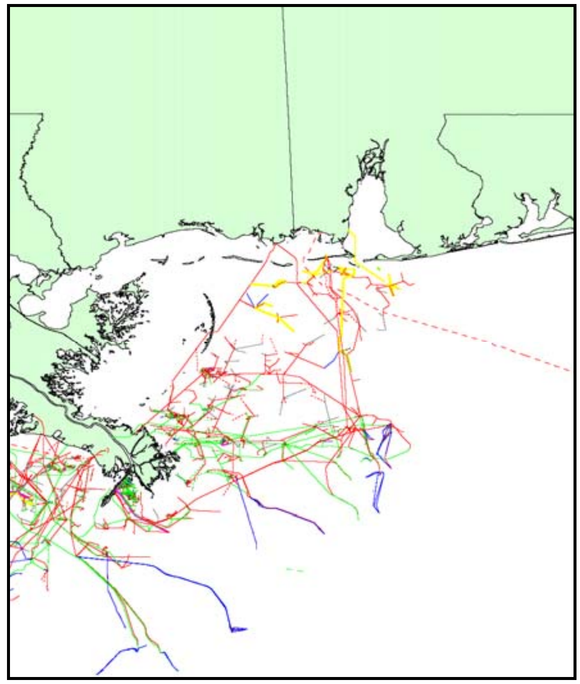

Figure 6-1. Actual and Proposed Pipelines Regulated by the MMS
Source: MMS, 2003

The oil and gas pipeline network offshore of Gulf Coast states is extensive. Figure 6-1 shows the extent of actual and proposed pipelines as of April 2003. The great majority of pipelines lie to the west of the NSWC PCD Study Area. However, a few encroach on the very westernmost edge of W-155 (includes Pensacola Operating Area).

Texas and Louisiana offer some lease sales in state waters, independent of the Federal OCS Program. Production has been in decline in recent years, while the number of wells has risen (MMS, 2003; NMFS, 2004b).

This trend is expected to continue. The State of Mississippi began offering tax breaks to companies in 1994 based on the types of discovery and the methods used. As a result, many inactive wells have been brought back into production and new development wells have been drilled (NMFS, 2004b). Alabama has leased a limited number of tracts in state waters. However, the last lease sale was held in 1997 and further lease sales are not expected in the near future (MMS, 2003). The State of Florida has experienced very limited drilling in coastal waters.

Oil and gas activities conducted off states other than Florida probably have a similar suite of effects as those conducted in federal waters, but to a much lesser degree. The majority of activities occur in regions outside of the NSWC PCD Study Area. For example, some of the most productive areas include the Sunniland Trend in south Florida and Lake Trafford Field in Collier County. Therefore, state activities are not expected to contribute significantly to the overall effects of oil and gas activities in the GOM.

6.2.17 Marine Ecotourism

Marine mammals may be affected by whale-watching activities (Hoyt, 1995). Potential effects in the NSWC PCD Study Area are limited to territorial waters and focus on marine mammals that are not listed under the ESA such as bottlenose and Atlantic spotted dolphins. No whale watching occurs here and therefore, further consideration in this BE is not warranted.

6.2.18 Maritime Traffic

NMFS identified commercial and recreational traffic and recreational pursuits as potentially having adverse effects on sea turtles and cetaceans through propeller and boat strike damage (NMFS, 2004b). Private vessels participating in high-speed marine events are particular threats. The magnitude of the effects has been difficult to quantify. Marine transportation in the GOM is expected to grow linearly in the future. Tanker imports and exports of crude and petroleum products are projected to increase approximately 30 to 60 percent. In 1999, total upbound and downbound domestic and foreign trips in the Gulf Intracoastal Waterway were almost 300,000. Underwater noise produced by surface vessels is ubiquitous in the GOM. Surface vessel traffic is a major contributor to noise in all oceans, particularly at low frequencies. The effect on marine species is unknown, but it is possible that this persistent noise may affect marine mammals' use of sound for communication and hunting.

6.3 REASONABLY FORESEEABLE FUTURE ACTIONS RELEVANT TO THE PROPOSED ACTION

A number of actions reasonably expected to occur in the future may potentially contribute to cumulative effects to the resources identified in Chapter 4. A brief description of these actions follows, with an emphasis on components of the activity that are relevant to the effects previously identified. When determining whether a particular activity may contribute cumulatively and significantly to the effects identified in Chapter 4, the following attributes are considered: geographical distribution, intensity, duration, and the historical effects of similar activities. The conclusions given in Subsections 6.3.3 through 6.3.7 were determined through the respective agency's environmental planning processes. Conclusions will be determined in future documents related to activities discussed in Subsections 6.3.1 and 6.3.2.

6.3.1 U.S. Navy Activities in the Gulf of Mexico (GOMEX) Range Complex

The Theater Assessment Program is a comprehensive program established to address potential environmental effects associated with naval training activities. For the Atlantic Fleet Command, the Theater Assessment Program includes preparing environmental planning documentation as relevant to this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) for operations that occur on the Navy Range Complexes located in the GOM. Specifically, the Navy is proposing to support and conduct current and emerging training operations and research, development, test, and evaluation (RDT&E) operations by: (1) maintaining baseline operations at current levels; (2) increasing training operations from current levels as necessary to support the Fleet Readiness Training Plan; (3) accommodating mission requirements associated with force structure change; and (4) implementing enhanced range complex capabilities.

The Navy is currently in the process of developing an EIS/OEIS to address operations occurring in the GOM. The scope of actions to be analyzed in this GOMEX Range Complex EIS/OEIS includes current and proposed future Navy Fleet training and RDT&E operations within Navy-controlled operating areas, airspace, and ranges. It also includes proposed Navy-funded range capabilities enhancements, including infrastructure improvements, which support Range

Complex training and RDT&E operations. . The alternatives discussed in this EIS/OEIS do not restrict the development of alternatives for the GOMEX Final EIS/OEIS. The Notice of Intent (NOI) to prepare the EIS/OEIS for the GOMEX Range Complex was released on August 31, 2007 (DON, 2007g). The Navy conducted four scoping meetings in September 2007. The NOA to formally announce the release of the Draft EIS/OEIS and public hearing dates was published on January 2, 2009 (DON, 2009a). The Navy conducted four public hearings in February 2009.

The types of training activities include the deployment of charges of C-4 explosive by mine warfare ships throughout the year in the operating areas (OPAREAs). The Navy also plans to conduct additional training, including the detonation of charges on practice MLOs/inert mines and VEMs and mine firing mechanisms by mine warfare divers throughout the test sites during the year. The scope of the impact analysis includes activities that may potentially affect geology, water quality, cultural resources, biological resources including marine mammals, sea turtles, fish, and the anthropogenic (man-made) environment including commercial and recreational activities. The GOMEX EIS would incorporate the appropriate mitigation measures. Training activities involving the use of active sonar are proposed to occur in the Range Complex.

While this EIS/OEIS covers the same geographic area as the GOMEX Range Complex, it analyzes different activities. The GOMEX Range Complex EIS/OEIS documents will not specifically analyze potential environmental effects associated with the use of active sonar for antisubmarine warfare (ASW) and mine warfare (MIW) training exercises. However, the Atlantic Fleet Active Sonar Training (AFAST) EIS/OEIS addresses all of the activities for the U.S. Atlantic and the GOM.

6.3.2 Atlantic Fleet Active Sonar Training (AFAST)

Title 10 U.S.C. 5062 requires the Navy to be “organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea.” In an effort to meet this requirement the U.S, Navy Atlantic Fleet conducts Anti-Submarine Warfare (ASW) and Mine Warfare (MIW) training events using active sonar along the east coast and within the Gulf of Mexico. These training events include Independent Unit Level Training (ULT) activities, Coordinated ULT activities, and Strike Group training exercises, RDT&E activities, and active sonar maintenance.

The Navy has finalized an EIS/OEIS to analyze the potential environmental effects associated with the use of mid- and high-frequency active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet training exercises. The Navy is also developing the advanced extended echo ranging (AEER) system as a replacement to the IEER system, which was addressed in the AFAST EIS/OEIS.

The overall scope of the AFAST EIS/OEIS analysis focused on the potential impacts to the physical, biological and anthropogenic environments, associated with the usage of mid- and high-frequency sonars, explosive source sonobuoys, the operation of surface and subsurface vessels and expended materials from training exercises.

The NOI to prepare the AFAST EIS/OEIS along with public scoping meeting dates were published in the *Federal Register* on 29 September 2006 (DON, 2006b). The Navy conducted eight scoping meetings in October and November 2006. The NOA to formally announce the release of the AFAST Draft EIS/OEIS and public hearing dates was published on 15 February 2008 (DON, 2008b). The Navy conducted six public hearings in March 2008. The Final EIS/OEIS was published and released to the public on December 12, 2008 and the Record of Decision (ROD) was signed on January 30, 2009 (DON, 2009b). In the ROD, the No Action Alternative was selected as the preferred alternative for the Navy to continue conducting active sonar activities within and adjacent to existing operating areas rather than designating active sonar areas or areas of increased awareness. Active sonar activities will occur in locations that maximize active sonar opportunities and meet applicable operational requirements associated with a specific active sonar activity (DON, 2008d).

6.3.3 Conversion of Two F-15 Fighter Squadrons to F-22 Fighter Squadrons at Tyndall AFB, Florida

The U.S. Air Force has identified the need to replace the F-15 aircraft with the new F-22 "Raptor" (U.S. Air Force, 2000). Advantages of the F-22 include the use of stealth technology, sophisticated radar and electronic systems, and the ability to fly at supersonic speeds without using afterburners. The Air Force proposes to convert two of the three F-15 Fighter Squadrons at Tyndall AFB, Florida, to F-22 Fighter Squadrons. The conversion would occur over a five-year period with a continual reduction of F-15s lasting three or more years. This plan relies on a gradual transition of aircraft with the total number of aircraft stationed at Tyndall AFB slowly increasing to a maximum of 104 during FY 2008 and ending with a total number of 87 in FY 2011. At the end of the conversion, a single F-15 Fighter Squadron would remain at Tyndall AFB. A total of 60 F-22s would ultimately be assigned to Tyndall AFB (U.S. Air Force, 2000).

The introduction of a new aircraft would obviously require increased training sorties. The total number of sorties would increase by approximately 26 percent during the peak year (FY 2008). At the end of the conversion (FY 2011), a 7 percent increase over current operations is anticipated. Around Tyndall AFB, the increase in airspace use is approximately three operations per hour, and in the special use areas (military airspace), the increase averages approximately two operations per day (U.S. Air Force, 2000). Table 6-13 shows the estimated annual number of sorties throughout the conversion period.

Table 6-13. Estimated Annual Number of Sorties Associated With F-22 Conversion at Tyndall AFB

Aircraft	Current	Peak Year FY 2008	Changes in Sorties Current to Peak	End-State FY 2011	Changes in Sorties Current to End-State
F-15	16,688	8,783	-7,905	5,270	-11,418
F-22	0	12,222	+12,222	12,600	+12,600
Cumulative Total	**16,688**	**21,005**	**+4,317**	**17,870**	**+1,182**

Source: U.S. Air Force, 2000

Two major airspace actions are proposed: (1) expanded utilization of currently used special airspace, and (2) expanded use of other available special use airspace in the region. The over-water airspace proposed for use includes W-470, W-151 (includes Panama City Operating

Area), and W-168 (U.S. Air Force, 2000). The estimated annual number of sorties is summarized in Table 6-14.

Table 6-14. Estimated Annual Number of Sorties by Airspace Associated With F-22 Conversion at Tyndall AFB

Airspace	Baseline (FY 1998)	Peak (FY 2008)		End-State (FY 2011)	
	F-15	F-15	F-22	F-15	F-22
W-470 A	4,391	2,249	1,791	1,350	1,846
W-470 B	3,180	1,628	1,297	977	1,337
W-470 C	1,205	617	491	370	507
W-151 A,B	856	510	670	306	690
W-151 C,D	857	451	1,403	271	1,446
W-168	0	65	2,326	39	2,398
Total by Aircraft	**10,489**	**5,520**	**7,978**	**3,313**	**8,224**
Total by Year	**10,489**	**13,498**		**11,537**	

FY = fiscal year
Source: U.S. Air Force, 2000

F-22 training would result in an increase in the quantities of chaff and flares expended, the majority of which are expended over water ranges (U.S. Air Force, 2000). As part of the program, the Air Force proposes to train pilots in the use of the internal aircraft gun. This would consist of shooting 20 mm inert training rounds at targets towed by an F-15 aircraft. The aerial gunnery training would occur only in W-470 and W-151 (includes Panama City Operating Area). Tyndall AFB currently does not utilize 20 mm training as part of F-15 training (U.S. Air Force, 2000). The estimated quantities of chaff bundles, flares, and 20 mm rounds are shown in Table 6-15.

Table 6-15. Estimated Annual Number of Chaff and Flare Expenditures Associated With F-22 Conversion at Tyndall AFB

Airspace	Baseline (FY 1998)		Peak Year (FY 2008)			End-State (FY 2011)		
	Chaff	Flares	Chaff	Flares	20 mm	Chaff	Flares	20 mm
W-470 A	128,042	64,021	91,882	45,941	45,967	72,682	36,341	45,967
W-470 B	92,717	46,359	66,533	33,266	45,967	52,630	26,315	45,967
W-470 C	35,146	17,573	25,221	12,610	4,086	19,950	9,975	4,086
W-151 A,B	24,970	12,485	26,819	13,410	3,065	22,655	11,327	3,065
W-151 C,D	24,984	12,492	42,164	21,082	3,065	39,048	19,524	3,065
W-168	0	0	54,382	27,191	0	55,423	27,711	0
Over-water Total	**305,859**	**152,930**	**307,001**	**153,500**	**102,150**	**262,388**	**131,193**	**102,150**

FY = fiscal year
Source: U.S. Air Force, 2000

Increased noise produced in the Warning Areas is expected to be not significant (U.S. Air Force, 2000).

The resulting effects on air quality were estimated for Tyndall AFB and for Bay County for both the peak year and the end-state. The results are summarized in Table 6-16.

Table 6-16. Estimated Effects on Air Quality Associated with F-22 Conversion at Tyndall AFB

Category	Pollutant (% Change)					
	CO	NO_2	PM_{10}	SO_2	Pb	VOCs
Tyndall AFB Peak Year (FY 2008) Change	-7.10%	46.42%	10.59%	17.84%	20.00%	-24.90%
Bay County Peak Year Change	-0.07%	1.34%	0.20%	0.01%	-	-0.52%
Tyndall AFB End-State (FY 2011) Change	-23.93%	30.69%	0.14%	1.90%	20.00%	-42.15%
Bay County End-State Change	-0.25%	0.89%	0.00%	0.00%	-	-0.88%

Source: U.S. Air Force, 2000

CO = carbon monoxide; FY = fiscal year; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides; Pb = lead; VOCs = volatile organic compounds; FY = fiscal year

Training activities would result in extremely small (maximum of 0.04 percent of background in W-470) quantities of chemical elements such as aluminum and magnesium being added to the marine waters of the GOM. These additions are too small to affect GOM waters or any of the biological resources found there. The levels would be further reduced through the physical movements of tides, currents, waves, and wind, which serve to disperse chemical materials (U.S. Air Force, 2000). In addition, there is a potential for increased noise levels within the W-470 area. However, based on the location of Tyndall AFB and its close proximity to the GOM, the majority of flights including takeoffs and landing would not occur over populated areas.

6.3.4 B61 Joint Test Assembly Weapons Systems Evaluation Program

Air Combat Command (ACC) has requested the use of Eglin AFB as an alternative to the Department of Energy's (DOE's) Tonopah Test Range for conducting B61 Joint Test Assembly (JTA) Weapons Systems Evaluation Program (WSEP) flight tests (U.S. Air Force, 2004a). The military has nuclear weapons in active inventory, which are full up weapons ready for use, and are called war reserve (WR) nuclear weapons. Every year a certain number of these WR nuclear weapons are randomly selected to be shipped to a DOE production facility where selected parts from those WR weapons are used to build a JTA. The JTAs are then flight tested to assess the performance of the WR parts. Each JTA retains as many of the WR components as possible including portions of the explosive package, but no JTA configuration is capable of providing a nuclear detonation (U.S. Air Force, 2004a).

The goal for the testing is high-speed, low- and high-altitude release on Test Area (TA) B-70 (U.S. Air Force, 2004a). TA B-70 consists of a 43.7-km^2 (16.9-mi^2; 10,799-acre) cleared area located 24.1 km (15 mi) northwest of Eglin AFB. The desired target will be an 8,361 m^2 (91 m x 91 m) or 90,000 ft^2 (300 x 300 ft) concrete pad constructed on TA B-70. Additional testing would include a shallow-water drop in the GOM (W-151, which includes the Panama City Operating Area, in less than or equal to 15 m [50 ft] depth). Aircraft would drop JTAs during flight following a predetermined altitude (152 to 1,829 m [500 to 6,000 ft]) as directed by Flight Safety. The JTAs would be immediately removed after each test. Therefore, other assets on site may include chase boats used in the retrieval of the JTA from the GOM target drop areas (U.S. Air Force, 2004a). The preferred testing scenario involves one JTA drop every two years for each profile on both TA B-70 and in W-151 (includes Panama City Operating Area) (Table 6-17).

Table 6-17. JTA WSEP Flight Test Proposed Action (per Two-Year Period)

Profile	B-70	EGTTR W-151 Shallow-Water Drop
Freefall Air (FFA) – parachute	1	1
Retarded Ground (REG) – parachute	1	1

JTA = Joint Test Assembly; WSEP = Weapons Systems Evaluation Program; EGTTR = Eglin Gulf Test and Training Range
Source: U.S. Air Force, 2004a

The chemical materials of interest for the B61 JTA testing are depleted uranium, thermal batteries, neutron generators, and other hazardous materials and explosives. All other explosives and hazardous materials contained in the B61 JTA are classified and cannot be identified or discussed in detail (U.S. Air Force, 2004a).

These activities may potentially affect water quality and biological resources (protected species) (U.S. Air Force, 2004a). Although the B61 JTA spin rocket and motor would produce explosion products that may enter GOM waters, these amounts are minimal and are not expected to produce any environmental effects. The B61 JTA would be immediately retrieved upon entry into the GOM, and the neutron generator should remain intact. Calculations regarding the possible direct physical strike of a protected marine animal suggest that only 0.000045 dolphins and 0.00000895 sea turtles would be affected per test. These numbers are so low as to be not significant (U.S. Air Force, 2004a).

6.3.5 Eglin Base Realignment and Closure (BRAC) 2005 Decisions and Related Actions at Eglin Air Force Base (AFB), Florida

The Air Force, Army, Navy, and Marine Corps identified four activities to implement the following Eglin BRAC recommendations:

(1) Cantonment area for the Army 7th Special Forces Group (Airborne) (7SFG[A])

(2) Range training areas for the 7SFG(A),

(3) Cantonment for the Joint Strike Fighter (JSF) Initial Joint Training Site (IJTS), and

(4) Flight training areas for the JSF.

All activities would occur within the jurisdiction of Eglin AFB on the 724 mi^2 (1,875 km^2) Eglin Reservation or within nearly 130,000 mi^2 (336,698 km^2) of airspace overlying the land and water ranges of Eglin AFB (U.S. Air Force, 2008a). The 7SFG(A) utilizes unmanned aerial vehicles (UAVs) and wheeled, but not tracked (e.g., tank), vehicles for training exercises. The 7SFG(A) does not possess or operate any aircraft for personnel transport but utilizes various fixed-wing and rotary-wing aircraft from the Army and Air Force to conduct air operations. The 7SFG(A) Range Training component requires the utilization of the Firing Ranges, Aircraft Operations (fixed-wing and rotary), and Water Operations and Ground Maneuvers areas of the Eglin Range. The aircraft accompanying the JSF IJTS and beddown is the F-35, a single-seat, single-engine aircraft capable of performing and surviving lethal strike warfare missions. This requires sufficient infrastructure to support a maximum of 140 aircraft with associated personnel (U.S. Air Force, 2008a).

The U.S. Air Force finalized an EIS for the proposed implementation of the 2005 BRAC decisions and related actions at Eglin AFB in October 2008 (U.S. Air Force, 2008a). The EIS evaluated the effects associated with implementing the recommendations to relocate the 7SFG(A) from Fort Bragg, North Carolina to Eglin AFB and to realign and relocate from Luke AFB, Arizona, Marine Corps Air Station Miramar, California, Naval Air Station (NAS) Oceana, Virginia, Sheppard AFB, Texas, and NAS Pensacola, Florida a sufficient number of pilots and operations support personnel to stand up their associated portions of the JSF IJTS to be established at Eglin AFB. The analysis in the EIS included the potential impacts associated with the change in airspace usage with the Air Operations component of the 7SFG(A) range training and the F-35 beddown for the JSF IJTS. Currently, the Air Force utilizes the airspace over Warning Areas W-151, W-470, and occasionally W-155 for a variety of training activities and test missions. While these activities could add congestion to an area already facing airspace challenges, the EIS outlines mitigation measures to lessen the effects from all increased flight operations across the region (U.S. Air Force, 2008a). Air quality was also analyzed in the EIS and was determined that activities associated with the implementation of the 2005 BRAC decisions would not adversely affect the overall air quality of the region (U.S. Air Force, 2008a).

On November 20, 2008, the ROD was signed for the implementation of the 2005 BRAC decision and associated activities required to realign the Army 7SFG(A) from Fort Bragg to Eglin AFB by selecting the Cantonment Alternative 3 West of Duke Field and Range Alternative 3 East and West Side of the Eglin Range (U.S. Air Force, 2008b). On February 5, 2009 the U.S. Air Force signed the ROD for the implementation of the BRAC 2005 recommendations for the JSF IJTS and decided to allow delivery of 59 aircraft, associated cantonment construction, and limiting flight training operations until a Supplemental EIS is completed (U.S. Air Force, 2009).

6.3.6 Fiber Optic Cable Installation

There is a proposal for Eglin AFB to partner with Gulf Fiber Corp. and the U.S. Navy to bring an armored fiber optic cable from the GOM to either Panama City, Florida, or Eglin AFB property on SRI (U.S. Air Force, 2004d). If the cable goes to Eglin property, it would be run to test site A-3, and from there would be connected to the AT&T backbone near Highway 98.

Gulf Fiber Corp. is developing a fiber network between production oil platforms off Texas, Louisiana, Mississippi, and Alabama, and would provide the military with fiber conductivity into the GOM. This capability would support joint Gulf Test and Training Range operations (U.S. Air Force, 2004d). Figures Figure 6-2, Figure 6-3, and Figure 6-4 show the current fiber optic ring, a proposed pathway from an oil platform to A-3, and possible future routes.

Resources potentially affected by the cable installation include geology, biological resources, and cultural resources (U.S. Air Force, 2004d). Installation of the cable would necessitate the disturbance of the sea floor for relatively long distances. The proposed pathways could intersect with essential fish habitat, artificial reefs, and submerged cultural resources (U.S. Air Force, 2004d).

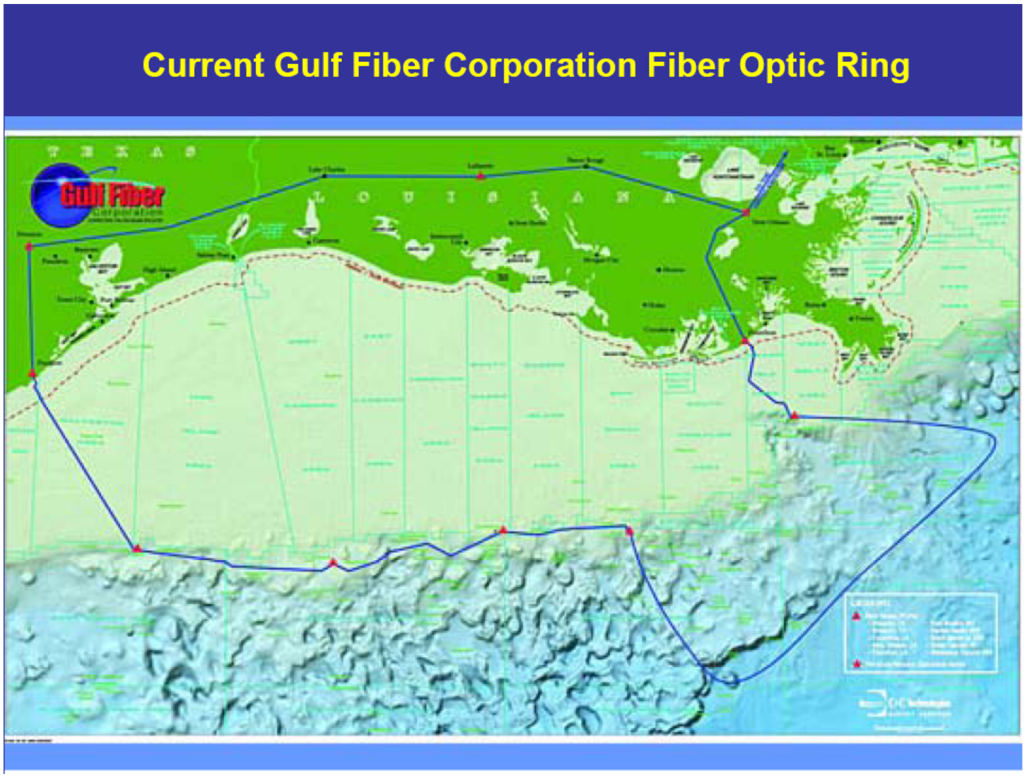

Figure 6-2. Existing Fiber Optic Ring in the GOM
Source: U.S. Air Force, 2004d

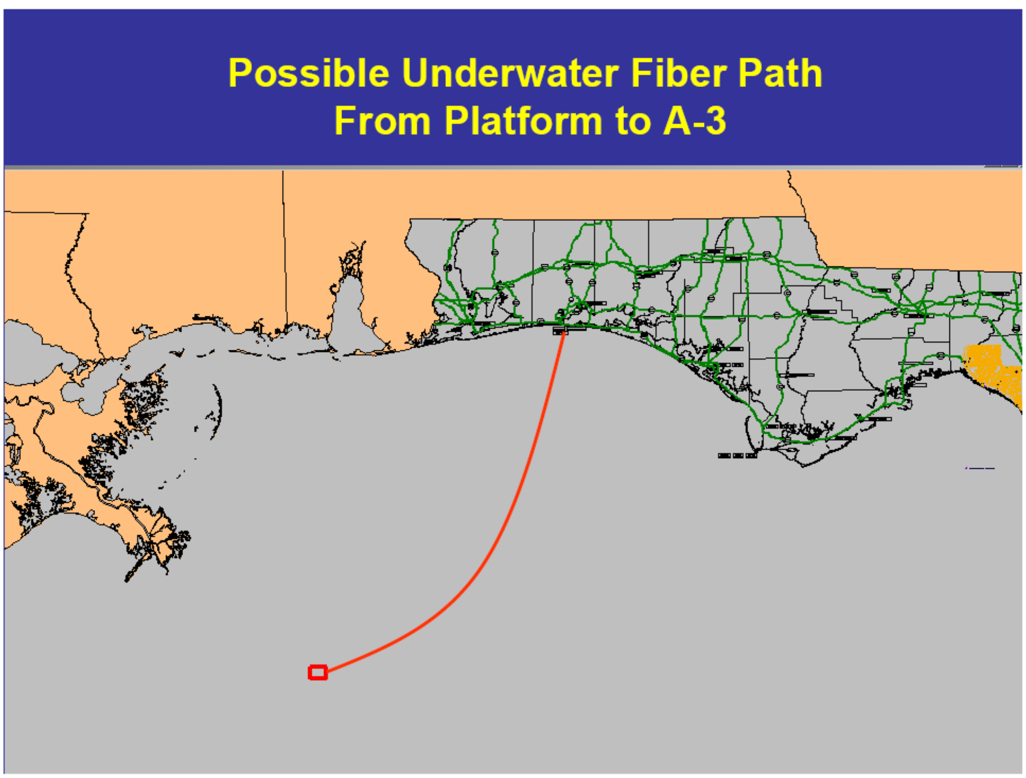

Figure 6-3. Proposed Fiber Optic Cable Pathway from Oil Platform to A-3
Source: U.S. Air Force, 2004d

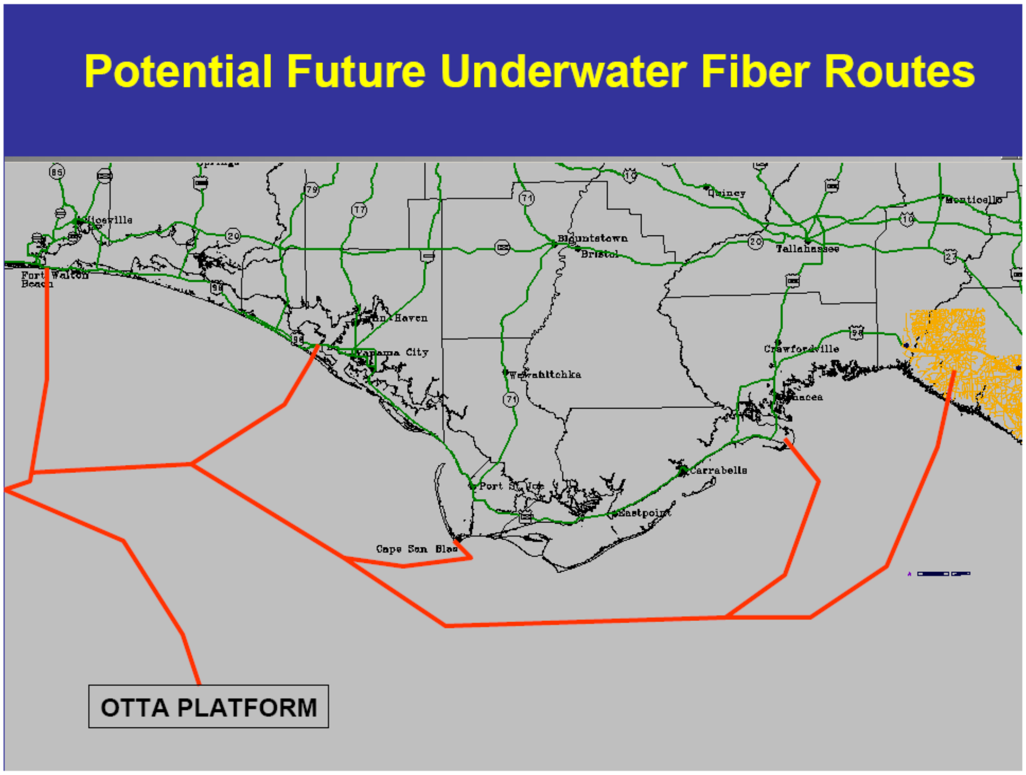

Figure 6-4. Potential Future Fiber Optic Cable Pathways
Source: U.S. Air Force, 2004d

6.3.7 Artificial Reefs

As discussed in Section 6.2.6, artificial reefs provide habitat for marine life and benefits for fishermen and divers. The establishment of additional artificial reefs is almost certain to continue into the foreseeable future. The Florida Fish and Wildlife Conservation Commission (FWC) manages the ongoing development of such reefs in accordance with the following six goals and objectives outlined in the State of Florida Artificial Reef Strategic Plan:

- Assure that long-term social, economic, and quality of life values of artificial reefs benefit the local and regional economies of Florida,
- Utilize artificial reefs in scientific research to gain an understanding of how artificial reefs function ecologically and physically in time and space,
- Use artificial reefs as a component of fisheries management,
- Identify, procure, and maximize new and existing sources of funding for artificial reefs,
- Improve intergovernmental coordination and public/private sector cooperation in artificial reef development, and
- Foster public and private sector marine ecosystem stewardship and accurate understanding of artificial reef issues (FWC, 2003a).

Approximately 70 to 100 public artificial reefs are constructed annually off the Florida coastlines. Of the 448 permitted artificial reef areas, approximately 300 are currently active. Of those reefs, eight large area artificial reef sites (LAARS) are located off the coasts of Escambia, Okaloosa, Bay, and Taylor counties. These eight LAARS account for 73 percent of Florida's total permitted artificial reef area off both the Atlantic and Gulf coasts (FWC, 2007b).

As mentioned above, the establishment of new artificial reefs is expected to continue, particularly along the Gulf Coast of Florida. There is a higher demand here for artificial reef construction to support local recreational fishing and diving organizations. For example, the Escambia County Division of Marine Resources (ECDMR), plans to submit Artificial Reef Permit Applications in Fiscal Year 2007-2008 to the U. S. Army Corps of Engineers and the Florida Department of Environmental Protection for several new permits including the renewal of the Escambia East LAARS for public reef deployments, and the renewal, expansion, and modification of Escambia West LAARS for personal reef deployments. ECDMR also plans to submit applications for a new Escambia #3 LAARS, a Nearshore Fishing Reef, a Dive Training Reef, and a Snorkeling Reef (ECDMR, 2007).

6.4 SUMMARY OF CUMULATIVE IMPACTS RELATIVE TO THE PROPOSED ACTION

Environmental effects associated with the proposed Navy action were thoroughly analyzed in Chapter 4. Most of these effects were determined to be not individually significant. However, these actions, when combined with other similar actions occurring in the region of influence, may contribute to a cumulative significant effect on one or more environmental resources. Table 6-18 shows, in tabular format, the environmental resources identified previously in this EIS/OEIS, and other activities in the region of influence potentially affecting the same resources, and the magnitude of each individual action. Ideally, the effects of all activities would be quantifiable, and the cumulative results combined as appropriate. In reality, quantifiable data are available for only a portion of the activities. For example, analyses of the potential effects associated with commercial shipping, fishing, boating, and other activities occurring within the NSWC PCD Study Area are not required to comply with NEPA; there is little to no analysis data available for these activities. Since a quantitative analysis of potential effects for these areas is not possible; qualitative information, such as known marine species injuries or deaths was used as appropriate. At this time, environmental impact analyses have not been conducted for most of the future actions identified in Section 6.3 and include all or portions of the GOMEX operations and the Eglin AFB fiber optic cable project. Therefore, the environmental effects of these projects are not currently available for consideration within the analysis of cumulative impacts. Table 6-18 contains qualitative terms to identify the magnitude of potential effects. Relevant resource categories are discussed in the following subsections.

Table 6-18. Summary of Cumulative Effects in the NSWC PCD Study Area

	Physical Resources				Biological Resources						Anthropogenic (Man-made) Environment						
	Geology	Air Quality	Water Quality	Noise (underwater)	Marine Habitats	Marine Life Non-protected	Sensitive Habitats	Sensitive Species	Essential Fish Habitat	Special Biological Resource Areas	Socioeconomics	Airspace Management	Artificial Reefs	Ordnance and Hazardous Materials	Safety	Environmental Justice and Risks to Children	Cultural and Historical Resources
COMPTUEX/JTFEX		*		*								*					
ARG/MEU				*			*	*	*		*						
EGTTR		*	*	*				*				**					
Cape San Blas		*									*	*					
Santa Rosa Island	*	*	*	*	*	*	*	*	*			*					
MMS-regulated				*				*									*
State Oil and Gas				*				*									*
Dredging	*						*	*	*								*
Fishing						**	*	**									
ESA Permits								***									
MMPA Permits								*									
Maritime Traffic				**				**									
NEODS	*		*	*	*	*		*									
COMINEWARCOM	*		*	**	*	**		**	*				*				*
PSW				*		*		*			*	*					
F-22 Fighter Squadron		*										*					
JTA/WSEP			*														
Fiber Optic Cable	*				*		*		*				*				*
Artificial Reefs																	
Airport Relocation		*															
Proposed Action – No Action Alternative				*	*		*	*									*
Proposed Action – Alternative 1				*	*		*	*									*
Proposed Action – Alternative 2				*	*		*	**									*

ARG/MEU = Amphibious Ready Group/Marine Expeditionary Unit; COMINEWARCOM = Commander, Mine Warfare Command; COMPTUEX/JTFEX = Composite Training Unit Exercise/Joint Task Force Exercise; EGTTR = Eglin Gulf Test and Training Range; ESA = Endangered Species Act; JTA/WSEP = Joint Test Assembly/Weapons Systems Evaluation Program; MMPA = Marine Mammal Protection Act; MMS = Minerals Management Service; NEODS = Naval Explosive Ordnance Disposal School; PSW = Precision Strike Weapons; *potential for minor adverse effects ** potential for moderate adverse effects *** potential for major adverse effects

6.4.1 Geology

The activities associated with several projects have the potential to affect geological resources in the NSWC PCD Study Area, particularly ocean sediments. Military activities that involve detonations on the sea floor include mine warfare operations, surf zone detonations, and unexploded ordnance disposal training. These types of missions can suspend sediment in the water column and, depending on the sediment type, currents, and magnitude of the explosion, disperse the sediment material over some distance. Dredging operations may move large amounts of sediment and cause sediment suspension in the water column. Cable installation in the seabed causes a small amount of sediment suspension and dispersal.

Of the operations encompassed within this cumulative impacts section, none of the analyses conducted for activities other than those associated with this NSWC PCD EIS/OEIS has quantified the potential effects to sediment. The Tyndall AFB F-22 conversion and the SRI programmatic activities identify potential effects from interactions between debris, chaff and flares, or line charges and sediments (U.S. Air Force, 2000; 2005). The disturbance of sediment by NSWC PCD, Tyndall AFB, and SRI operations would result in localized and temporary effects that would be washed away or redistributed by wave action in high energy environments (U.S. Air Force, 2000; 2005). Furthermore, no environmental concerns from 20 mm ammunition and chaff and flares were identified in the Tyndall AFB F-22 EIS (U.S. Air Force, 2000). When considered in context of the sea floor area and sediment volume existing in the NSWC PCD Study Area, no significant cumulative impacts on the geology of the area from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.2 Air Quality

Air emissions occur as a result of a great variety of activities on and near the portion of the GOM defined as the NSWC PCD Study Area. These activities include military, recreational, and commercial operations. Military activities that result in air emissions include live ordnance detonations, weapons usage, surface vessel operation, and aircraft operations. Eglin AFB and Tyndall AFB schedule thousands of flights per year in the NSWC PCD Study Area. In addition, the Panama City–Bay County International Airport and several smaller airports are located at the perimeter of the NSWC PCD Study Area. Aircraft flights occur in association with NSWC PCD RDT&E activities as well.

NSWC PCD RDT&E activities are expected to result in more than 2,000 hours of surface vessel operation annually. Hundreds of commercial shipping vessels traverse the GOM annually. In addition, hundreds of thousands of recreational boat trips are made in the GOM and St. Andrew Bay (SAB) annually. Although there are no active oil or gas leases within Florida coastal waters, these operations do occur in other portions of the GOM, including along Alabama's coast.

All these activities result in the emission of pollutants into the atmosphere. The effects of air pollutants in a given area are dependent upon the type and amount of pollutants, the size and topography of the air basin, and the prevailing meteorological conditions. All counties bordering the NSWC PCD Study Area are currently in attainment of the USEPA and state air quality standards. NSWC PCD mission activities and the activities with quantifiable air quality values were analyzed to determine the potential cumulative effects as compared to additional activities which include the COMPTUEX/JTFEX, the ARG/MEU training exercises, the EGTTR missions, the CSB programmatic activities, and the Tyndall AFB F-22 conversion. An analysis of the potential air pollutants reveals that the activities would not go beyond the 10 percent criterion for individual pollutants in comparison to the NSWC PCD Study Area (Table 6-19). The proposed NSWC PCD RDT&E activities would contribute to an increase in emissions, ranging from 3.6 percent to 16 percent, dependent upon the individual pollutant evaluated as compared to additional regional Department of Defense (DoD) activities. The additional activities would contribute to air pollution, primarily in the form of diesel exhaust. However, it is unlikely that the pollutant levels would reach the 10 percent threshold, shown in Table 6-19 as the percentage of emissions for the NSWC PCD Study Area. This calculation is derived by dividing the total quantifiable emissions, including NSWC PCD, by the total NSWC PCD Study Area emissions). Therefore, no significant cumulative impacts on air quality from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

Table 6-19. Air Pollution Levels in the NSWC PCD Study Area

	CO (tons)	NO_x (tons)	PM_{10} (tons)	SO_x (tons)	VOCs (tons)
Other Quantifiable Emissions	819.15	760.23	95.73	23.92	145.7
NSWC PCD Emissions	64.79	272.37	34.96	0.27	14.48
Total Quantifiable Emissions, including NSWC PCD	883.94	1,032.6	130.7	24.19	160.18
Total NSWC PCD Study Area Emissions	601,523	137,060	145,873	150,675	118,817
Percentage of NSWC PCD Study Area[1]	0.15%	0.75%	0.090%	0.016%	0.13%
NSWC PCD Contributions to Total Emissions[2]	7.3%	26%	27%	1.1%	9.0%

CO = carbon monoxide; NO_x = nitrogen oxides; NSWC PCD = Naval Surface Warfare Center, Panama City; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides; VOCs = volatile organic compounds

1 – Percentage for each pollutant was calculated by dividing the Total NSWC PCD Study Area Emissions value by the Total Emissions Value.

2 – Percentage for each pollutant was calculated by dividing the Total Emissions by the NSWC PCD Contributions value

Sources for Total Emissions: U.S. Air Force, 1999, 2000, and 2002b; U.S. Marine Corps and U.S. Air Force, 2003; U.S. Navy, 2004a

6.4.3 Water Quality

Water quality in the NSWC PCD Study Area is affected by many military, industrial, and recreational activities. Military activities affect water quality by the introduction of explosion products from live detonations, the turbidity generated by detonations and subsurface activities, and metal leaching from ammunition. Effects also occur from military surface vessels. NSWC PCD RDT&E activities are expected to result in approximately 3,000 surface operations annually. In addition, hundreds of commercial vessel trips and hundreds of thousands of recreational boat trips are made in the NSWC PCD Study Area annually. Leakage of oil and other substances, leaching from lost lead anchor weights, and anchor-caused turbidity are some of the effects caused by surface vessels. Although there are no active oil or gas leases within the action area, these operations do occur in other portions of the GOM and have the potential to degrade water quality from construction activities, spills, daily operations, and explosive removal operations. In addition to the metals contained in spent munitions, thousands of pounds of steel have been added to the GOM in the form of artificial reefs.

Quantitative analyses have been performed for potential effects associated with CSB, EGTTR, SRI, ARG/MEU, PSW, and Tyndall AFB operations that show cumulative effects of 0.053 milligrams per liter (mg/L) of JP-8 fuel and no greater than 0.00227 mg/L of aluminum by-products (U.S. Air Force, 1999; 2002b; 2000; 2005a; and 2005b; U.S. Marine Corps and U.S. Air Force, 2003). Increases in iron and aluminum debris from at least two of these activities would occur; however, the slow oxidation rate, as well as the dispersion of these elements in the water column, would reduce the potential for significant cumulative effects to occur (U.S. Air Force, 2000 and 2002b). The amounts of pollutants and other substances introduced into the waters of the NSWC PCD Study Area are relatively substantial. However, when considered in the context of the volume of seawater present and the dispersing ability of wind, waves, and currents, no substance is expected to have more than a local and temporary effect. Furthermore, NSWC PCD operations would introduce additional pollutants together with all of the activities that occur within the NSWC PCD Study Area; however, none of the concentrations would exceed the established water quality standards. Therefore, no significant cumulative impacts on water quality from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated

6.4.4 Underwater Noise

Ambient underwater sound is dynamic and dependent on a variety of components including physical, biological, and anthropogenic sources, which were discussed in detail in Section 3.3.5. Given the wide range of factors that contribute to the overall underwater acoustic environment, it is not likely that any one source will permanently affect other sources when all components are taken into consideration. However, underwater noise does have the potential to affect only certain biological resources, which include non-protected and protected species. To maintain consistency throughout this EIS/OEIS, cumulative effects associated with underwater noise will be discussed within the marine life (non-protected) and protected species subsections of this chapter.

6.4.5 Marine Habitats

Sensitive marine habitats may be degraded or destroyed by activities that affect the sea floor or that affect the physical parameters of seawater. Such habitats include coral reefs, hardbottom areas, and seagrass beds. Military activities that include the placement of objects on the sea floor as well as marine construction projects and dredging activities can affect these habitats. However, many of these activities require permits, and it is unlikely that they would be allowed to occur in areas of sensitive habitats.

Military operations that identified the potential to affect corals, hardbottoms, and seagrasses include ARG/MEU training, SRI operations, Tyndall AFB conversion events, and PSW testing as well as NSWC PCD RDT&E activities. None of the operations have quantified the potential effects to any of the sensitive marine habitats (U.S. Marine Corps and U.S. Air Force, 2003; U.S. Air Force, 2000; 2005a; 2005b). Therefore, a qualitative discussion is provided. The operation of vessels in shallow water affects these habitats, especially seagrass. Many areas of significant seagrass beds in Florida show evidence of substantial scarring by boat propellers. Once a seagrass area is scarred, recolonization by the grass may be a very slow process. Fishing operations, particularly trawling, and boat anchoring can also affect sensitive habitats. The largest contribution of potential scarring would arise from recreational boaters. Military operations would avoid seagrasses, which would reduce the potential for effects to occur (U.S. Marine Corps and U.S. Air Force, 2003). Activities that increase water turbidity can negatively affect all of these habitat types. Corals are suspected to be vulnerable to pollutants and nutrient loading of the water. In addition, corals may suffer damage from recreational activities such as fishing and diving. Sensitive habitats in the NSWC PCD Study Area have been subjected to some level of degradation. Recreational activities are considered to be a significant to predominant contributor to these effects. Since identified activities would largely avoid sensitive marine habitats and other military actions would employ this same management practice, no significant cumulative impacts to sensitive marine habitats from any of the NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions (U.S. Marine Corps and U.S. Air Force, 2003; U.S. Air Force, 2000; 2005a; 2005b) in the NSWC PCD Study Area are anticipated.

6.4.6 Fish

Fish may be killed or injured by detonations during military operations, including EGTTR, PSW, and NSWC PCD RDT&E activities (U.S. Air Force, 2002b; 2005b). The number of fish species affected by military activities is unknown. Commercial fishing operations exert a much more profound pressure on fish stocks. A number of commercially important fish species are considered to be over-fished. Restrictions on fishing gear, seasons, areas, and quotas are designed to relieve some of the pressure on these stocks. Given the likelihood that most pre-mission activities startle fish and birds from the area (U.S. Air Force, 2002b; 2004d; 2005b), the known hearing range for fish, the lack of evidence for use of sound by seabirds, and the restrictions instituted to recover fish stocks, no significant cumulative impacts from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.7 Protected Species

The biological significance of anthropogenic noise on sensitive species, as well as safe threshold levels, is currently a source of debate. Anthropogenic (man-made) noise has existed in the marine environment since the industrialization of human societies, and has steadily increased over time. Anthropogenic noise in the underwater environment has the potential to injure the hearing mechanism of marine species, as well as interfere behaviorally. Anthropogenic noise is generated by many activities such as military, commercial, and recreational operations. Military operations may involve the use of underwater detonations and sonars. The sounds produced by these sources can be quite intense at close range. Mine clearance and ordnance disposal could result in underwater detonations on or close to the sediment. This could cause turbidity and damage to habitat (such as natural or artificial reefs). Military activities conducted on or in the vicinity of sensitive habitats, such as natural or artificial reefs, could negatively affect the function of such structures. Other potential affects to such habitats and marine species could result from fiber optic cable installation. Installation of the cable would necessitate the disturbance of the sea floor for relatively long distances. The proposed pathways could intersect with essential fish habitat, artificial reefs, and submerged cultural resources (U.S. Air Force, 2004).

Noise produced by surface vessels (commercial, military, and recreational) has become practically ubiquitous in the marine environment. Sounds from engine noise and cavitation caused by propellers can be transmitted for great distances. Many sounds associated with ships are of low frequency, which may travel hundreds of miles. Many fish-finding devices are used daily in the GOM and introduce sounds of varying frequencies and intensities. As stated above are the potential affects to all marine species, sea turtles, and fish. Below are these effects divided into the appropriate subsections.

6.4.7.1 Marine Mammals

Sound is utilized by marine mammals in a variety of activities including communication, hunting, exploration of the environment, and possibly migration. The effect of sound on marine species is unknown, but it is possible that persistent noise may affect marine mammals' use of sound for communication and hunting. The only potential for impacts to marine mammals will occur at Level B harassment.

Underwater detonations may project pressure and sound intensities sufficient to cause physical trauma, acoustic or behavioral effects to protected marine mammals. As stated before, injury can result from the shock wave interacting with air spaces in an animal's body, such as swim bladders, the inner ear, and viscera. Other direct physical effects to marine mammals may also occur when the surface of the water is physically struck by gunnery ordnance or other falling objects. The possibilities of an animal being struck by a falling object are extremely remote given the large area within which an item may land. Specifically, it was determined an average of 0.21 cetaceans could potentially be injured or killed by projectiles and falling debris per year (U.S. Air Force, 2002b). Other effects to marine mammals besides noise and ordnance, include commercial and recreational traffic, such as fishing. Commercial and recreational fishing have potential adverse effects on cetaceans through propeller and boat strike damage. The combined takes from all Navy activities would be mitigated to insignificance via mitigation and protective measures discussed in Chapter 5, LOA and ESA BO terms and conditions, Navy ICMP conservation initiatives and other protected species research funded by the Navy. These measures would minimize any potential adverse impacts to marine mammals and would avoid any significant or long-term adverse impacts to threatened and endangered species. Impacts are expected to be limited to temporary behavioral impacts. Therefore, no significant cumulative impacts to marine mammals from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.7.2 Sea Turtles

Sea turtles may utilize sound, but the extent is unknown. In addition to noise, dredging, ordnance activities, and commercial fishing also affect protected sea turtle species. Physical effects to marine mammals may occur when the surface of the water is physically struck by gunnery ordnance or other falling objects. The possibilities of an animal being struck by a falling object are extremely remote, however, given the large area within which an item may land. Specifically, it was determined an average of 0.04 sea turtles could potentially be injured or killed by projectiles and falling debris per year (U.S. Air Force, 2002b). As stated before, injury can possibly result from the shock wave interacting with air spaces in an animal's body, such as swim bladders, the inner ear, and viscera.

Commercial and recreational traffic, such as fishing, could have potential adverse effects on sea turtles through propeller and boat strike damage. Other adverse effects are possible due to gillnet, longline, trawl, and pot fisheries. Shrimp trawling is considered to have by far the greatest effects on turtles, with many thousands of turtles affected annually. The use of Turtle Excluder Devices has significantly reduced mortality by up to 50 percent. The implementation of new TED regulations is expected to further decrease mortality. NMFS has identified dredging operations as an activity that may cause sea turtle mortality (NMFS, 2004b). Hopper dredges move faster than sea turtles and can entrain them. Other additional potential effects to sea turtles are the possibility of surface vessels physically disturbing large *Sargassum* mats. These mats are considered likely habitat for juvenile turtles as well as habitat for a number of fish species during various life stages. Large *Sargassum* mats, however, are distributed in a very patchy manner and are usually associated with ocean current convergence lines.

It is expected that the mitigation measures identified in Chapter 5 would be implemented to minimize any potential adverse effects to sea turtles. Moreover, the Navy consulted with NMFS in accordance with Section 7 of the ESA for any potential effects NSWC PCD RDT&E activities may have on sea turtles. For all Navy actions, there is a potential for moderate, recoverable cumulative effects to sea turtles. However, the combined takes from all sources would be mitigated through ESA BO terms and conditions, Navy ICMP conservation initiatives discussed in Section 5.3.2.5.2, and other protected species research funded by the Navy. As such, it was determined that no significant cumulative impacts to sea turtles from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.7.3 Fish

Fish may utilize sound, but the extent is unknown. Cumulative effects to protected species of fish in the GOM are anticipated to be not significant based on the location and timing of events (U.S. Air Force, 2002b; U.S. Marine Corps and U.S. Air Force, 2003; U.S. Air Force, 2005a; 2005b; U.S. Navy, 2004a).

The activities associated with the PSW testing and the EGTTR missions occur in areas farther offshore where the Gulf sturgeon would not be expected to occur (U.S. Air Force, 2002b; 2005b). However, the use of line charges will occur in the near shore environment, where Gulf sturgeon may occur. It has been found that subadult and adult Gulf sturgeon will begin migrating downstream, specifically from the Apalachicola River to the GOM, in late September for the duration of the winter and will return the following spring by the end of May (USFWS and GSMFC, 1995). Tagging efforts have documented the occurrence of these ESA-listed species from typically about one-half to one mile off the shore of Tyndall Air Force Base (AFB) and as far as 6.4 km (4 mi) in the GOM (USFWS PC, 2004). The potential exists that if NSWC PCD conducts tests of line charges from late September through April, ordnance operations may affect Gulf sturgeon. The potential affects to fish are caused by underwater shock waves that can rupture swim bladders and blood vessels of fish, tear their tissues, and rupture and hemorrhage the spleen, kidney, liver, gonads, and sinus venous (first chamber in the heart, which connects to the veins and receives blood from the body) of fish (Wright, 1982 and Govoni et al., 2003).

The smalltooth sawfish is extralimital to the NSWC PCD Study Area. Historic records show that the species at one time likely existed in the Florida panhandle; however, current scientific research has shown that the species distribution is limited predominantly to the Florida Everglades and throughout peninsular Florida (National Marine Fisheries Service [NMFS], 2006). These locations are outside of the NSWC PCD Study Area; therefore, ordnance operations will have no effect on the smalltooth sawfish.

Dredging activities also have the potential to affect the protected Gulf sturgeon, particularly juveniles that may not be able to avoid entrapment. Future events associated with the ARG/MEU will not take place in the Gulf of Mexico or Santa Rosa Sound. Finally, the U.S. Air Force's activities off of Santa Rosa Island include visual monitoring, which would reduce the potential impacts to the species (U.S. Air Force, 2005a). Considering the best available data, no data exist that demonstrate any long-term negative effects on fish from underwater sound associated with sonar activities. Therefore, it was determined that no significant cumulative impacts to fish populations from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.8 Essential Fish Habitat (EFH)

EFH is primarily affected by activities that occur on the sea floor. Although the water column is considered EFH for some species, water quality in the NSWC PCD Study Area is not being affected to the degree necessary to be considered degrading to EFH. Military activities, including NSWC PCD RDT&E activities, have the potential to impact EFH by physically damaging bottom structure such as hardbottoms, rocky outcrops, and reefs. However, military operations generally avoid particular types of EFH including seagrasses, corals, and hardbottom areas (U.S. Air Force, 2002b; 2005b; U.S. Marine Corps and U.S. Air Force, 2003; U.S. Navy, 2004a). Therefore, no significant cumulative impacts to EFH from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.9 Socioeconomics

The socioeconomic effects of activities occurring within the NSWC PCD Study Area consist primarily of temporary closures of water surface areas to fishing and recreational activities. The operations that have been analyzed for restricted access include the Cape San Blas programmatic activities, the SRI operations, the PSW missions, the Tyndall AFB F-22 training, and the ARG/MEU training as well as the activities encompassed by this EIS/OEIS. Military activities have the potential to temporarily close portions of the GOM to public activities of at least 1,043 km^2 (402.7 mi^2) and 739 km^2 (585.3 mi^2) (U.S. Air Force, 1999; 2000; 2005a; and 2005b; U.S. Marine Corps and U.S. Air Force, 2003). (The analysis for closures was conducted differently for the various operations and, therefore, the two measurements reflect this.) The total number of hours whereby a portion of the GOM that may be temporarily closed could approach 4,400 hours (U.S. Air Force, 1999; 2000; 2005b). These figures do not take into account ARG/MEU hours or the SRI area because they were not available in analyses.

However, the number of hours for temporary closures that would be associated with ARG/MEU activities would be primarily during nighttime hours when recreational and commercial activities are limited. The total amount of area available in the NSWC PCD Study Area is 81,032 km^2 (31,287 mi^2). The amount of area temporarily closed per year would not exceed 2 percent of the total area of the GOM available for fishing, boating, and other recreational and commercial activities. Furthermore, local Notices to Mariners (NOTMARs) mitigate these effects by allowing alternate activities or locations to be planned in advance. For all of the military activities, NOTMARs are required to be submitted days prior to temporary closures (U.S. Air Force, 1999; 2000; 2005a; 2005b; U.S. Marine Corps and U.S. Air Force, 2003). Area closures are localized and temporary, and would not be significant. Therefore, no significant cumulative impacts to socioeconomics from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.10 Airspace Management

Airspace management issues potentially arise due to the large number of military flights in the NSWC PCD Study Area, which is in close proximity to several civilian airports. The total amount of air operations that include flight time for helicopters, and/or fixed-wing aircraft over the NSWC PCD Study Area would approach 2,600 operations (U.S. Air Force, 1999; 2000; 2005b; U.S. Marine Corps and U.S. Air Force, 2003). These operations do not include the number of commercial flights or other unidentified activities. Eglin AFB schedules and controls the airspace over the NSWC PCD Study Area, and has developed a system of air control over the course of many years. The number of flights is not expected to approach the limit of Eglin's management capability. Furthermore, the Jacksonville Air Route Traffic Control Center (ARTCC) controls air traffic in the airspace, and all pilots using the airspace are required to use "see-and-avoid" standards of flight safety (U.S. Air Force, 1999; 2000; 2005a; 2005b; U.S. Marine Corps and U.S. Air Force, 2003). Therefore, no significant cumulative impacts are anticipated from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area.

6.4.11 Artificial Reefs

Artificial reefs may be damaged by activities that occur on or close to the sea floor. Such activities include certain fishing techniques (e.g. trawling), installation of cable under the sea floor, mineral extraction activities, and military missions such as mine placement. Activities that have been analyzed for potential effects to artificial reefs include the ARG/MEU operations, the CSB programmatic activities, the PSW testing, Tyndall AFB conversion, and the SRI operations. NSWC PCD, ARG/MEU, and SRI activities have the greatest potential to affect artificial reefs. However, the effects would be concentrated in a localized area, particularly with the ARG/MEU and SRI missions (U.S. Air Force, 1999; 2000; 2005a; 2005b; U.S. Marine Corps and U.S. Air Force, 2003). All of the listed missions emphasize the importance of avoiding artificial reefs as a means to reduce the potential for interaction with a reef. Interactions can damage both the reef and military equipment (U.S. Air Force, 1999; 2000; 2005a; 2005b). Military actions such as the PSW testing and the Tyndall AFB operations have the potential to introduce marine debris into the environment; this debris is similar in structure and content to the reefs that are placed on the sea floor (U.S. Air Force, 2005b; 2000). The effects of other activities are expected to be minimal. No significant cumulative impacts to artificial reefs are anticipated from NSWC PCD activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area.

6.4.12 Cultural and Historical Resources

Submerged cultural and historical resources have the potential to be damaged or destroyed by activities occurring on the sea floor. Examples of such activities include mineral extraction, dredging, and military actions such as the placement of mines and other objects on the sea floor and the firing of munitions. The MMS requires sea floor surveys for the presence of cultural resources before mineral extraction operations are initiated. Otherwise, the location of these resources is largely unknown (although probability areas have been identified). The potential for effects to occur to cultural and historical resources were identified in a variety of NEPA documents and include operations associated with the Tyndall AFB EIS, the SRI EA, the PSW EA, the Cape San Blas EA, and the EGTTR EA as well as with activities covered under this EIS/OEIS. Effects to cultural resources in the marine environment are unlikely as the submerged resources are protected under the bottom sediment by sediment and from wave action (U.S. Air Force, 1999; 2000; 2005a; 2005b; U.S. Marine Corps and U.S. Air Force, 2003). Furthermore, Eglin's Environmental Management Division, Cultural Resources Branch requires that all activities conducted at Eglin AFB and undergoing environmental review there are coordinated through their office and that avoidance of sensitive resources be employed. Actions covered by nearly all of the aforementioned operations also require consultation with the State Historic Preservation Officer (SHPO) and compliance with the various laws that protect cultural and historical resources (U.S. Air Force, 1999; 2000; 2005a; 2005b; U.S. Marine Corps and U.S. Air Force, 2003). The frequency and extent of damage to submerged cultural and historical resources due to military and other activities in the NSWC PCD Study Area is not known. However, based on the requirements previously described, no significant cumulative impacts are anticipated from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area.

6.4.13 Environmental Justice and Safety Risks to Children

Although the potential exists for a variety of the socioeconomic and anthropogenic (man-made) effects to occur, none of the activities evaluated within this cumulative impact section have revealed effects associated with environmental justice and safety risks to children. Therefore, no cumulative impacts to environmental justice and safety risks to children from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area are anticipated.

6.4.14 Conclusions

The cumulative impact analysis included evaluation of activities in the GOM for physical, biological, and anthropogenic resources. Based on the analysis, no significant effects would occur to any of the resource areas with respect to cumulative impacts from NSWC PCD RDT&E activities coupled with past, present, and reasonably foreseeable future actions in the NSWC PCD Study Area.

6.5 UNAVOIDABLE ADVERSE IMPACTS

There would be no adverse effects as a result of implementation of the Proposed Action within territorial waters. Potential effects would be short-term and localized. No significant, unmitigable environmental effects of the Proposed Action were identified.

6.5.1 Relationship Between Short-Term Uses of Man's Environment and the Enhancement of Long-Term Productivity

There would be no anticipated effects that would be expected to adversely affect the long-term productivity of implementing the Proposed Action within the territorial waters. There would be some short-term adverse effects on the environment; however, they would be brief and localized.

6.6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Implementation of the Proposed Action would irretrievably commit the use of nonrenewable resources such as fuel, materials, and human labor. Destruction of submerged cultural or historical resources would also be considered an irretrievable commitment because these resources are irreplaceable. The required mitigation measures make interaction with cultural or historical resources very unlikely.

The Proposed Action would inevitably require the use of some nonrenewable resources. However, the action is not expected to result in the destruction or degradation of environmental resources to the point that their use is appreciably limited presently or in the future. The Navy, through operational constraints and mitigation measures, would minimize the irreversible and irretrievable commitment of resources present within the NSWC PCD Study Area.

6.7 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

NEPA requires that federal agencies consider energy requirements and identify energy conservation potential for the various alternatives proposed. The proposed NSWC PCD RDT&E include alternatives that address increased testing events in the NSWC PCD OPAREA. To implement the proposed activities, increased amounts of fossil fuels would be required to power the increased use by ships and aircraft. These fuels are currently in adequate supply from either Navy-owned sources or from commercial distributors. Additionally, NSWC PCD has transitioned from their previous use of 2-stroke engines on all of their small boats to the use of more fuel efficient 4-stroke engines. All planning for NSWC PCD RDT&E activities is completed prior to commencing operations. Therefore, missions identify and select the shortest direct routes to arrive at and return from testing locations and the closest locations for particular NSWC PCD RDT&E activities based on test requirements and characteristics. In conjunction with EO 13423, *Strengthening Federal Environmental, Energy and Transportation Management*, the use of energy sources has been minimized wherever possible without compromising safety or testing. No additional conservation measures related to direct energy consumption by the proposed NSWC PCD RDT&E activities are identified.

7. STATEMENT OF PUBLIC PARTICIPATION

7.1 INTRODUCTION

This chapter provides information on the public participation efforts associated with the planning process for this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). The National Environmental Protection Act (NEPA) processes require that federal agencies include public involvement in their planning, which is stipulated in 40 Code of Federal Regulations (CFR) Part 1503 of the Council on Environmental Quality's regulations as well as within 32 CFR Part 775 of the Navy's requirements. The Navy has identified various ways to involve the public, which includes federal, state, and local agencies and governmental representatives, interested organizations at Naval Surface Warfare Center Panama City Division (NSWC PCD), and individuals in the EIS/OEIS planning process through early and open communications, which include:

- Public scoping meetings,
- Public comment period for scoping,
- Scoping meetings with the Florida Department of Environmental Protection (FDEP) and with the Alabama Department of Environmental Management (ADEM),
- Federal and state agency scoping packages,
- Local and organizational scoping packages,
- Public hearings, and
- Public comment period for the Draft EIS/OEIS.

7.2 SCOPING PROCESS

To initiate scoping, the Notice of Intent to prepare this EIS/OEIS was published in the *Federal Register* on August 19, 2004 (Department of the Navy [DON], 2004). The closing date for the scoping period was set at November 6, 2004. The purpose of this scoping process was to identify the significant environmental issues relevant to the Proposed Action and alternatives including a No Action Alternative. The period also provided an opportunity for public involvement in the development of the EIS/OEIS.

Potentially interested federal and state agencies were briefed on the overall scope of the EIS/OEIS and were given the opportunity to assist in the development of the document as a cooperating agency. The National Marine Fisheries Service (NMFS) and the Navy entered into a cooperative agreement for this EIS/OEIS because NMFS has jurisdiction over marine protected species and habitat. Furthermore, NMFS is responsible for issuing permits under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). None of the other five agencies approached were interested in pursuing the status of a cooperating agency. Table 7-1 identifies each agency and the associated reason for declining the opportunity to act as a cooperating agency.

Table 7-1. Invitees to Serve as Cooperating Agencies

Entity	Description of Entity's Jurisdiction in Relation to the NSWC PCD EIS/OEIS	Decision	Justification
Florida Department of Environmental Protection (FDEP)	Could aid in identification of natural, social, economic, energy, urban quality, historic, and/or cultural issues (40 CFR § 1502.16)]. Jurisdictional issues governing use determinations of the sovereign submerged lands of the state.	No	Initially considered as a potential cooperating agency. Subject was approached and FDEP determined that it was not in their best interest to serve as a cooperating agency.
United States Fish and Wildlife Service (USFWS)	Jurisdiction over protected coastal species and habitats; has the authority to authorize activities that allow takes of ESA listed species and to provide management requirements for those species.	No	Due to limited jurisdictional responsibilities over species and NSWC PCD Study Area, USFWS was not considered.
Eglin Air Force Base(AFB)	Manages the schedule of airspace in the EGTTR, where NSWC PCD RDT&E activities would occur. Missions require environmental compliance.	No	Eglin AFB determined that it was not in NSWC PCD's best interest to be a cooperating agency.
Tyndall AFB	Conducts Air Force missions in the W-470 airspace; utilizes some of the airspace required by the activities of the NSWC PCD. Missions require similar environmental compliance.	No	Very little to no NSWC PCD testing would actually be performed in the same waters as Tyndall AFB missions.
Naval Air Station (NAS) Pensacola	Conducts similar missions in the GOM in the W-155 (includes Pensacola Operating Area) air space and requires similar environmental compliance and use of the surface waters.	No	Very little to no testing would actually be performed in the same waters as NAS Pensacola missions.

CFR = Code of Federal Regulations; EGTTR = Eglin Gulf Test and Training Range; ESA = Endangered Species Act; GOM = Gulf of Mexico; NSWC PCD = Naval Surface Warfare Center, Panama City

The Navy acted to provide sufficient opportunities for agencies, organizations, and the general public to learn about NSWC PCD research, development, test, and evaluation (RDT&E) activities, current environmental stewardship, and the proposal for operational expansion. Formal notification of public scoping was made through local media and in letters to federal, state, and local agencies and officials, and interested groups and individuals. Local newspapers also published articles about the NSWC PCD effort. Scoping meetings were held on the following dates at the specified locations:

- October 5, 2004 Panama City, FL
- October 6, 2004 Port St. Joe, FL

Public scoping meetings consisted of a two-part session. From 6 – 7 p.m., guests were invited to examine display boards about NSWC PCD, the RDT&E activities encompassed by the EIS/OEIS, and current status of, as well as future enhancement for environmental stewardship. At this time, attendees were also encouraged to discuss their concerns, ask questions, and provide input to personnel.

At the registration table at both meetings, attendees were asked to sign-in and encouraged to sign up for copies of the Draft EIS/OEIS, to submit their name for oral comment, and to make written comments. Fact sheets were also provided that gave detailed information not only about NSWC

PCD RDT&E activities and environmental stewardship, but also about the public involvement process and ways in which the public can provide input to the NSWC PCD mission planning process.

During the second portion of the meetings, Navy representatives made a formal presentation. The presentation included information on the need for mission activities at NSWC PCD, the level of RDT&E activities under the projected alternatives, the potential associated environmental issues, and the environmental benefits of the EIS/OEIS to NSWC PCD and the various resources. Following the formal presentation, the public was invited to share their comments.

In addition to the public meetings, a public website was developed to provide information on the effort throughout the process. All interested entities were encouraged to visit this site, http://nswcpc.navsea.navy.mil/Environment.htm, as well as the local information repositories set up at the following libraries:

- Bay County Public Library
- Gulf County Public Library
- Fort Walton Beach Public Library
- Pensacola Public Library
- Mobile Public Library

Comments were accepted during the scoping period in four forms.

(1) Oral comments during the scoping meetings captured by a court reporter.

(2) Written comments submitted at the scoping meeting.

(3) Written comments mailed to the NSWC PCD EIS/OEIS Environmental Lead.

(4) Electronic comments emailed to the NSWC PCD EIS/OEIS Environmental Lead.

Comments were received from a variety of agencies, organizations, and individuals. Table 7-2 provides detailed information on the commenting entity, the nature of the comment, and the inclusion of the comment listed verbatim as received and the Navy's response.

Table 7-2. Responses to Public Scoping Comments

Issue Category	Letter #-Comment #	Agency/Individual	Comment*	Response
Alternatives	0008-1	NRDC	Navy give full consideration to all reasonable geographic and seasonal alternatives for the purpose of minimizing harm.	Addressed in Chapter 2, Proposed Action and Alternatives.
Alternatives	0008-2		The relative benefits and disadvantages of alternative locations for testing and training must be discussed. None of these alternatives can be disregarded merely because they do not offer a complete solution to the problem.	Addressed in Chapter 2, Proposed Action and Alternatives.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Water Quality	0007-1	FDEP	The DEP notes that the proposed activities may have potential to directly or indirectly affect water quality and benthic habitat. Chemical and physical components that will enter water column from additional testing should be evaluated for impact to water quality, including fate and transport	Addressed in Subsection 4.2.4, Water Quality.
Underwater Noise, Biological Resources	0005-1	AWI	What is the upper level of received sound you will consider acceptable exposure to marine mammals? To Fish? To Turtles? And what is the basis for each?	Addressed in Subsection 4.3.3, Protected Species.
Noise	0005-2	AWI	What types of active sonar will be used in waters and what areas? At what frequency, duration and volume? How often and for how many hours?	Addressed in Subsection 4.3.3, Protected Species and Appendix M, Supplemental Information for Underwater Noise Analysis.
Noise In-water	0005-3	AWI	Will there be a measure of the total number of times an individual creature might be hit by a single sonar pulse as it reverberates in a shallow water situation? Or of how many hits a near shore creature might absorb over a year of testing?	Addressed in Subsection 4.3.3, Protected Species.
Underwater Noise, Biological Resources	0008-3	NRDC	It is essential that the Navy carefully disclose and evaluate the potential noise impacts of its expanded operations in the NSWC PCD EIS/OEIS on these and other species – (sperm whales, dwarf and pygmy sperm whales, Bryde's whales, several species of beaked whales, northern GOM stocks of bottlenose dolphins, Atlantic and pantropical spotted dolphins, striped dolphins, spinner dolphins, Clymene dolphins, Fraser's dolphins, killer whales, pygmy killer whales, Risso's dolphins, melon-headed whales, and short-finned pilot whales as well as right whales) including the potential not only for immediate, short-term behavioral effects, but for delayed indirect effects that in some cases may be lethal or severe.	Addressed in Subsection 4.3.3, Protected Species.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Underwater Noise, Biological Resources	0008-4	NRDC	The EIS must pay particular heed to vulnerable species. Of the seven baleen whale species known to occur in the GOM, five are listed as endangered or threatened (the blue whale, finback whale, sei whale, humpback whale, and northern right whale. Other endangered and threatened species known to occur in the GOM include sperm whale, West Indian manatees, Kemp's Ridley sea turtles, leatherback sea turtles, hawksbill sea turtles, smalltooth sawfish, green sea turtles, loggerhead sea turtles, and Gulf sturgeon. Candidate species (those considered for listing as endangered or threatened) include the sand tiger shark, Warsaw grouper, and goliath grouper.	Addressed in Subsection 4.3.3, Protected Species.
Underwater Noise; Protected Species	0008-5	NRDC	In particular, the risk that animals exposed to explosive noise will later succumb to ship-strikes or entanglements has been documented in the literature and cannot be ignored.	Addressed in Subsection 4.3.3, Protected Species
	0005-11	AWI	What will be your operative definition of level B harassment?	Addressed in Subsection 3.3.5, Underwater Sound/Subsection 4.3.3, Protected Species.
Marine Habitats	0007-2	FDEP	The DEP notes that the proposed activities may have potential to directly or indirectly affect water quality and benthic habitat. Chemical and physical components that will enter water column from additional testing should be evaluated for impact to water quality, including fate and transport	Addressed in Subsection 4.3.1, Marine Habitats.
	0007-3	FDEP	Hardbottom habitat and other benthic habitat (natural and artificial reef structures) that support fish and/or invertebrate populations should be identified in the Draft EIS and avoided during testing activities.	Addressed in Subsection 4.3.1, Marine Habitats.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Special Biological Resource Areas	0008-6	NRDC	It can reasonably be anticipated that activities within the NWCPC may have both direct and indirect effects on the resources and values of the preserve (St. Andrew State Recreation Area). The Navy must therefore consider these effects. Potential conflicts with any other federal, state, or local policies governing use of the area must also be discussed.	Addressed in Chapter 6, Cumulative Impacts and Other NEPA Considerations.
Protected Species	0008-7	NRDC	The GOM is home to several species of dolphins that have had significant stranding events and the possibility of link between naval activities and a coincidental mass stranding in March 2004 is under investigation.	Addressed in Subsection .3.3, Protected Species.
Marine Life	0002-1	Private Individual	The waters of the GOM, the skies, estuaries, and beaches that provide habitat for several endangered species will be effected in a very negative manner.	Addressed in Subsection 4.3.3, Protected Species, and Subsection 4.3.1, Marine Habitats.
Protected Species	0008-8	NRDC	The federal Endangered Species Act, 16 U.S. C §1531 *et seq.* requires the Navy to enter into formal consultation with the National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service and receive a legally valid Incidental Take Permit prior to its "take" of any endangered or threatened marine mammals or other threatened or endangered species, including fish, sea turtles, or birds, or its "adverse modification" of critical habitat.	Addressed. Initial meeting with NMFS requesting them to participate as a cooperating agency was conducted on 01/27/05.
Socioeconomics	0017-1	MMS	The proposed Navy activities will occur in areas where MMS currently has Eastern GOM leases as well as where we expect to have additional leases in the future.	Addressed in Subsection 4.4.1, Socioeconomics.
	0016-1	MBARA	Denial of access by fishermen and divers of GOM areas of interest due to military exercises.	Addressed in Subsection 4.4.1, Socioeconomics.
Artificial Reefs	0016-2	MBARA	Use of explosives in the proximity of natural reef areas and artificial reefs.	Addressed in Subsection 4.3.14, Marine Habitats, and Chapter 5, Mitigation and Protective Measures.
Safety	0008-9	NRDC	The effects of this proposed expansion of NSWC PCD RDT&E activities on human divers must be incorporated into the EIS.	Addressed in Subsection 4.4.4, Safety.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Affected Environment	0008-10	NRDC	The preparer of an EIS must make every attempt to obtain and disclose data necessary to its analysis.	Addressed in Section 3.2, Marine Resource Assessments.
Environmental Consequences	0008-11	NRDC	Throughout the document, the agency is required to "insure the professional integrity, including scientific integrity," of its discussions and analyses.	Addressed in Chapter 4, Environmental Consequences.
	0008-12	NRDC	The EIS must carefully investigate, describe, and analyze potential impacts to the affected environment and to all species that may be impacted, including, but not limited to, marine mammals, sea turtles, fish, invertebrates, sea birds, and human divers. Marine mammals should clearly not be the sole focus of the analysis.	Addressed in Chapter 4, Environmental Consequences.
Scientific Uncertainty/ Environmental Consequences	0018-1	Individual at Scoping Meeting	I want to question how you're going to deal with the question of bias, because the Navy has such a reach that 70 percent of all marine scientists in the country are funded at least part of the time. By the Navy, and 50 percent worldwide, so I think addressing that bias is very large problem area to gain confidence. If this is truly the facts, that should be addressed.	Noted.
Scientific Uncertainty/ Environmental Consequences	0008-13	NRDC	Where uncertainty exists, the data gaps must be filled or, if they cannot be filled, clearly discussed and explained, together with the underlying risks. The simple assertion that "no information exists" will not suffice: unless the cost of obtaining the information is exorbitant, NEPA requires the essential information to be obtained. If the costs are deemed excessive, then the EIS must explain the relevance of incomplete information, summarize existing credible scientific evidence on the issue, and evaluate impacts using theoretical approaches or research methods that are generally accepted in the scientific community.	Addressed in Chapters 3 and 4.
CZMA	0008-14	NRDC	The federal consistency provisions of the Coastal Zone Management Act, govern the resources off the coast and also apply.	Addressed in Coastal Zone Consistency Determination Appendices I & K.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Mitigations	0005-4	AWI	What mitigation measures do you propose for reducing the effects of active sonar testing on marine mammals, fish, and turtles? For detonations of explosives? For electromagnetic devices?	Addressed in Chapter 5, Mitigation and Protective Measures.
	0005-5	AWI	Would curtailment of your testing activity be considered as one mitigation measure?	Addressed in Section 2.2, Alternative Development
	0008-15	NRDC	A thorough and well-planned monitoring program is essential, not only to keep such vulnerable species as marine mammals and sea turtles away from planned activities, but also to assess activities' indirect impacts and behavioral effects and to make appropriate changes in management if unforeseen impacts are observed.	Addressed in Chapter 5, Mitigation and Protective Measures.
Mitigations Cont'd	0008-16	NRDC	The Navy must consider ways to mitigate activities' impacts, including but even in addition to the fundamental step of sitting them in areas with low marine mammal and endangered species abundance. These measures should include, without limitation, seasonal and year-round exclusion zones, operational restriction, modifications to acoustic and other technologies, site remediation, reductions in activities, and the establishment of an independent, publicly inclusive committee to review environmental management practices during the life of the range.	Addressed in Chapter 5, Mitigation and Protective Measures.
	0016-3	MBARA	… In our judgment, military operations would be performed at least 50 miles offshore and perhaps more if close to reefs used by the recreational community.	Addressed in Chapter 5, Mitigation and Protective Measures.
	00016-4	MBARA	We propose that military operations be conducted in waters not used by fishermen and divers, such as areas in water sufficiently offshore and away from natural reef bottom and artificial reefs.	Addressed in Chapter 3, Affected Environment, Subsection 4.4.1, Socioeconomics and Chapter 5, Mitigation and Protective Measures.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Cumulative Impacts	0008-17	NRDC	Consider at least the cumulative impacts of (1) all the proposed activities at NSWC PCD taken together, (2) other military activities in the region, (3) watercraft in the region, and (4) industrial and commercial activities such as fishing, shipping, and – importantly –ongoing seismic explorations activities undertaken by the oil and gas industry that may impact the same populations of animals.	Addressed in Chapter 6, Cumulative Impacts and Other NEPA Considerations.
	0008-18	NRDC	Take into account their [see comment 0008-17] indirect effects, which, though reasonably foreseeable, may occur later in time or at a farther remove. This requirement is particularly critical in the present case given the potential of underwater noise to cause indirect harms not clearly observable in the short or immediate term, such as shifts in abundance or distribution of prey species and secondary effects of hearing loss.	Addressed in Chapter 6, Cumulative Impacts and Other NEPA Considerations.
Cumulative Impacts Cont'd	0008-19	NRDC	Considering both the cumulative effects of various sources of noise on the natural resources of the area and the synergistic effects of such acoustic impacts together with other environmental stressors, such as chemical pollution, habitat degradation, fishing bycatch, and ship strikes.	Addressed in Chapter 6, Cumulative Impacts and Other NEPA Considerations.
Marine Species, Protected Species	0018-2	Individual at Scoping Meeting	I want to plan and one of the things you said, Carmen, is how do we plan for these resources. I'm not sure if you're referring to that bio that's the resources or the what is the resources. I just want to point out that not all see all creatures on earth as resources. We see them as independent life forms of their own and not necessarily here for us to use.	Noted.
	0018-3	Individual at Scoping Meeting	Establishing the beginning for your baselines to deal with, and how you going to research what the same pre-exploitation level, or pre-development level of populations we have already out there.	Addressed in Subsection 4.3.3, Protected Species.
	0018-4	Individual at Scoping Meeting	Where do you pick as a starting point? Do you pick it now? Do you pick when the base opened? Do we try to figure out what lived here once upon a time?	Addressed in Subsection 4.3.3, Protected Species.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Protected Species / Non-protected Species	0018-5	Individual at Scoping Meeting	Is your intent to cause no increased environmental damage, no increased death of fish, turtles, marine mammals? Is that the intent or is it to ameliorate the effect; to reduce it as much as you can and still carry out the mission as you wish?	Addressed in Subsection 1.4, Regulatory Compliance.
Proposed Action	0005-16	AWI	What activities would be included in this blanket EIS?	Addressed in Section 2.1, Proposed Action.
Falls outside the scope of NSWC PCD EIS	0005-6	AWI	Do you embrace the Zero Mortality Rate Goal (ZMRG)?	Noted.
	0005-7	AWI	In what ways do you see your activities constrained by the National Environmental Policy Act and Endangered Species Act, and the Marine Mammal Protection Act? How has this changed with the passing of the DOD exemptions to the ESA and MMPA last year?	Outside scope of EIS/OEIS.
Falls outside the scope of NSWC PCD EIS Cont'd	0005-8	AWI	What would be omitted (for example- was an EIS filed or an incidental take permit requested from NMFS before launching the exercise of the USS John F. Kennedy and its task force this year)? Which operations would entail separate take permits or EIS?	Activities included addressed in Chapter 2, Proposed Action and Alternatives
	0005-9	AWI	What, if any, invasive research requiring either tagging or capture of cetaceans will be done to determine whether damage is occurring? For fish? For turtles?	Not part of the Proposed Action of this EIS/OEIS.
	0005-10	AWI	Can non-governmental organizations be notified of the details of activities (including dates, locations, and times) such that independent observations can be made about the potentially hazardous and/or lethal consequences to marine life of each such activity?	Noted.
	0008-20	NRDC	The Navy must also give full consideration to alternatives that train Navy personnel through means other than expansion of this range.	Noted.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Falls outside the scope of NSWC PCD EIS Cont'd	0008-21	NRDC	Provide deep-sea and coastal observation and monitoring for acoustic activities, a well-funded response and reporting system for marine mammal strandings, and a means of investigating unusual mortality events, such as fish kills. Details of the monitoring program, including funding and identification of non-Navy individuals, organizations, or agencies conducting the program, should be fully disclosed in the EIS.	Noted.
	0008-22	NRDC	The analysis of alternatives must be objective, unbiased and searching. In addition to the "no project" alternative, the EIS should address not only alternative scales of expansion of training activities at NSWC PCD generally, but also alternative methods (other than wholesale expansion of activities at this facility) for accomplishing the goal of force readiness.	Addressed in Subsection 1.4, Regulatory Compliance.
Falls outside the scope of NSWC PCD EIS Cont'd	0008-23	NRDC	Because this expansion proposal has almost certainly been developed primarily within the United States, NEPA, rather that the Executive Order, gives rise to the Navy's legal obligations here an the scope and process of environmental review must be wholly consistent with its provisions. We would hope that the Navy reconsiders its position at the beginning of this process, so as to avoid any future inconsistency with the governing statute.	Noted.
	0018-6	Individual at Scoping Meeting	I'm concerned because I am the victim of having gone through one of your earlier EIS of the Navy, and that's dealing with the low-frequency active sonar. That the process not be done like that one. There were over ten thousands comments from the public on that system, and many were answered in a way such as, it is this way because it is this way rather than really describing or really breaking down the answer. And I request that questions are truly answered in this EIS.	Noted.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/Individual	Comment*	Response
Falls outside the scope of NSWC PCD EIS Cont'd	0018-7	Individual at Scoping Meeting	What activity's now getting EA, or don't, and for what reason, and what ones will be included under this umbrella EIS as far as seasonal activities such as that which didn't seem to really be covered in your normal?	Refer to Chapter 2, Proposed Action and Alternatives.
Protected Species	0007-4	FDEP	FDEP references FWC letter that the proposed activities may potentially cause adverse impacts to rare and endangered cetaceans and sea turtles as well as endangered west Indian manatee.	Addressed in Subsection 4.3.3, Protected Species.
	0006-1	FWC	During the summer months, the endangered West Indian manatee (*Trichechus manatus*) may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the GOM.	Addressed in Subsection 4.3.3, Protected Species.
	0005-12	AWI	How do you propose to establish a baseline of original populations of creatures living within your test areas in order to ascertain the health of present and future populations?	Addressed in Subsection 4.3.3, Protected Species
Non-protected Species	0005-13	AWI	What will be the response of your office if it is determined that damage is occurring to wildlife in the test area? Suspend operations? If so, for how long?	Addressed in Chapter 5, Mitigation and Protective Measures.
	0008-24	NRDC	The MMPA requires all federal agencies to obtain a permit or other authorization from the Nation Marine Fisheries Service or U.S. Fish and Wildlife Service prior to any "take" of marine mammals, whether on high seas or in waters under U.S. jurisdiction. The Navy is not exempt from this requirement.	Addressed.
	0006-2	FWC	Given the nature and scope of these activities, there will potentially be adverse impacts to cetaceans that have been documented to reside within the Northern GOM continental shelf, or to utilize it as part of their migratory pathway. This group includes several rare and imperiled species such as the northern Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Metaptera novaeangliae*), blue whale (*Balaenoptera nuscculus*), and false killer whale (*Pseudorca creassidens*).	Addressed in Subsection 4.3.3, Protected Species.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Protected Species, Marine Mammals	0006-3	FWC	Five of the world's seven sea turtle species are found in the GOM. These include the endangered Kemp's Ridley (*Lepidochelys kempii*). Leatherback (*dermochelys coriancea*), hawksbill (*Eretmochelys imbricate*) and green (*Chelonia mydas*) sea turtles as well as the threatened loggerhead (*Caretta caretta*).	Addressed in Chapter 3, Protected Species.
	0003-1	FL SHPO	We look forward to receiving the document and coordinating with the Dept. of the Navy regarding cultural resources that may be impacted by this project.	Noted.
Underwater Noise	0008-26	NRDC	With regard to noise producing activities, for example, the navy must describe source levels, frequency ranges, duty cycles, and other technical parameters relevant to determining potential impact on marine life.	Addressed in Subsection 4.3.3, Protected Species, and Appendix M, Supplemental Information for Underwater Noise Analysis.
Public Participation	0005-14	AWI	To what degree will public input be considered in deciding to embrace the No Action Alternative or Alternative 1 or 2?	Addressed in Chapter 7, Statement of Public Participation.
	0005-15	AWI	Are we correct in understanding that there will be public hearings to solicit comments after the release of your draft EIS?	Addressed in Chapter 7, Statement of Public Participation.
	0006-4	FWC	Receiving of the NOI	Noted.
	0006-5	FWC	Copy of draft EIS	Noted.
	0007-5	FDEP	Receipt of NOI	Noted.
Public Participation Cont'd	0007-6	FDEP	All subsequent environmental documents prepared for the project must be reviewed to determine the project's continued consistency with the FCMP.	Noted.
	0013-1	Private Individual	Concerned Citizen**	Noted.
	0014-1	Private Individual	Concerned Citizen	Noted.
	0015-1	Private Individual	Concerned Citizen	Noted.
	0008-25	NRDC	Disclosure of the specific activities contemplated by the Navy is essential if the EIS process is to be a meaningful one.	Addressed in Chapter 7, Statement of Public Participation.

Table 7-2. Responses to Public Scoping Comments (Cont'd)

Issue Category	Letter #-Comment #	Agency/ Individual	Comment*	Response
Agency Coordination	0017-2	MMS	All of the leases in the area of the proposed Navy activities already have or will have a military stipulation which requires coordination with military officials responsible for activities in the relevant military warning areas. MMS made a phone call to the Navy and confirmed that the proposed Navy activities will be conducted through the same offices that MMS consults with as per that military stipulation.	Addressed.
	0017-3	MMS	Our standard military stipulation coordination requirement should handle any space-use conflicts between oil and gas leases and the proposed Navy activities. Nonetheless, the MMS would like to be kept abreast of any future updates or documents related to this Navy proposal.	Noted.
Request for Information	0006-6	FWC	Copy of draft EIS	Noted.
	0009-1	Private Individual	Requesting copy	Noted.
	0010-1	Private Individual	Requesting copy	Noted.
Request for Information	0011-1	Individual	Requesting copy	Noted.
	0012-1	Individual	Requesting copy	Noted.

AWI = Animal Welfare Institute; FDEP = Florida Department of Environmental Protection; FWC = Florida Fish and Wildlife Commission; MBARA = Mexico Beach Artificial Reef Association; MMS = Minerals Management Service; NRDC = National Resources Defense Council
*All comments appear exactly as submitted through oral or verbal comment by the individuals, organizations, and agencies.
**General comments included interest letters from individuals that provided no direct questions or inquiries in one or more particular subject areas.

The Draft EIS/OEIS will be distributed to federal, state, and local agencies, local organizations, and those individuals and organizations that signed up for a copy at the public meetings. The document will also be made readily available on the aforementioned website and in the information repositories.

7.3 PUBLIC HEARINGS AND COMMENTS

Upon release of the Draft EIS/OEIS, the U.S. Environmental Protection Agency (USEPA) placed a notice of availability in the *Federal Register* on April 11, 2008. The document was circulated for review and comment through May 19, 2008, to government agencies and to those persons and organizations that were interested or affected. The Draft EIS/OEIS was also made available for general review in public libraries, as well as the website. The purpose of the public process on release of the Draft EIS/OEIS was to obtain input on the environmental analysis relevant to the Proposed Action and alternatives including a No Action Alternative.

Public hearings were held following the release of the Draft EIS/OEIS to seek additional public comments on a variety of issues, including the range of alternatives considered and their associated impacts, accuracy and completeness of data, and analytical conclusions. NSWC PCD hosted public hearings on the following dates at the specified locations:

- May 5, 2008 Panama City, FL
- May 6, 2008 Pensacola, FL
- May 7, 2008 Port St. Joe, FL

The dates and locations of the public hearings were included in the notice of availability, as well as in advertisements in the *Panama City News Herald*, the *Pensacola News Journal*, and the *Northwest Florida Daily News*. Formal notification of public hearings and the availability of the Draft EIS/OEIS was also made in letters distributed to federal, state, and local agencies and officials, and interested groups and individuals.

Public hearings followed the scoping meeting formats and consisted of a two-part session. From 6 to 7 p.m., guests were invited to examine display boards about NSWC PCD, the alternatives, the acoustic analysis, and the environmental impacts from the NSWC PCD RDT&E activities. Fact sheets were also provided at each station that gave detailed information about NSWC PCD RDT&E activities, the environmental analysis, and the public involvement and input process. At the registration table at all hearings, attendees were asked to sign-in and encouraged to sign up for copies of the Final EIS/OEIS, to submit their name for oral comment, and to make written comments.

During the second portion of the meetings, Navy representatives made a formal presentation. The presentation included information on NSWC PCD, the proposed action and alternatives, the acoustic and non-acoustic environmental impact analysis, and the proposed mitigations and monitoring. Following the formal presentation, the public was invited to share their comments.

In addition to the hearings, the public website identified in Section 7.2 *Scoping Process* was maintained to provide information on the effort throughout the process. NSWC PCD also provided access to an electronic copy of the Draft EIS/OEIS here. All interested entities were encouraged to visit the website, as well as the local information repositories identified in Section 7.2 *Scoping Process.*

Comments were accepted during the Draft EIS/OEIS public comment period in four forms.

(1) Oral comments during the hearings captured by a court reporter.

(2) Written comments submitted at the public hearing.

(3) Written comments mailed to the NSWC PCD EIS/OEIS Environmental Lead.

(4) Electronic comments emailed to the NSWC PCD EIS/OEIS Environmental Lead.

Comments were received from a variety of agencies, organizations, and individuals. Table 7-3 provides detailed information on the commenting entity, the comment listed verbatim as received, and the inclusion of the comment. Appendix N contains copies of the original letters.

7.4 FINAL EIS/OEIS AND RECORD OF DECISION

A Final EIS/OEIS will be prepared that incorporates and formally responds to all public comments received on the Draft EIS/OEIS. Responses in the Final EIS/OEIS may include modifying the alternatives including the Proposed Action; developing and evaluating alternatives not previously given serious consideration; supplementing, improving, or modifying the analysis; making factual corrections; and explaining why comments do not warrant further response. The notice of availability of the Final EIS/OEIS will be published in the *Federal Register,* thereby beginning a 30-day public review cycle.

A Record of Decision (ROD) will be issued no less than 30 days after the Final EIS/OEIS is made available and will be published in the *Federal Register* and local newspapers. The ROD will be a concise summary of the decision made by the Navy from the alternatives presented in the Final EIS/OEIS. Specifically, the ROD will state the decision, identify alternatives considered (including that which was environmentally preferable), and discuss other (nonenvironmental) considerations that influenced the decision identified. The ROD will also describe the intended implementation of all practical measures to avoid impacts resulting from the chosen alternatives and explain any decision behind the nonimplementation of any of these means. Once the ROD is published, public involvement is considered complete and the Navy can implement the Proposed Action.

7.5 CONCLUSION

The purposes of this public involvement program are (1) to fulfill the requirements of NEPA; (2) to determine the environmental issues of concern to be addressed; (3) to identify the significant public and regulatory issues related to the Proposed Action; and (4) to provide for the participation of interested persons, organizations, and agencies. In addition, public involvement was designed to inform interested stakeholders, to develop trust and credibility, and to avoid misunderstandings through a mutual exchange of information. The high level of effort to keep the public informed in turn provides interested individuals the opportunity to express their concerns and have those concerns considered throughout the decision making process.

Table 7-3. Responses to Comments on the Draft EIS/OEIS

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
1	1	Private Citizen	N/A	N/A	FAR TOO OFTEN THE US NAVY HAS BEEN RESPONSIBLE FOR CAUSING HEMORRHAGES IN WHALES BRAINS AND IN THE BRAINS OF OTHER MARINE LIFE. FAR TOO OFTEN THE US NAVY HAS BOMBED THE HELL OUT OF GOD'S CREATURES SIMPLY TRYING TO EXIST IN THE OCEAN. IT IS TIME TO STOP THAT.	Thank you for your comment.
1	2	Private Citizen	1	1.1/1.2	THE US NAVY SHOULD START PRACTICING MORE IN SIMULATION AND STOP BOMBING THE HELL OUT OF THE US MAINLAND AND ENVIRONS.	See Sections 1.1 Purpose and 1.2 Need
1	3	Private Citizen	N/A	N/A	WE ARE ALL TIRED OF THE DAMAGE DONE TO THIS EARTH AND TO GOD'S CREATURES BY THE US NAVY. THEY THINK NOTHING OF CAUSING DEATH. THIS IS COMPLETELY UNACCETABLE. I WANT THE US NAVY REINED IN.	Thank you for your comment.
2	4	Private Citizen	N/A	N/A	Duplicate letter - exact copy of letter #1.	See Letter #1.
3	5	Geo-Marine, Inc.	N/A	N/A	I would like to request a **CD copy** of the Draft EIS/OEIS for the Naval Surface Warfare Center Panama City Division (NSWC PCD) Mission Activities list in the April 9, 2008 Federal Register. Please send to the following address:Joseph B. Kaskey, Geo-Marine, Inc.; 2201 K Avenue; Suite A2; Plano, Texas 75074	NSWC PCD sent a CD to Mr. Kaskey.
3	6	Geo-Marine, Inc.	N/A	N/A	In addition, your website for the Draft EIS/OEIS for electronic public viewing cannot currently be accessed. Thank you for your time.	The website was fixed.
4	7	MMS	N/A	N/A	The Minerals Management Service, Gulf of Mexico Region would like the opportunity to review a copy of the Draft EIS/OEIS to determine if the proposed action will affect OCS Oil and Gas Activities in the Eastern or Central Planning Areas. I have reviewed your website for the subject Draft EIS/OEIS, but was unable to find an electronic copy on your website. Is it possible to receive an electronic PDF version of the EIS/OEIS? If not, I would like to receive a hard copy to review. Thank you for your assistance.	NSWC PCD sent a CD to the MMS Gulf of Mexico Region representative.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
5	8	MMS	N/A	N/A	Duplicate letter - exact copy of letter #4.	See Letter #4.
6	9	MMS	N/A	N/A	Our office will prepare a letter to provide updated information to the NSWC regarding MMS lease sales in the Gulf of Mexico.	NSWC PCD looks forward to receipt of updated information.
6	10	MMS	N/A	N/A	Also, please add me to the mailing list for Scoping and public notices for Navy projects as well as to receive digital or electronic copies of draft and final NEPA documents, including the GOMEX and AFAST documents.	MMS Gulf of Mexico Region representative was added to the mailing list. NSWC PCD forwarded contact information and request to AFAST and GOMEX teams.
6	11	MMS	N/A	N/A	A Marine Resources Assessment was prepared for the Gulf of Mexico for the Department of the Navy. Was a Marine Resource Assessment also prepared for the Atlantic as well. If so, could you send me a link the information? Thanks.	NSWC PCD forwarded this request to AFAST team.
7	12	DOI	7	-	The Department of the Interior has reviewed the draft EIS for the Naval Surface Warfare Center Panama City Division, Florida. The following comments are offered for your consideration. Chapter 10, List of References, page 10-21 The link provided for "USGS, 2006" contains a typographical error; the correct link is: http://capp.water.usgs.gov/gwa/ch_g/G-Floridan.html.	The EIS/OEIS does not contain this reference (USGS, 2006). The Ground Water Atlas of the United States was not cited.
7	13	DOI	N/A	N/A	Thank you for the opportunity to review and comment on this DEIS. If you have any questions concerning these comments, please contact Lloyd Woosley, Chief of the USGS Environmental Affairs Program, at (703) 648-5028 or at lwoosley@usgs.gov. You can reach me at 404-331-4524 if you should have any questions or comments.	Contact information was added to the mailing list.
8	14	USEPA, Region 4	4	-	Strengthen the Environmental Effects/Impacts chapter (chapter #4). This chapter is the most important part of the EIS/OEIS.	Specific information is given by the agency in this comment letter and the EIS/OEIS was updated as reflected in comment resolutions.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
8	15	USEPA, Region 4	4	-	It needs more scientifically-substantiated conclusions and demarcations where the science/data/environmental information is lacking or so limited that making environment-impacts related conclusions/determinations is impossible.	NSWC PCD has made conclusions stronger in chapter 4. All NEPA conclusions in the EIS/OEIS are made using the best available scientific data.
8	16	USEPA, Region 4	4	-	Moreover, the NEPA analysis and findings should not be limited by or based solely on ESA or MMPA-designated species impacts as defined by the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA). For example, apply the information provided in both the Operations (chapter #2) and Affected Environment Chapter (#3) to the Environmental Consequences Chapter (#4). The described environmental impacts are generalized without relating to the specifics of the Study Area's environment, ecosystem, and biota.	In addition to ESA and MMPA-designated species, NSWC PCD analyzed potential effects to invertebrates (Section 4.3.2), fish (Section 4.3.3), EFH (Section 4.3.4), birds (Section 4.3.5). Additional topics included geology and sediments (Section 4.2.1), air quality (Section 4.2.2), water quality (Section 4.2.4), and anthropogenic resources (Section 4.4).
8	17	USEPA, Region 4	N/A	N/A	Expand existing operations performance-related environmental-data collection to include operations' environmental-impacts information so this information can be used in this and the next EIS/OEIS.	NSWC PCD included relevant information for line charges, AUV, and DDX events, as applicable. As years have gone by and issues elevated, data collections on environmental impacts is increasing. The operations will include standard data collection, which has not been required in previous years. As time and the science has evolved, the Navy has incorporated mitigation

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						measures in conjunction with operations. The Navy is currently spending over $15 million to research potential impacts to marine mammals, as this issue has been placed at the forefront of the scientific community.
8	18	USEPA, Region 4	4	-	Be more precise in language use.	NSWC PCD defined generalized terms throughout the EIS/OEIS to provide more clarification, where needed.
8	19	USEPA, Region 4	4	-	Be more direct in language use, for example the EIS/OEIS states that the small levels of electrical current generated (roughly equivalent to two car batteries) repreesents no danger of electrocution. The reader must assume this is associated with OASIS and is relevant to the statement that OASIS is unlikely to electrocute or be a source of lethality for biological resources (i.e., fish) near the electrode. Unclear from first paragraph that the EIS/OEIS is discussing OASIS. But since OASIS is mentioned for the first time in conjuction with the electrode discussion, (i.e., OASIS is unlikely to electrocute or be a source of lethality for biological resources) the reader must then assume OASIS is the topic of discussion.	NSWC PCD deleted specific references to OASIS and discussed electromagnetic operations in terms of general EMF systems.
8	20	USEPA, Region 4	4	-	EPA recommends the FEIS/FOEIS be more direct and minimize the reader's need to make assumptions and the opportunities for making inappropriate assumptions.	NSWC PCD defined generalized terms throughout the EIS/OEIS to provide more clarification, where needed.
8	21	USEPA, Region 4	N/A	N/A	The references and studies cited in the EIS/OEIS should be made available to the reviewer to allow the	All references provided are publicly available

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					reviewer complete access to the materials used to support the Navy's final position i.e., FONSI.	items that can be obtained from libraries, the Internet, and other widely accessible sources.
8	22	USEPA, Region 4	N/A	N/A	The reviewer should not be expected to accept the Navy's interpretation of its cited studies without some degree of verification. Acceptable availability would be to provide an electronic copy of these studies via a Cd Rom or an Internet address to these studies.	All references provided are publicly available items that can be obtained from libraries, the Internet, and other widely accessible sources. Navy MRAs are available on the EIS/OEIS website.
8	23	USEPA, Region 4	1	1.6	The EIS/OEIS states that NSWC PCD has developed a website: http://nswcpc.navsea.navy.mil/environmental/eis.asp to provide a forum for the dissemination of materials, data, and notices for this EIS/OEIS. As of 5/14/08 this site was not accessible nor was it accessible from the link, http://www.gomexrangecomplexis.com/, from the web page located at http://nswcpc.navsea.navy.mil/Environment.htm. EPA recommends this be addressed so that this information can be accessed or remove this statement from the FEIS/FOEIS.	The website location was updated and the site is functional. The EIS/OEIS document was updated to include directions on how to download the document in case the navigation pages were not clear.
8	24	USEPA, Region 4	1	1.5	Clarify the statement: actions that fall outside the scope of this document (i.e., those actions that may increase the effects or create new effects), would be addressed separately as they are proposed. It is unclear from the text provided what this means in terms of the EIS/OEIS and the proposed action.	Information in parentheses was deleted and "as identified in chapter 2 of this EIS/OEIS" was inserted.
8	25	USEPA, Region 4	4	-	Because of the current escalating concerns regarding the potential for human impacts toward accelerating climate change, the recommendation is being made that DON consider estimating its CO_2 emissions and investigating possibilities for incorporating measures to reduce or offset its CO_2 emissions.	The CAA analysis was conducted although it does not apply to activities offshore of the Gulf of Mexico. Section 6.7 *Energy Requirements and Conservation Potential*

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						was incorporated to address this comment.
8	26	USEPA, Region 4	4	-	Because of the current escalating concerns over increasing demands on limited existing energy sources and the call for development and use alternative energies, the recommendation is being made that DON discuss its energy strategies for addressing these issues.	Section 6.7 *Energy Requirements and Conservation Potential* was incorporated to address this comment.
8	27	USEPA, Region 4	4	-	EPA also recommends incorporating into the EIS/OEIS a direct discussion of energy efficiency measures/activities/opportunities.	Section 6.7 *Energy Requirements and Conservation Potential* was incorporated to address this comment.
8	28	USEPA, Region 4	N/A	N/A	NEPA is the basic national charter for environmental protection and important issues of environmental protection and important issues of environmental protection and quality include energy and resource use, efficiency, and conservation.	Section 6.7 *Energy Requirements and Conservation Potential* was incorporated to address this comment.
8	29	USEPA, Region 4	4	-	NEPA's regulations specifically require addressing in the discussion of environmental consequences: energy requiremetns and conservation potential of various alternatives and mitigation measures and natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures.	Section 6.7 *Energy Requirements and Conservation Potential* was incorporated to address this comment.
8	30	USEPA, Region 4	2	3	NEPA regulations require the EIS/OEIS to describe alternatives that reflect the development a range of alternatives that could reasonably achieve the identified need of the proposed action.	Section 2.3 addresses this comment.
8	31	USEPA, Region 4	2	3	This range of alternatives needs to be sufficient to address issues	Section 2.3 addresses this comment.
8	32	USEPA, Region 4	2	3	and suggest an environmentally preferred alternative. It is to NEPA §101 that the "environmentally preferred" alternative responds.	NSWC PCD will identify the environmentally preferred alternative in the ROD.
8	33	USEPA, Region 4	2	3	This draft EIS'/OEIS' alternatives analysis considered three alternatives: 1) no action as in current activities,	NSWC PCD examined a range of alternatives in

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					2) increasing the level of current activities and adding new activities (i.e., Alternative #1), and 3) increasing three-fold the activities described in 2) above (i.e., Alternative #2). The above identified range of alternatives may be too narrow to sufficiently explore environmental issues	Section 2.3 and chose alternatives that fit the purpose and need for the proposed action. A description of alternatives considered but eliminated from further analysis is included in Section 2.4.
8	34	USEPA, Region 4	2	3	and to suggest an environmentally preferred alternative.	NSWC PCD will identify the environmentally preferred alternative Navy policy in the ROD.
8	35	USEPA, Region 4	2	3	For example, the EIS'/OEIS' alternatives do not explore the location	NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. Section 1.3 *Purpose and Need* set forth the requirement to conduct tests in the NSWC PCD Study Area.
8	36	USEPA, Region 4	2	3	and timing aspects to the implementation of its activities i.e., avoiding potential impacts to spawning, juveniles, and adult marine bird, and other affected (non ESA and MMPA designated protected) species at certain life-cycle critical times.	NSWC PCD testing occurs year-round and is not seasonally determined. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.a to explain these

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						factors.
8	37	USEPA, Region 4	5	5.11	While the EIS/OEIS attempts to address the temporal-spatial (seasonal and geographic) issue, it does so on a limited basis: it is tailored MMPA and ESA.	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. (Duplicate comment)
8	38	USEPA, Region 4	5	5.11	Additionally, the protective measures appear to have caveats to their application, i.e., "other identified areas **may** be avoided due to potential effects to biological, economic, or social resources." However, consideration of potential effects to biological, economic, or social resources are the factors that should be part of the EIS'/OEIS' alternatives-development analysis.	NSWC PCD defined generalized terms throughout the EIS/OEIS to provide more clarification, where needed. (Duplicate comment)
8	39	USEPA, Region 4	5	5.11	EPA recommends the FEIS/OEIS discuss alternatives that consider the location and timing aspects to the implementation of its various operational activities.	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. (Duplicate comment)
8	40	USEPA, Region 4	5	5.11	Of interest is whether there are certain locations and timing (e.g., season) in the Study Area that are the best environmental alternative(s) for conducting the ordinance	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated information into Section 2.1 to explain these factors. NSWC PCD also identified non-territorial waters as the best locations for ordnance over 75 lbs to reduce potential environmental effects in Section 2.1.7. (Duplicate comment)
8	41	USEPA, Region 4	5	5.11	Projectile firing	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. NSWC PCD also identified non-territorial waters as the only location for projectile firing in Section 2.1.8. (Duplicate comment)
8	42	USEPA, Region 4	5	5.11	sonar	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated information into Section 2.1 to explain these factors. (Duplicate comment)

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
8	43	USEPA, Region 4	5	5.11	and/or electromagnetic field (EMF) operations	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated information into Section 2.1 to explain these factors. (Duplicate comment)
8	44	USEPA, Region 4	5	5.11	For example, the hypothetically best environmental alternative for conducting ordnance operations might be in the deepest part of the Study Area that is greatest distance from any designated marine protected area and estuaries when marine mammals are not known to be migrating, which hypothetically might be W-151's southern border outside the DeSota Canyon Closed Area.	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated information into Section 2.1 to explain these factors. NSWC PCD also identified non-territorial waters as the best locations for ordnance

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						over 75 lbs to reduce potential environmental effects in Section 2.1.7. (Duplicate comment)
8	45	USEPA, Region 4	3 & 4	3.4.3 & 4.3.2	**Ecosystem assessment lacking**: the EIS'/OEIS' environmental impacts analysis discusses only the impacts to individual organisms, in lieu of the actual near and offshore marine ecology, e.g., trophic levels or the food chain.	NSWC PCD added additional information in applicable sections of Chapters 3 and 4.
8	46	USEPA, Region 4	3 & 4	3.4.3 & 4.3.2	EPA recommends the FEIS/OEIS discuss the near and offshore benthic and pelagic invertebrates communities.	NSWC PCD added additional information in applicable sections of Chapters 3 and 4.
8	47	USEPA, Region 4	3 & 4	3.4 & 4.3	The organisms selected for evaluation were primarily either those deemed threatened or endangered species (e.g., ESA & MMPA).	NSWC PCD used ESA and MMPA-designated species as the most sensitive species to be affected by NSWC PCD activities. In addition to these ESA and MMPA-designated species, NSWC PCD analyzed potential effects to invertebrates (Section 4.3.2), fish (Section 4.3.3), EFH (Section 4.3.4), birds (Section 4.3.5).
8	48	USEPA, Region 4	3 & 4	3.4 & 4.3	The protective measures for marine mammals and sea turtles do not ensure a functioning near and offshore ecosystem, which provides the valuable ecosystem service: nursery to the GOM's fisheries on which the ESA & MMPA designated species depend upon for their survival.	NSWC PCD analyzed potential effects to fish (Section 4.3.3) and EFH (Section 4.3.4), and determined there would be no significant impacts, harm, or adverse effects to these resources. Additionally, NSWC PCD will implement appropriate

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						protective measures as identified in Chapter 5.
8	49	USEPA, Region 4	4	-	NEPA §101's emphases is on using all practicable means to create and maintain conditions where man and nature can coexist in productive harmony and the attainment of the widest range of beneficial uses of the environment without degradation.	NSWC PCD has developed mitigation measures to prevent any unnecessary environmental degradation.
8	50	USEPA, Region 4	4	4.3.2.1	For example, the EIS/OEIS speaks to "any "***small level***" of mortality caused by the NSWC PSD RDT&E activities involving detonations will most likely not be significant to the population as a whole given the "***localized effects***" of a small amount of NEW used in territorial waters." While the total invertebrate populations may not be seriously affected, however the ecosystem or communities might be impacted.	NSWC PCD incorporated a discussion of the different species potentially affected into Section 4.3.2.2. and examined the terms "small level" and "localized effects".
8	51	USEPA, Region 4	4	4.3.2.1	Because the environmental analysis lacks a community-ecosystem assessment focus, the effects of a small level of mortality to a certain level in the food chain, e.g., an entire invertebrate species serving a specific ecosystem purpose (e.g., trophic level) could have devastating effects up to the food chain, including birds and marine mammals. This issue is not discussed in the EIS/OEIS.	NSWC PCD addressed the invertebrate impacts in Section 4.3.2 and concluded that there would be no significant impact or harm to invertebrates. Therefore, there will be no significant impact or harm to the food chain.
8	52	USEPA, Region 4	4	4.3.2.1	EPA recommends the FEIS/OEIS define "small level" and "localized effects" to invertebrate populations be defined e.g., which species, what degree of harm or mortality and this mortality may affect the ecosystem they exist e.g., are they known to be a "keystone" species or serve an ecosystem function that may be disrupted	NSWC PCD incorporated a discussion of how one single species would not be wiped out and how mortality covers a range of various invertebrates into Section 4.3.2.
8	53	USEPA, Region 4	3	3.3.5.3	**Anthropogenic sources [of sound]:** the anthropogenic-sources information lacks specificity.	NSWC PCD researched the availability of information and incorporated new information into Section

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						3.3.5.3 and Appendix D.
8	54	USEPA, Region 4	4	4.3.1	**Special biological areas:** this section does not discuss the Crystal River National Wildlife Refuge (NWR) and only mentions the Big Bend Sea Grass Aquatic Preserve without describing both as foraging habitat for (and therefore attracting) manatees and sea turtle, which has implications to the proposed action. The Crystal River NWR may support the largest Florida manatee populations and provides critical habit for approximately 25% of the Nation's endangered manatee population. Furthermore, the Crystal River/Kings Bay area is one of two areas supporting growing Florida manatee populations. In warmer months the manatees spend most of hteir timeat sea while from October-March the colder water drives them inland to find warm water.	Big Bend Sea Grass Aquatic Preserve is outside the Study Area by 14 nautical miles (NM). Crystal River is 42 NM outside the NSWC PCD Study Area. Furthermore, activities are generally concentrated in W-155 and W-151. The W-470 area was only considered for effects analysis for flexibility.
8	55	USEPA, Region 4	4	4.3.1	EPA recommends the FEIS/OEIS add the Crystal River National Wildlife Refuge (NWR)	Crystal River is 42 NM outside the NSWC PCD Study Area. Furthermore, activities are generally concentrated in W-155 and W-151. The W-470 area was only considered for effects analysis for flexibility. (Duplicate comment.)
8	56	USEPA, Region 4	4	4.3.1	and provide more information on the Big Bend Sea Grass Aquatic Preserve to its "affected environment" and "environmental consequences" discussions.	Big Bend Sea Grass Aquatic Preserve is outside the NSWC PCD Study Area by 14 NM. Furthermore, activities are generally concentrated in W-155 and W-151. The W-470 area was only considered for effects analysis for flexibility. (Duplicate comment.)

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
8	57	USEPA, Region 4	4	3.4.1.3	**Special biological areas:** this sections does not discuss that St. Andrews Bay's sea grass beds contain sea grass species that constitute a large portion of manatees' diets, i.e., shoal, manatee, turtle, and widgeon grasses	NSWC PCD included information on St. Andrew Bay sea grasses in Section 3.4.1.4.
8	58	USEPA, Region 4	4	3.4.1.3	and that sea grass beds are important to manatee feeding sites. EPA recommends this information be added to the FEIS/FOEIS	NSWC PCD included information on St. Andrew Bay sea grasses in Section 3.4.1.4.
8	59	USEPA, Region 4	4	4.3.1	**Special biological areas:** the EIS/OEIS describes the specially designated marine managed areas (i.e., DeSoto Canyon Closed Area, Florida Middle Grounds, Madison-Swanson Spawning Site, Steamboat Lumps Spawning Site, and the Reef Stressed Areas) within the Study Area but does not elaborate on what the purpose of these areas and how the Proposed Action will affect these purposes and areas. EPA recommends this information be added to the FEIS/FOEIS.	NSWC PCD added the purpose of these areas where information was missing and discussed how NSWC PCD RDT&E activities will have no effect on their purposes because the Proposed Action does not affect fishing effort.
8	60	USEPA, Region 4	3	3.4.7	**Marine Mammals:** the EIS'/OEIS' statement that sightings of the endangered Florida manatee rarely occur west of the Wakulla River conflicts with the position that summer sightings in Alabama are common and that during summer months they may be found as far west as Texas.	NSWC PCD looked at websites provided and at the scientific literature and incorporated pertinent information into Section 3.4.7.
8	61	USEPA, Region 4	3	3.4.7	Furthermore, the introduction of power plants and paper mills in northern Florida, Louisiana, and Texas have given manatees an opportunity to expand their winter range to areas not previously frequented. EPA recommends this information be added to or clarified in the FEIS/FOEIS.	NSWC PCD looked at websites provided and at the scientific literature and incorporated pertinent information into Section 3.4.7.
8	62	USEPA, Region 4	3	3.1	**Sea Turtles:** this section correctly states that the Hawksbill turtle does not nest in the Study Area but Table 3-15 is unclear as to whether it occurs in the Study Area. Section 3.4.8 generally indicates that is one of five species that occur along the eastern GOM continental shelf. EPA recommends this information	NSWC PCD added a statement that this species does not regularly occur in the NSWC PCD Study Area.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					be clarified in the FEIS/FOEIS	
8	63	USEPA, Region 4	3	3.1	**Sea Turtles:** this section did not mention or provide turtle nesting data for the other Florida counties (Wakulla (St. George Island), Jefferson Taylor, Dixie, Levy, Citrus, Hernando, Pasco, & Pinellas) that border the eastern edge of the Study Area, i.e., W-470	Counties east of Franklin are more than 2.5 NM from the edge of the NSWC PCD Study Area. Therefore, the information is not warranted.
8	64	USEPA, Region 4	3	3.1 3.4.7	Moreover the Big Bend Seagrass Aquatic Preserve encompasses the coast of the four western counties mentioned above and is a foraging area for both turtles and manatee. EPA recommends this information be addressed in the FEIS/FOEIS.	Big Bend Sea Grass Aquatic Preserve is outside the NSWC PCD Study Area by 14 miles. Furthermore, activities are generally concentrated in W-155 and W-151. The W-470 area was only considered for effects analysis for flexibility. (Duplicate comment.)
8	65	USEPA, Region 4	3	3.5.3.3	**Artificial Reefs:** the EIS/OEIS provides confusing information regarding the Alabama Artificial Reef Program. First it is unclear as to why the Alabama reefs are not included in the EIS/OEIS when they appear to be included in Figure3-8 despite text stating otherwise.	NSWC PCD deleted statement that they are not included in the Figures.
8	66	USEPA, Region 4	3	3.1	Second, are just the "inshore reefs in Mobile Bay, Bon Secour Bay, and Mississippi Sound close to shore and inside the barrier reef system and not a factor in the military operations? Or are all the reefs outside of and including the barrier reef system considered not to be a factor?	NSWC PCD added "inshore" before "reefs" to the sentence: These reefs are close to shore, inside the barrier reef system, and would not be a factor in military operations in W-155 (includes Pensacola Operating Area).
8	67	USEPA, Region 4	3	3.5.3	And last, both Figure 3-8 and the associated Artificial Reef Text is unclear in explaining "Artificial Reef General Permit Area." For instance, the text states	NSWC PCD identified the five Florida areas in Section 3.5.3.1 and the

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					that Alabama maintains five artificial-reef general permit areas, which implies that Alabama permits them as part of its artificial reef program. However, Figure 3-8 depicts five additional areas off the Florida coast. Should the uneducated reader assume (incorrectly) that Alabama permits these or the USACOE? Because the text that actually speaks to the USACOE as regulating artificial reef construction is silent regarding Artificial Reef General Permit Area, it appears that is part of the Alabama Reef Program and that only those reefs outside these General areas require USACOE permits.	five in Alabama 3.5.3.2 to reduce confusion. Permitting for each state is discussed in their respective sections.
8	68	USEPA, Region 4	3	3.5.3	If that is the case, how does Alabama maintain Artificial Reef General Permit Areas off the FL coast? EPA recommends the above information be clarified in the FEIS/FOEIS.	Alabama does not maintain the areas off the Florida coast. Information on the Florida reefs is provided in Section 3.5.3.1.
8	69	USEPA, Region 4	4	4.3	**Birds:** the EIS/OEIS indicates that one of the two types of laser operations is the air-to-water mine identification but does not discuss potential impacts to birds, which fly and float on the water surface, from these laser operations. EPA recommends this issue be addressed in the FEIS/FOEIS.	NSWC PCD incorporated information on potential effects to birds from lasers in Section 4.3.5.3.
8	70	USEPA, Region 4	4	4.3.4	**Fisheries:** EPA recommends the FEIS/FOEIS address how the Proposed Action's operations impact the Gulf of Mexico Fishery Management Council's seven fishery management plans for coastal migratory pelagics, spiny lobster, reef fish, shrimp, stone crab, red drum, and coral/reefs and the designated marine management areas?	The Proposed Action will not impact FMPs. NSWC PCD RDT&E activities are not addressed in FMPs. Potential effects to the fish species are addressed in the fish section (Section 4.3.3).
8	71	USEPA, Region 4	4	-	**MMPA & ESA Coordination**: the EIS/OEIS states that the DON has initiated ESA § 7 and MMPA § 101 consultation with NOAA. However the environmental information related to this process is necessary for EPA to fulfill its CAA § 309 responsibilities (e.g.,	The LOA request is available on the NMFS website.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					reviewing and commenting on the adequacy of the environmental analysis and the proposed federal action's environmental impacts). EPA recommends this information be provided in the FEIS/FOEIS.	
8	72	USEPA, Region 4	2	2.1.6	**Environmental Consequences:** the EIS/OEIS states that surface, subsurface, air, laser, and electromagnetic operations would result in no effects to any one of the areas addressed including physical, biological, and anthropogenic sources. Is it accurate to say "no effect" or is "no effect" presume due to the absence of relevant science, data, and environmental information. If the latter, then this should be clearly stated. EPA recommends the FEIS/FOEIS clarify this issue.	Table 2-4 provides the summary of effects from chapter 4. NSWC PCD made conclusions stronger in chapter 4 All NEPA conclusions in the EIS/OEIS were made using the best available scientific data.
8	73	USEPA, Region 4	2	2.1.4	**Sonar Operations:** the EIS/OEIS in unclear that the towed arrays are on the surface or near the surface, as opposed to the sea-floor bottom. EPA recommends this FEIS/FOEIS contain a statement to that effect.	NSWC PCD added a statement that the arrays are towed in the water column in Section 2.1.4.
8	74	USEPA, Region 4	4	4.3.2.1 4.3.3.2 4.3.5.2 4.3.6.3	**Sonar Operations:** EPA recommends the FEIS/FOEIS discuss how does the Proposed Action's sonar operations compete with the background sonar use associated with other anthropogenic sources, i.e., commercial and private fisheries and academic sonar use?	NSWC PCD researched this topic and determined that the background underwater noise in the region is dynamic and depends, for example, on the characteristics of the ships that traverse the area; the sea state variability, the biological noise; and other contributors.
8	75	USEPA, Region 4	4	4.3.2.1 4.3.3.2 4.3.5.2 4.3.6.3	**Sonar Operations**: the EIS/OEIS does not discuss what the background underwater noise levels are in the Study Area	NSWC PCD researched this topic and determined that the background underwater noise in the region is dynamic and depends for example on the characteristics of the ships that traverse the area;

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						the sea state variability, the biological noise; and other contributors.
8	76	USEPA, Region 4	4	4.3.2.1 4.3.3.2 4.3.5.2 4.3.6.3	and how background compares with the "noise" associated with Proposed Action's sonar ops (and other relevant operations, e.g., ordnance surface vessel etc. Nor what the potentially "annoying" noise levels are (e.g., marine species most affects). EPA recommends the FEIS/FOEIS address the above.	NSWC PCD researched this topic and determined that the background underwater noise in the region is dynamic and depends for example on the characteristics of the ships that traverse the area; the sea state variability, the biological noise; and other contributors.
8	77	USEPA, Region 4	4	4.3.3.2	**Sonar Operations - fish:** the EIS/OEIS states that studies indicate that **most** of the marine fish studied are hearing generalists and have their best hearing sensitivity at or below 0.3 kHz. EPA recommends the FEIS/FOEIS define what "**most**" means in this context.	NSWC PCD reviewed with the original reference. The best available scientific information was incorporated to address this comment on "most".
8	78	USEPA, Region 4	4	4.3.3.2	**Sonar Operations - fish:** The EIS/OEIS states that "**few**" marine hearing "specialists" can detect sounds up to 4.0 kHz and some can detect above 120 kHz and for one of these species a gap in sound "hearing" exists between 3.2 kHz - 12.5 kHz. Two comments: first the EIS/OEIS does not define what "**few**" means in the context.	NSWC PCD reviewed with the original reference. The best available scientific information was incorporated to address this comment on "few".
8	79	USEPA, Region 4	4	4.3.3.2	And second are any of these "hearing specialists" likely to inhabit the Study Area?	NSWC PCD conducted research on fish hearing specialists and identified those that inhabit the NSWC PCD Study Area.
8	80	USEPA, Region 4	4	4.3.3.2	How will they likely to be affected?	NSWC PCD expanded this section based on the NUWC write-up/study.
8	81	USEPA, Region 4	4	4.3.3.2	E.g., how intense will the sonar operations be?	NSWC PCD included a note in Section 4.3.3.2.2

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						that the sonar operations will mostly be concentrated in the 118-235 dB range.
8	82	USEPA, Region 4	4	4.3.3.2	When are they likely to occur? EPA recommends the FEIS address the above.	NSWC PCD included information that sonar operations occur year-round and not on a seasonal basis in Section 2.1. (Duplicate comment.)
8	83	USEPA, Region 4	4	4.3.3.2	**Sonar Operations - fish:** care is needed with the EIS'/OEIS' language as the (No Suggestions) states that studies indicates most marine fish are haring generalists. The EIS/OEIS should be more precise with its language, e.g., most (define this term) of the species studied, i.e., fewer (define this term) than 100 species of the 27,000 known fish species, appear to be hearing generalists.	NSWC PCD reviewed with the original reference. The best available scientific information was incorporated to address this comment on "most" and "few". (Duplicate comment)
8	84	USEPA, Region 4	4	4.3.3.2	This statement is different than simply stating "most marine fish" and far less misleading.	NSWC PCD reviewed paper with references and incorporated best available scientific information to address this comment on "most" and "few". (Duplicate comment).
8	85	USEPA, Region 4	4	4.3.3.2	Additionally, the appropriateness of extrapolating from fewer than 100 fish species to cover the entire 27,000 fish species is questionable, particularly when MSA § 2 broadly defines "fish" to include other aquatic organisms not typically associated with the word, "fish," i.e., mollusks, crustaceans, and all other forms of marine animal & plant life, other than marine mammals and birds.	NSWC PCD used the best available scientific information on fish hearing. Furthermore, mollusks, crustaceans, etc are discussed in Section 4.3.2. *Invertebrates* (Duplicate comment.)
8	86	USEPA, Region 4	4	4.3.3.2	Another example, "*however,* ***most*** *marine fish species are not expected to* [be] *able to detect sounds in the mid-frequency range of the sonars used in the proposed action."* The [be] indicates that "be" is	NSWC PCD inserted "be".

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					missing and is necessary to complete this sentence	
8	87	USEPA, Region 4	4	4.3.3.2	and "most" needs defining and put in context of less than 100 fish species studied of a known 27,000 fish species. EPA recommends the FEIS/FOEIS clarify and address the above.	NSWC PCD used the best available scientific information on fish hearing and reviewed the original reference. The best available scientific information was incorporated to address this comment on "most". (Duplicate comment)
8	88	USEPA, Region 4	4	4.3.3.2	**Sonar Operations - fish:** the EIS'/OEIS' discussions of the sensitive species (e.g., herring and clupeids) are unclear as to whether these species are common in the study area	NSWC PCD added a statement of occurrence in NSWC PCD Study Area in Table 3-10.
8	89	USEPA, Region 4	4	4.3.3.2	and if so what protective measures (e.g., the use of low-frequencies and ultrasound) might be taken to clear the operational area prior to testing.	The use of low-frequencies or ultrasound is not included in this EIS/OEIS. No such mitigations are planned.
8	90	USEPA, Region 4	4	4.3.3.2	The EIS/OEIS only mentions ultrasound detecting clupeids (such as shad and menhaden) with distributions overlapping the NSWC PCD Study Area may have similar reactions to mid-frequency active sonar because of their similarities in hearing sensitivity - good information but where are these sensitive species in the Study Area	NSWC PCD added a statement of occurrence in the NSWC PCD Study Area in Table 3-10.
8	91	USEPA, Region 4	4	4.3.3.2	and where are they in relationship to the Proposed Action's operations?	NSWC PCD added a statement of their occurrence and distribution in GOM in Table 3-10.
8	92	USEPA, Region 4	4	4.3.3.2	Can these sensitive-species-dominated areas be avoided?	No.
8	93	USEPA, Region 4	4	4.3.3.2	What other fish known to inhabit the Study Area are known to be hearing "sensitive" or "generalists,"	Research and include information on hearing sensitive or generalists in

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						the NSWC PCD Study Area.
8	94	USEPA, Region 4	4	4.3.3.2	and of the known fish to inhabit the Study Area, which ones have "unstudied" hearing? EPA recommends the FEIS/FOEIS address the above identified issues.	NSWC PCD included statement that hearing capability data only exists for approximately 0.4 percent of all fish species in Section 3.4.4.4. .
8	95	USEPA, Region 4	4	4.3.3.2	**Sonar Operations - fish:** the EIS/OEIS states the only experiments showing mortality in fish have been investigations on juvenile hearing when exposed to intense mid-frequency. However, it does not define "mid-frequency"	NSWC PCD included frequency range used in that particular experiment in Section 4.3.3.2.1.
8	96	USEPA, Region 4	4	4.3.3.2	and does not discuss the potential environmental impacts associated with the specifics of the Proposed Action's proposed "mid-frequency" sonar use as described in Tables 2-1,2, & 3, in the Study Area. EPA recommends the FEIS/FOEIS address these issues.	NSWC PCD compared how the paper defines mid-frequency in comparison to the Navy.
8	97	USEPA, Region 4	4	4.3.3.2	**Sonar Operations - fish:** the EIS/OEIS states that individual juvenile fish with a swim bladder resonance in the frequency rage of the operational sonars, and especially hearing specialists such as some clupeid species may experience injury or mortality. But the EIS/OEIS does not describe how this is relevant to the Study Area.	NSWC PCD researched and included information on hearing sensitive or generalists in the NSWC PCD Study Area in Section 4.3.3.2.
8	98	USEPA, Region 4	4	4.3.3.2	In other words, the EIS/OEIS does not apply the information provided in Chapters 2 (proposed action specifics) and to the affected environment (Chapter 3) to determine the environmental impacts (i.e., Chapter 4). This is a reoccurring problem throughout Chapter 4 for all the Proposed Action's operations. EPA recommends the FEIS/FOEIS address the above identified issues.	NSWC PCD used the best available scientific information to make the conclusions in Chapter 4. Furthermore, portions of Chapter 4 were re-written to add clarity for the reader and to approach the analysis based on the description of the proposed action in Chapter

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						2 and the affected environment included in Chapter 3.
8	99	USEPA, Region 4	4	4.3.3.3	**Electromagnetic Operations:** the distinction should be made that previous research focused on undersea cables and chronic, continuous, and low level EMF emissions and contrasted with the EMF specifics of the proposed action	NSWC PCD included information on how the EMF emissions from the best available scientific information compares/contrasts with NSWC PCD activities in Section 4.3.3.3.
8	100	USEPA, Region 4	4	4.3.3.3	Moreover it is unclear what the Proposed Action's EMF effects may have on (studied or unstudied) sensitive species, e.g., mating and reproduction or can EMF (and sonar) operations facilitate aggressive behaviors, i.e., shark attacks? EPA recommends the FEIS/FOEIS address the above identified issues.	NSWC PCD included information on how the EMF emissions from the best available scientific information compares/contrasts with NSWC PCD activities in Section 4.3.3.3.1.
8	101	USEPA, Region 4	4	4.3.3.3	**Projectile Operations:** the EIS/OEIS speaks to using "rounds" and "projectiles" but does not describe the size volume, and the projected surface area of the sea floor in terms of communities affected (e.g., near or offshore benthic invertebrates that should be identified in the "affected environment" chapter) that could be covered by the spent portion of these rounds.	NSWC PCD included effects analysis on projectile operations effects to sediments and invertebrates in Section 4.3.2.4.3.
8	102	USEPA, Region 4	4	4.2.4.2	Additionally, the EIS/OEIS speaks to mining ammunition from the sea floor but does not discuss the potential environmental impacts of the mining or describe the mining action in any detail. EPA recommends the FEIS/FOEIS address the above identified issues.	NSWC PCD is not mining ammunition. Recovered pieces are retrieved from the surface of the sea floor.
8	103	USEPA, Region 4	2	2.3	**Operational-activity information:** the EIS/OEIS provides operational-activity information in terms of "*hours-per-year," "items-per-year,"* and *"rounds-per-year"* but provides limited information on the intensity, time, and location of these operations.	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. (Duplicate comment)
8	104	USEPA, Region 4	2	2.1.6	For example, is the 244 hours of laser operations under the No Action Alternative conducted every day of the year? Or are there certain months of the year when these operations are conducted?	No. Activities are given on a per year basis. NSWC PCD testing occurs year-round and is not seasonally determined. (Duplicate comment)
8	105	USEPA, Region 4	2	2.1.6	Another example, are the laser operations conducted through out the Study Area or are they confined to a certain geographical area?	NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. (Duplicate comment)
8	106	USEPA,	2	2.3.3	Similarly for the ordnance operations: "*rounds-per-*	No. NSWC PCD RDT&E

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
		Region 4			*year,*" will these be fired all in one place at one time? How many hours in involved with firing 3,624 rounds?	testing activities occur throughout the NSWC PCD Study Area, year-round and are not seasonally determined. Ordnance operations are measured as "items-per-year" not "hours-per-year".
8	107	USEPA, Region 4	2	2.3.3	Lastly, will these rounds be collected or left on the seafloor for marine scavengers to bioaccumulate these rounds and associated pollutants and put them into the food chain, e.g., the potential aquatic version of the "condor (bird) lead" issue? EPA recommends the FEIS/FOEIS address the above identified issues.	NSWC PCD addressed this comment in the invertebrate effects analysis for projectile operations in Section 4.3.2.4.3.
8	108	USEPA, Region 4	5	-	EPA applauds the inclusion of these protective measures in the draft EIS/OEIS. It notes they are primarily targeted to ESA & MMPA-designated species and does not consider communities of interest and the important food chain that supports the ESA & MMPA-designated species. The issue of concern is larger than "habitat" protection and touches upon the rationale for creating EFHs and Marine Management Areas. Hence, EPA's earlier recommendations that the FEIS/FOEIS include alternatives that explore environmentally preferred alternative for each other proposed action's operations to identify likely impacts to the near and offshore marine ecology, which might be addressed in an expanded version of this topic.	NSWC PCD RDT&E testing activities occur year-round and are not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated information into Section 2.1 to explain these factors. (Duplicate comment)
8	109	USEPA, Region 4	5	5.1	This section speaks to using visual surveys using people located in the highest points of ships and in airplanes that focus on surface water sightings of	No, this action is not feasible. Fish finders do not identify objects. They

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					actual marine mammals and sea turtles, or indicators for their potential presence, e.g., presence of large *Sargassum* rafts and large concentration of jelly fish (sea turtle indicators) and large flocks of birds and schools of fish (marine mammal indicators). Would the use of "fish finder" type sonar operated from small-craft operations an option to identify submerged marine life (e.g., whales and turtles and large schools of fish, or large fish schools) that may not surface and therefore not be identified in the visual surveys nor be in the vicinity of the targeted indicators but in the vicinity of potential ordnance and projectile firing operations?	merely show that something is there.
8	110	USEPA, Region 4	4	4.3.6.2	The proposed protective measures attempt to address ordnance operations effects on Gulf sturgeon migration from fresh to GOM waters during October and November, but does not (and EPA recommends that the FEIS/FOEIS) address general manatee migrations from GOM waters to inland waters for the winter months and from inland waters to GOM water for the summer months. Moreover these seasonal-transitional manatee migrations may be affected by more than the proposed action's ordnance operations. Furthermore, watercraft strikes tend to be the largest contributing factor to manatee mortality and the preferred alternative proposes 7,433 hours per year of surface vessel operations, when a 365-day year has 8,544 hours.	NSWC PCD researched regular occurrence of manatees in the NSWC PCD Study Area. Literature indicates that manatees are not typically seen in NSWC PCD Study Area (Duplicate comment.)
8	111	USEPA, Region 4	4	-	Concern exists over numerous instances of imprecise use of language particularly in the Environmental Effects/Impacts sections to substantiate the Navy's environmental impact findings. A few examples are identified below to illustrate this concern. EPA recommends that the FEIS/FOES define its generalities and be clear in its word choices.	NSWC PCD provided definitions where applicable. (Duplicate comment.)
8	112	USEPA, Region 4	4	4.3.3.2	In the sonar operations environmental effects upon fish discussion, the EIS/FOEIS states that studies	NSWC PCD defined the percentage. (Duplicate

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					indicate that "**most**" of the marine fish studied are hearing generalists without defining "**most**". Same is true for "**few**" in the statement: "**few**" marine hearing "specialists" can detect sounds up to 4.0 kHz, and best available fish hearing data exists for "**fewer**" than 100 of the 27,000 species of fish. The use of "**most**" and "**few**" fails to convey a sufficient level of detail to facilitate meaningful analysis.	comment.)
8	113	USEPA, Region 4	4	4.3.3.2	Additionally the statement, "*however, most marine fish species are not expected to [be] able to detect sounds in the mid-frequency range of the sonars used in the proposed action,"* is misleading as written. Best available fish hearing data exists for fewer (needs to be defined) than 100 of the 27,000 species of fish and suggest that for these studied fish, the preponderance (needs to be defined) of fish hearing occurs below 1 kHz. The EIS/OEIS should be more precise with its language, e.g., what number of fish species studied is not expected to detect sounds in the mid-frequency range (will they be able to detect high-frequency sounds? Is the answer known?). Do these fish inhabit the Study Area? EPA recommends that the FEIS/FOES address all similar examples to the above.	NSWC PCD used the best available scientific information on fish hearing, incorporated definitions and identified the fish in the NSWC PCD Study Area. (Duplicate comment.)
8	114	USEPA, Region 4	4	4.3.1.1.1	The EIS/OEIS states that RDT&E activities "***typically***" occur "***well seaward*** of estuarine and near shore environments." the language "**typically**" and "**well seaward**" are imprecise and fail to convey a sufficient level of detail to facilitate meaningful analysis. EPA recommends that the FEIS/FOEIS define the above generalities and all similar ones that are not identified in these comments.	NSWC PCD defined "typically" as approximately 80 percent. NSWC PCD also defined "well seaward" as beyond St. Andrews Bay and the inshore surf zone.
8	115	USEPA, Region 4	4	4.3.1.1.1 & 4.3.1.2.2	The EIS/OEIS speaks to RDT&E activities conducted in the near shore environment may "***temporarily***" increase "**minor**" wave action in estuarine areas. Sediment suspension will be "***temporary***" and "***local."*** How are these terms defined? Seconds? Feet? The language is imprecise and fails to convey a sufficient	NSWC PCD defined "temporarily" as how fast it settles. NSWC PCD defined "minor" (ex. 1 foot or less).

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					level of detail to facilitate meaningful analysis. EPA recommends that the FEIS/FOEIS define the above generalities and all similar ones that are not identified in these comments.	
8	116	USEPA, Region 4	4	4.3.2.2.1	The EIS/OEIS speaks to any **"small level"** of mortality cauesd by the NSWC PCD RDT&E activities involving detonations will most likely not be significant to the population as a whole given the "**localized effects"** of a small amount of NEW used in territorial waters.	NSWC PCD defined "small level" and "localized effects.
8	117	USEPA, Region 4	4	4.3.2.2.1	However, **"small level"** and **"localized effects"** lack a sufficient level of detail to facilitate meaningful analysis. Because the mortality is undefined, it is difficult to ascertain impacts to the ecosystem and its food chain see heading, **"Ecosystem assessment lacking**" in the *"Affected Environment*" section below. EPA recommends that the FEIS/FOEIS define the above generalities and all similar ones that are not identified in these comments.	NSWC PCD defined "small level" and "localized effects. (Duplicate comment).
8	118	USEPA, Region 4	4	4.2.4.1.4	In its discussion of water quality effects, the EIS states that "currently there are no **ecological** criteria for each constituent in non-territorial waters." The way the section is set up, the reader expects "**water quality**" criteria not ecological. EPA recommends that the FEIS/FOEIS clarify the above.	NSWC PCD replaced "ecological" with "water quality".
8	119	USEPA, Region 4	4	4.3.3.4.1	Another example is where the EIS/OEIS states, "*Operation of the laser at eye safe levels ensure that damage from laser wavelengths within the visible spectrum (400 - 700 nm) will not occur to the scales."* EPA recommends that the FEIS clarify levels for whom? Fish? Humans?	Human eye-safe levels were used for fish write-up and applied similar to sea turtle/marine mammal section. NSWC PCD clarified by using marine mammal/sea turtle write-up, where needed.
8	120	USEPA, Region 4	4	-	This concern based over the absence in the environmental effects discussion (chapter #4) of the application of the specifics associated with the Proposed Action's various operations (chapter #2) and the affected environment (chapter #3). Moreover,	NSWC PCD used the best available scientific information to make the conclusions in Chapter 4. Furthermore, portions of

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					insufficient operations specifics are provided in any chapter at a sufficient level of detail to facilitate meaningful analysis of potential environmental impacts. Additionally, information provided in the form of studies cited either are not applied or incompletely applied (i.e., compared and contrasted) to the specific facts of hte Study Area and the Proposed Action's operations. Consequently, the Environmental Effects discussion contains generalities to substantiate the Navy's environmental impact findings but limited as to specifics regarding the proposed action's actual environmental impacts. EPA Recommends that the FEIS/FOEIS address the issues identified above and illustrated in the following examples.	Chapter 4 were re-written to add clarity for the reader and to approach the analysis based on the description of the proposed action in Chapter 2 and the biological resources included in Chapter 3.
8	121	USEPA, Region 4	4	4.3.2.3.3	One example is the EIS'/FOEIS' application of two generalized statements: 1) approximately 96% of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost and 2) the potential for damage due to exposure to a laser beam below the water's surface decreases as the depth increases into one generalized conclusion: thus the potential for effects will be greatest at the surface and since the majority of the invertebrates live on the sea floor or in the sediment where the energy from a laser bean will be unlikely to reach due ot adsorption and scattering there will be no significant impact to invertebrates.	NSWC PCD used the best available scientific information to make the conclusions in Chapter 4. Furthermore, portions of Chapter 4 were re-written to add clarity for the reader and to approach the analysis based on the description of the proposed action in Chapter 2 and the biological resources included in Chapter 3.
8	122	USEPA, Region 4	4	4.3.2.3.3	A concern is the EIS'/OEIS' failure to define the relevant terms used in the generalized statements and omission of the Study Area's specifics. "Ocean" is undefined and it is not compared to the Study Area's specific characteristics. Numerous figures in the EIS/OEIS depict the study area's bathymetry such that it appears the predominant depth is less than 200 meters.	In this document the GOM (i.e., NSWC PCD Study Area) is the ocean. The majority of activities occurs from the mean high water line (MHWL) and out to the continental slope.
8	123	USEPA,	4	4.3.2.3.3	Does the above generalized statement apply to water	Yes.

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
		Region 4			depths of less than 200 meters?	
8	124	USEPA, Region 4	4	4.3.2.3.3	Will the laser operations be conducted in water depths less than 200 meters?	Yes.
8	125	USEPA, Region 4	4	4.3.2.3.3	Furthermore, water clarity (i.e., absence of turbidity) also significantly influences the laser beam's ability to penetrate and impact invertebrates.	NSWC PCD used the best available scientific information in making conclusions and took this point into consideration.
8	126	USEPA, Region 4	4	4.3.2.3.3	Also relevant is the surface area affected by laser beams (or repeated beams), which could be compared to the overall surface area of the affected sea floor and benthic inhabitants and any repetitiveness of the laser operations (i.e., will the same area be repeatedly affected) to provide the reader better information on the degree of seafloor that may be affected.	See discussion in Chapter 2 on how laser operations are conducted. Lasers will be used throughout the NSWC PCD Study Area and are used on platforms that travel over large areas. The same area will not be repeatedly affected.
8	127	USEPA, Region 4	4	4.3.2.3	As written the EIS/OEIS is unclear as to where and what water depths in the Study Area the laser operations will occur and therefore the EIS'/OEIS' existing discussion is not (and needs to be) relevant to the particulars of the Study Area. Consequently it is unclear how the EIS/OEIS makes the conclusion that there will be no significant impacts to invertebrates. To do this, one has to make a lot of assumptions (which have not been and should be clearly stated) to make the Navy's environmental impacts conclusions.	NSWC PCD clarified information, where needed.
8	128	USEPA, Region 4	4	4.3.3.3.1	Another example is the EIS' discussion of electromagnetic field (EMF) studies associated with offshore wind farms. There appears to be an absence in comparison between similar data metrics used in the Proposed Action (e.g., tesla and Gauss metrics) and that used in the offshore wind farm studies (e.g., volts/meter and Hz metrics). Without the use of comparable metrics, it is difficult to compare and contrast between the information provided in the wind farms studies and the Proposed Action to determine	NSWC PCD included information on how the EMF emissions from the best available scientific information compares/contrasts with NSWC PCD activities. (Duplicate comment.)

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					potential environmental impacts. In other words, an insufficient level of detail has been provided to facilitate meaningful analysis.	
8	129	USEPA, Region 4	4	4.3.3.3.1	Moreover, the EIS/OEIS does not make the distinction (contrast) between the chronic, continuous and low emissions nature of the EMF studied with the offshore wind farms with that of the Proposed Action, which might be more acute, episodic, and higher in intensity? These distinctions may be relevant, even if currently unknown/unstudied, to impacts on the marine biology. In other words, the offshore wind farms EMF generation studies are focused on the specific facts associated with wind farms and not with the Navy's surface-mine-countermeasure-testing related activities and therefore limited in relevance and applicability. The EIS/OEIS needs to inform as to how limited and relevant they are to the Proposed Action.	NSWC PCD included information on how the EMF emissions from the best available scientific information compares/contrasts with NSWC PCD activities. (Duplicate comment.)
8	130	USEPA, Region 4	4	-	It is scientifically appropriate to state when impacts are unknown rather than textually leapfrogging from unrelated studies of limited relevance and applicability to an unscientific conclusion of no significant impacts. The NEPA decision maker and public needs to know what is known and unknown and what this status means to the Proposed Action.	NSWC PCD made conclusions stronger in Chapter 4. All NEPA conclusions were made using the best available scientific data.
8	131	USEPA, Region 4	4	4.3.3.5	In the EIS/OEIS discussion of ordnance operations impacts to fish, it provides threshold information for physical injury to fish and invertebrates from detonations and generalized information on fish impacts, e.g., shock waves associated with underwater use of explosives has the potential to rupture swim bladders and blood vessels, tear fish tissues , and ruptures/hemorrhage the spleen, etc., in the proximity of the detonation source.	NSWC PCD used the best available scientific information to make the conclusions in Chapter 4.
8	132	USEPA, Region 4	4	4.3.3.5.1	The EIS/OEIS explains that the offshore-removal-of-oil-rigs related studies revealed a few generalities: at very close range, underwater explosions are lethal to most fish species regardless of size shape, or internal	NSWC PCD used the best available scientific information to make the conclusions in Chapter 4.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					anatomy leading to the generalized cause of death: internal bleeding associated with massive organ tissue damage. At longer range, fish species with gas-filled swim bladders (e.g., snapper, cod, and striped bass) are more susceptible than those without swim bladders (e.g., flounders and eels). Additionally, larger fish may be less susceptible than smaller fish. Open water pelagic fish (e.g., mackerel) may be less affected than reef fish.	
8	133	USEPA, Region 4	4	4.3.3.5.1	The EIS/OEIS has not taken the above information and applied it such that it is relevant to the Study Area and the Proposed Action. Absent is the application of this information to the specifics associated with the Proposed Action's operations (chapter 2) and the fish known to inhabit the area (chapter 3)? Moreover any estimations of the number of fish killed associated with the oil rig studies, e.g., number associated with the various net explosive weight categories proposed to be detonated in the Study Area would be useful. In other words, an insufficient level of detail has been provided to facilitate meaningful analysis.	NSWC PCD researched and compared the level of detonations for oil rigs with NSWC PCD activities and how it may compare to the amount of fish killed.
8	134	USEPA, Region 4	2	2.1	It is unclear where and how the various operations are occurring, e.g., the 3-dimnesion geographic territory: aerial extent, water depth, whether the same areas will be subjected to repeated laser beams, sonar operations, projectile firings, ordnance operations, etc., and whether and how nearshore and/or offshore benthic communities will be affected, birds, fisheries, etc.	NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated information into Section 2.1 to explain these factors. (Duplicate comment)
8	135	USEPA,	2	2.1.7	An exception to this observation is the depth	NSWC PCD RDT&E

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
		Region 4			component of the ordnance discussion regarding mine detonation and that discussion does not discuss the geographical where in relation to the different warning areas and SAB	testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. NSWC PCD also identified non-territorial waters as the best locations for ordnance over 75 lbs to reduce potential environmental effects. (Duplicate comment)
8	136	USEPA, Region 4	2	2.1.4	Another example, will sonar operations primarily occur in depths exceeding 200 meters?	No.
8	137	USEPA, Region 4	2	2.1.7	Will ordnance operations be focused off federally-owned coastal areas and which ones?	No. Only line charges occur off SRI, which is federally owned by the USAF.
8	138	USEPA, Region 4	4	-	And where the information is given it is not sufficiently discussed in the environmental impacts chapter. EPA recommends that the FEIS/FOEIS address the issues identified above.	NSWC PCD used the best available scientific information to make the conclusions in Chapter 4. Furthermore, portions of Chapter 4 were re-written to add clarity for the reader and to approach the analysis based on the description of the proposed action in Chapter

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						2 and the biological resources included in Chapter 3. (Duplicate comment.)
8	139	USEPA, Region 4	4	-	Two concerns exist: one is the identification of when science/data/environmental information does not exist or is too limited to determine whether a significant environmental impact (or environmental harm) will occur.	NSWC PCD made conclusions stronger in Chapter 4 All NEPA conclusions were made using the best available data. (Duplicate comment.)
8	140	USEPA, Region 4	4	-	The second is that this absence of science/data/environmental information not be portrayed to substantiate findings of no environmental significant impact (or harm).	NSWC PCD made conclusions stronger in Chapter All NEPA conclusions were made using the best available data (Duplicate comment.)
8	141	USEPA, Region 4	4	-	EPA recommends that the FEIS/FOEIS should clearly inform both the decision maker and the public as to what is or not and clearly indicate whether decisions are being based on unknown information. Where science/data/environmental information do not exist or are too limited to determine whether a significant environmental impact (or environmental harm) will occur, this should be so stated in lieu of making unsubstantiated findings of no significant impact (or harm). To do otherwise, is to fail to meet the NEPA obligation of informing the decision maker and the public.	NSWC PCD made conclusions stronger in Chapter 4. All NEPA conclusions were made using the best available data (Duplicate comment.)
8	142	USEPA, Region 4	4	4.3.2.3	If the most accurate conclusion is that the environmental impacts the use of laser (or sonar, etc.) within the study area on the invertebrate communities (or fish, turtles, etc.) in the area are unknown. This should be stated and why it is unknown. It is one thing to make a decision based on known science and quite another to make a decision based on unknown	The Navy concluded that there are not any reasonably foreseeable significant adverse effects. The Navy is mitigating against any effects.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					science.	
8	143	USEPA, Region 4	4	-	To implement NEPA's purpose, a decision maker and the interested public need to know and should be informed as to whether the decision is being made based on known science, the degree of confidence in the science's outcomes/conclusions, and the degree of the science's applicability to the proposed action, or when the science has not been done or lacking or limited and whether the available information is anecdotal.	NSWC PCD made conclusions stronger in Chapter 4. All NEPA conclusions are made using the best available data. (Duplicate comment.)
8	144	USEPA, Region 4	4	-	Furthermore, identifying the "unknown" allows for research priority setting and project design to fill in identified knowledge gaps, which is part of the NEPA's purpose, in "informing the public and decision maker."	All NEPA conclusions were made using the best available data. (Duplicate comment.)
8	145	USEPA, Region 4	4	4.3.3.3	For example, in the EIS'/OEIS' discussion of the EMF operations environmental impacts, it is unclear how the EIS/OEIS concludes that smalltooth sawfish and Gulf sturgeon will not be affected by the Navy's use of EMF. The clarity issue is caused by the information in the sentence immediately preceding this conclusion which states that "*the effects of EMF's on smalltooth sawfish and Gulf sturgeon are unknown; however based on the findings for sensitive species sensitive to electromagnetic fields the Navy finds its use of EMF will not affect smalltooth sawfish and Gulf sturgeon and there will be no NEPA significant impacts."*	NSWC PCD included a write-up in Section 4.3.3.3.1 that addressed the following questions: How similar are smalltooth sawfish and Gulf sturgeon compared to sensitive species? More or less? Where do they occur?
8	146	USEPA, Region 4	4	4.3.3.3	Moreover the EIS/OEIS is silent as to whether smalltooth sawfish and Gulf sturgeons' EMF sensitivities been studied.	NSWC PCD researched whether any new information exists and included updated information in Section 4.3.3.3.1
8	147	USEPA, Region 4	4	4.3.3.3	The EIS/OEIS only mentions the elasmobranches and flounder studies	NSWC PCD researched whether any new information exists and included updated information in Section

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						4.3.3.3.1
8	148	USEPA, Region 4	4	4.3.3.3	Furthermore the EIS/OEIS is silent as to whether the studied EMF-sensitive species have certain relevant bio-characteristics sufficiently similar to smalltooth sawfish and Gulf sturgeon to support the EIS'OEIS' conclusion of no significant impact to smalltooth sawfish and Gulf sturgeon or other marine species known to inhabit the Study Area.	A statement was included that NSWC PCD used information on the most sensitive species to analyze effects.
8	149	USEPA, Region 4	4	4.3.3.3	Additionally those species known to be sensitive to EMF are only those limited number of species that have been studied, likely those species associated with the offshore wind farm infrastructure, not the Navy's surface-mine countermeasures-testing activities within the Study Area.	NSWC PCD used the best available scientific data for the analysis
8	150	USEPA, Region 4	4	4.3.3.3	The EIS/OEIS does not inform the reader how many marine species have been studied, if those studied species inhabit the study area particularly where the EMF activities are likely to occur. EPA recommends that the FEIS/FOEIS address the issues identified above.	NSWC PCD clarified and incorporated information on how many species were studied and whether they are in the NSWC PCD Study Area.
8	151	USEPA, Region 4	4	4.3.3.4	Another example is the EIS/OEIS section on laser operations on fish. The EIS/OEIS states that no research has been conducted on fish yet concludes there will be no significant impacts to fish. An attempt is made to rationalize this finding by noting "*the duration that any given area will be radiated will be extremely short considering the majority of the platforms will be continuously moving in the test area.*" Because EPA is not and cannot be expected to be (nor the general public) familiar with Navy testing operations, it is unable to connect this statement to the determination of no significant impacts to fish, particularly since the EIS/OEIS states that fish have not been studied	NSWC PCD replaced "radiated" with "illuminated".
8	152	USEPA, Region 4	4	4.3.3.4	Will the platforms repeatedly traverse the same course causing repeated "radiation?" Moreover, what does the Navy mean when it says, "radiated." The use of	Yes, but over long time spans, whereby same fish will not be there. NSWC

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					"radiated" could imply radiation harm associated with chemical degradation (nuclear), which leads to confusion since the EIS/OEIS has stated that "eye" harm is the primary concern. EPA recommends that the FEIS/FOEIS address the issues identified above.	PCD replaced "radiated" with "illuminated".
8	153	USEPA, Region 4	4	4.3.3.5	In the EIS'OEIS' discussion on the ordnance operations impacts to fish, it is unclear how the Navy has determined that fish impacts will be minor and have little effect on fish populations as a whole when no data exists on the density of fish in the Study Area an consequently it is unable to determine the quantity of fish affected	NSWC PCD researched GOM fish populations. Duplicate comment.
8	154	USEPA, Region 4	3	3.4.4.1	The EIS/OEIS also states that the quantity of fish affected will be small relative to the abundance of these populations in the GOM, yet provides no GOM fish population information.	Research GOM fish populations. Duplicate comment.
8	155	USEPA, Region 4	3	3.4.5	Furthermore in the broadest sense, all the waters of the gulf, including estuarine and freshwater areas in state waters are designated as essential fish habitat (EFH). EPA defers to NOAA but has the following comments.	NSWC PCD concurs with this comment. NMFS is a cooperating agency.
8	156	USEPA, Region 4	3	3.4.5	EFH designations reflect the need to address declining not abundant fish populations in that the purpose of designating EFHs are to protect species believed to be declining due to overfishing.	NSWC PCD concurs with this comment .
8	157	USEPA, Region 4	3	3.4.5	The Study Area encompasses EFH for 26 species including groupers, shrimps, cobia, corals, sargassum, mahi, amberjacks, snappers, triggerfish, mackerel, little tunny, red drum, scamp, stone crab, spiny lobster, and tile fish. This information does not include all the temperate and tropical species known to the Study Area that have no EFH designation. Additionally, the Gulf of Mexico Fishery Management Council has developed seven fishery management plans that affect the Study Area.	Marine fish whose distribution overlaps the NSWC PCD Study Area (even those without EFH designation) were considered in the analysis. Section 3.4.5 discusses EFH in the NSWC PCD Study Area in detail, including the GOM FMPs.

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
8	158	USEPA, Region 4	4	4.3.3.5	The argument in the EIS/OEIS that most species experience a large number of natural mortalities especially during early life-stages, and therefore any small level of mortality (the one remaining undefined) caused by detonations during RDT&E activities will be minor and have little effect on the population as written appears to be self-serving and not to be grounded on best available environmental science/data/information.	NSWC PCD compared effects with oil rig removals and provided/clarified information on mitigation and monitoring efforts with line charges at NSWC PCD.
8	159	USEPA, Region 4	4	4.3.3.5	Furthermore, it is unclear from the EIS'/OEIS' statement that test personnel have not observed any fish mortalities associated with the use of line charges or small detonations is the result of strict protocols requiring these observations be made for all testing or whether this is an isolated and anecdotal piece of information. The EIS/OEIS declined to discuss this in a sufficient level of detail to facilitate meaningful analysis and to support its finding of so significant environmental impact to fish. EPA recommends that the FEIS/FOEIS address the issues identified above.	Although there are no strict protocols, test personnel have observed no fish kills during the two past test events in the NSWC PCD Study Area. NSWC PCD mitigated fish kills by using 0.5 lb charges through standard EOD mitigations to clear the area along Eglin before line charge testing. No fish kills occurred during line charge detonations off Tyndall property. NSWC PCD included this information in Section 4.3.3.5.
8	160	USEPA, Region 4	4	4.3.2.1	The EIS/OEIS states "[t]*here is no information that shows there will be any effect to marine invertebrates from sonar transmissions."* This statement is unclear as to whether no studies have been done or whether studies have been done but have found no invertebrate effects.	NSWC PCD updated information with squid study.
8	161	USEPA, Region 4	4	4.3.2.1	If no studies have been done, why has not NSWC PSD been studying this issue associated with their sonar operations in the Study Area during the history of their surface-mine countermeasures testing and development program? EPA recommends that the	The mission of NSWC PCD is to provide RDT&E, as well as in service support for expeditionary maneuver

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					FEIS/FOEIS address the issues identified above.	warfare, diving, maritime special operations, mine warfare (mines and MCM), and other naval missions that take place in the coastal region. As time and the science have evolved, the Navy has incorporated mitigation measures in conjunction with operations. The Navy is currently spending over $15 million to research potential impacts to marine mammals, as this issue has been placed at the forefront of the scientific community.
8	162	USEPA, Region 4	2	2.1	Concern - the EIS/OEIS fails to discuss the environmentally-relevant particulars of the various operations (e.g., the frequencies and intensities) and their potential environmental impacts. EPA recommends that the FEIS/FOEIS address this issue described above and identified in the following examples.	NSWC PCD testing occurs year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. NSWC PCD incorporated this information into Section 2.1 to explain these factors. (Duplicate comment)
8	163	USEPA,	2	2.1.6	For example, the EIS/OEIS does not discuss hours	NSWC PCD testing occurs

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
		Region 4			and their associated impacts of the anticipated laser operations. The EIS/OEIS states the laser operation hours will range from 244 (no action alternative) to 1,053 hours (preferred alternative). Yet the EIS/OEIS is silent on whether the laser operations will consist of continuous 244 hour operations, or several independent and discrete operations of varying hours. Nor does the EIS/OEIS discuss where the operations will occur - nearshore or offshore habitats- the water depth ranges, etc. Will there be a seasonality component to these operations?	year-round and is not seasonally determined. NSWC PCD RDT&E testing activities occur throughout the NSWC PCD Study Area and are concentrated from Pensacola to Apalachicola areas of W-155 and W-151. Tests are flexible and based on mission requirements and mitigations. This information was incorporated into Section 2.1 to explain these factors. (Duplicate comment)
8	164	USEPA, Region 4	4	4.3.3.4	Another example is the EIS section on laser operations on fish. The EIS/OEIS states that none of the laser operations in any of the proposed alternatives will affect smalltooth sawfish and Gulf sturgeon because they prefer the benthic habitats on the seafloor. If the laser operations are conducted in shallow waters, perhaps the seafloor might not offer much protection to any shallow-water occupying sawfish or sturgeon.	NSWC PCD used the best available scientific data for the analysis. (Duplicate comment)
8	165	USEPA, Region 4	4	-	Three basic types of uncertainty exist: incomplete or imperfect mastery of available knowledge, limitations in current knowledge, and difficulties in distinguishing between the above. The environmental impacts chapter (chapter #4) is written with more certainty and confidence than is warranted by the available science and environmental information/data it cites.	NSWC PCD made conclusions stronger in Chapter 4 All NEPA conclusions are made using the best available data (Duplicate comment.)
8	166	USEPA, Region 4	4	-	EPA recommends the FEIS/FOEIS should clearly state the limits of the available science, data, and environmental information and the limitations on the	This EIS/OEIS does not discuss beach nourishment.

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					mastery of the available information regarding the environmental impacts associated with beach nourishment projects.	
8	167	USEPA, Region 4	4	4.3.3.3.2	Findings of no significant impacts appear to based solely on whether an ESA-designated species is detrimentally impacted consistent with the ESA. NEPA is broader than the ESA, for example its scope includes non ESA-protected species and ecosystems, which is outside the ESA's scope and intent. EPA recommends that the FEIS/FOEIS address this issue described above and identified in the following examples.	NSWC PCD addressed the specific examples. Furthermore, NSWC PCD included information that the analysis focused on the most sensitive species and conclusions based on no effect to EMF-sensitive species. (Duplicate comment.)
8	168	USEPA, Region 4	4	4.3.3.3	For example in the EIS'/OEIS' discussion of EMF environmental impacts, it essentially states the effects of EMF's on smalltooth sawfish and Gulf sturgeons are unknown; however based on findings for sensitive species sensitive to electromagnetic fields the Navy finds its use of EMF will not affect smalltooth sawfish and Gulf sturgeon, in accordance with the ESA and there will be no NEPA significant impacts to fish associated with any of the described Alternatives.	NSWC PCD included information that the analysis focused on the most sensitive species and conclusions based on no effect to EMF-sensitive species (Duplicate comment.)
8	169	USEPA, Region 4	4	-	Yet the body of the discussion is silent as to the impacts to the other marine species known to inhabit the Study Area, as described in the EIS'/OEIS' Chapter 3, including the known EMF-sensitive species: the elasmobranches (sharks, rays, and skates) and flounder. As written, the EIS'/OEIS' "*NEPA no finding of significant impacts,"* conclusion appears to rest solely on whether the ESA-designated species, smalltooth sawfish and Gulf sturgeon, are significantly impacted as defined by the ESA.	NSWC PCD included information that the analysis focused on the most sensitive species and conclusions based on no effect to EMF-sensitive species (Duplicate comment.)
8	170	USEPA, Region 4	4	4.3.6.3.5	The absence of the NMFS biological opinion (BO) and request for a letter of authorization for the incidental harassment of marine mammals from the EIS/OEIS is relevant to the environmental impacts analysis. EPA recommends that the FEIS/FOEIS address this issue.	The Final EIS/OEIS incorporates the findings of the LOA and BO, as part of the standard consultation process.

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
8	171	USEPA, Region 4	5	5.3.2.5	Similar to all federal agencies, the Department of the Navy (DON) is in the business of activities that have tremendous ramifications to the state of the Nations environment, and for DON, the global environment. The concern is that due to the nature of DON's business it does not actively encourage, and understandable so, outside monitoring and assessment of environmental impacts associated with its global-scale operations. Consequently, DON has an added burden in meeting NEPA's goals and requirements. It needs to assess its own environmental impacts and cannot rely on outside studies as no one else is in the same business as DON or is in the position to know the specifics of DON's business to be able to assess associated environmental impacts.	The U.S. Navy is currently spending in excess of $15 million dollars in research to better understand the environmental impacts associated with its actions. Furthermore, the Navy has developed and implemented mitigation measures to reduce the likelihood of adverse environmental impacts.
8	172	USEPA, Region 4	4	4.3.1.1.1	For example buried in Section 4.3.1.1 "Surface Operations" the EIS/OEIS states "[n]*either regulations nor scientific literature provide criteria for determining the significance of the potential effects of the NSWC PSD activities."* This statement probably applies to all of the Proposed Action's operations. Yet, NSWC PSD has been in the surface-mine countermeasures testing and developing business for decades in the Study Area and will likely to continue into the future.	NSWC PCD is participating in the NEPA process to analyze potential impacts from their testing activities to prevent future harm to the environment.
8	173	USEPA, Region 4	N/A	N/A	Where in this EIS/OEIS are its environmental studies and associated environmental impacts-type information to fulfill NEPA's EIS/OEIS goals and EIS/OEIS requirements?	The mission of NSWC PCD is to provide RDT&E, as well as in service support for expeditionary maneuver warfare, diving, maritime special operations, mine warfare (mines and MCM), and other naval missions that take place in the coastal region. As time and the science has evolved, the Navy has

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
						incorporated mitigation measures in conjunction with operations.
8	174	USEPA, Region 4	N/A	N/A	NSWC PSD has likely been collecting a lot of environmental operational performance information since NEPA's passage, but apparently nothing on its operational environmental impacts.	Comment noted.
8	175	USEPA, Region 4	5	5.3.2.5	It is likely no one else has the access and authority to collect this environmental impacts information in a restricted area during testing operations. EPA recommends the FEIS/FOEIS provide this operational data and experience.	Mitigation and monitoring will occur in accordance with consultation requirements.
9	176	FDEP	N/A	N/A	The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, 16 U.S.C. §1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C.§§ 4321, § 4331-4335, § 4341-4347, as amended, has coordinated a review of the referenced Draft Environmental Impact Statement (EIS). Based on the information contained in the Draft EIS and comments provided by our reviewing agencies, the state has determined that, at this stage, the proposed federal activities are consistent with the Florida Coastal Management Program. Thank you for the opportunity to review this proposal. Should you have any questions regarding this letter, please contact Ms. Lauren P. Milligan at (850) 245-2170.	NSWC PCD included the letter with Florida CZMA Appendix.
10	177	MMS	6	6.2.12	Information regarding the Gulf of Mexico Energy Security Act of 2006 (GOMESA) was included in Chapter 6.2.16, State Oil and Gas Activities, of the EIS/OEIS. Because GOMESA provides for oil and gas leasing in Outer Continental Shelf waters, this information would be more appropriately listed under Chapter 6.2.8, Minerals Management Service (MMS) Regulated Activities.	NSWC PCD moved as sub-heading to 6.2.8.
10	178	MMS	6	6.2.16	The information in Chapter 6.2.16 describing MMS	NSWC PCD incorporated

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					actions related to GOMESA is not up to date. Below is more accurate information regarding MMS lease sales related to GOMESA: # The Gulf of Mexico Energy Security Act (GOMESA) of 2006 (P.L. 109-432, December 20, 2006) repeals the Congressional moratorium on certain areas of the Gulf of Mexico, places a moratorium on other areas in the Gulf of Mexico, and increases the distribution of offshore oil and gas revenues to coastal States. The GOMESA defines two areas in the Gulf of Mexico - the 181 Area and the 181 South Area. Approximately 2 million acres (ac) of the 181 Area are located in the Central Planning Area (CPA). Because this portion was not previously under moratorium, it was available for lease starting with CPA Lease Sale 205 held on October 3, 2007. The remaining portion of the 181 Area is approximately 500,000 ac located in the Eastern Planning Area (EPA). The MMS published a Final Supplemental EIS (SEIS) in October 2007 (copy of CD enclosed) on this eastern portion of the 181 Area, and it was offered in Lease Sale 224 on March 19, 2008. #One of the areas the GOMESA defines is referred to as the 181 South Area (Figure enclosed). This area is located in the CPA and is approximately 5.8 million acres (ac). The MMS is proposing the sale area for proposed CPA Sales 208(2009), 213 (2011), and 222 (2012) be expanded to include 4.3 million ac of the 181 South Area. The remaining acreage of the 181 South Area (1.5 million ac) is located beyond the U.S. Exclusive Economic Zone (EEZ) and, therefore, would not be offered. The MMS Multisale EIS (USDOI, MMS, 2007) did not analyze the 181 South Area. Therefore, MMS has prepared a separate National Environmental Policy Act (NEPA) review to reevaluate the expanded CPA sale area (USDOI, MMS, 2008). #As part of the environmental review process for the expanded CPA sale area, MMS held four scoping meetings in October 2007. One scoping meeting was held in Texas, two	the information in Section 6.2.16.

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					scoping meetings in Louisiana, and one scoping meeting in Alabama (USDOI, MMS, 2008). The Draft SEIS was released on April 11, 2008, and a copy of the CD is enclosed. Three public meetings will be held in Larose and Baton Rouge, Louisiana, and Mobile, Alabama, on May 13, 14, and 15, respectively. The comment period for the Draft SEIS will close on June 10, 2008. REFERENCES: US. Dept. of the Interior. Mineral Management Service. 2007. Gulf of Mexico OCS oil and gas lease sales: 2007-2012; WEstern Planning Area Sales 201, 207, 210, 215, and 218; Central Planning Area Sales 205, 206, 208, 213, 216, and 222 - final environmental impact statement. 2 vols. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA MMS 2007-018. #U.S. Department of the Interior. Minerals Mangement Service, 2008. Proposed Gulf of Mexico OCS oil and gas lease sales: 2009-2012; Central Planning Area Sales 208, 213, 216, and 222; Western Planning Area Sales 210, 215, and 218 - draft supplemental environmental impact statement. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orlenans, LA. OCS EIS/EA MMS 2008-011.	
10	179	MMS	6	6.2.16	The Gulf of Mexico Energy Security Act (GOMESA) of 2006 also includes a provision allowing for credits for exchanged leases. The credits will cover 79 active leases acquired between 1984 and 1990 within 125 mi of the Florida coast in the EPA and certain leases within 100 mi from the coast in the CPA. The proposed rule was placed in the *Federal Register* February 1, 2008 with a 60-day comment period. For further information, use the following link to the *Federal Register* notice: http://a257.g.akamaitech.net/7/257/2422/01jan20081800/edocket.access.gpo.gov/2008/pdf/E8-1860.pdf.	NSWC PCD incorporated the information in Section 6.2.16.
10	180	MMS	6	6.2.16	Line 31 of page 6-19 referenced *Tyson, 2007* while describing the effect of the State of Louisiana lawsuit	NSWC PCD updated the information with

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Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					against MMS requiring MMS to take into consideration the effects of Hurricanes Katrina and Rita cumulatively with the effects of the sale. The reference, *Tyson, 2007,* was not included in the bibliography in Chapter 10.	GOMESA data. The Tyson, 2007 reference, therefore, is no longer used.
10	181	MMS	6	6.2.16	All of the leases in the area of the proposed Navy activities already have or will have a military stipulation that requires coordination with military stipulation that requires coordination with military officials responsible for activities in the relevant military warning areas. The MMS standard military stipulation coordination requirement should handle any space-use conflicts between oil and gas leases an the proposed Navy activities. Nonetheless, MMS would like to be kept abreast of any future updates or revisions related to this Navy proposal.	NSWC PCD incorporated the statement on military coordination.
10	182	MMS	6	6.2.16	Current lease information, including the Gulf of Mexico OCS Region's lease map and lease status reports, can be accessed at http://www.gomr.mms.gov/homepg/lsesale/lsesale.html.	NSWC PCD accessed the OCS lease map and status reports
10	183	MMS	6	6.2.8	The last paragraph of Chapter 6.2.8 regarding marine mammal mitigation measures is not accurate. The Marine Mammals Protection Act (MMPS) Take-Regulations cited (NOAA, 2002c) expired on February 2, 2004. The American Petroleum Institute (API) petitioned for/received the authorization on behalf of its members (not MMS), and it did not authorize the taking of 200 bottlenose and spotted dolphins, but only a "small number" by harassment. Nowhere did they define "small number."#No removal operations have been covered by MMPA Take-Regulations since the 2002 extension's expiration. The MMS submitted a petition package under Subpart 1 of the MMPA for the promulgation of take-regulations for marine mammals impacted by explosive-severance operations on February 25, 2005. The National Marine Service	NSWC PCD updated the section with API information provided.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					(NMFS) published a Notice of Receipt of MMS Petition on August 25, 2005, and a Draft Rule on April 7, 2006. The comment period on the Draft Rule expired on May 22, 2006, but MMS has yet to receive the Final Rule. #No takes of a sperm whale will be issued via the Endangered Species Act (ESA) until the MMPA Take-Regulations are published. Even then (with a amended Biological Opinion (BO)/Incidnetal Take Statement (ITS)), MMS will only expect take **by harassment** of around 1/year.	
10	184	MMS	6	6.2.11	Table 6-12 contains out-dated information regarding the estimated number of sea turtle takes from MMS rig removals. On August 28, 2006, MMS received the BO/ITS from NMFS conducted under Section 7 of the ESA (on the MMPA Rulemaking exercise MMS began with its petition on February 25, 2005). The ITS allows for incidental take of **-3** sea turtles/year (or 18 sea turltes/6-year period) **by injury or mortality** from explosive severance; **-1** turtle may be captured in a site-clearance trawl (though they do not actually define it as an injury, mortality, or harassment); and **-84** sea turtles/year **by harassment**.	NSWC PCD updated Section 6.2.11 with the correct information.
10	185	MMS	3	3.5.4.1	Page 3-47, lines 22-23, states "There are currently no NRHP-listed properties administered by NSWC PCD within the NSWC PCD Study Area." However, there has been relatively little remote-sensing survey data collected in this area; therefore, it is not known how many potentially significant archaeological resources may be located within this area.	Comment noted.
10	186	MMS	4	4.4.4.1	Page 4-154, lines 39-41, states operations "will not be conducted in areas that are expected to contain known cultural resources." Since the entire operations area within Federal waters are located in navigable waters, and given the fact that this area was a high-traffic area for historic vessels, cultural resources could be expected to be located **anywhere** in the proposed project area. Given the limited amount of	Comment noted.

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					remote-sensing survey data in this area, there is no way of determining how many potentially significant archaeological resources could be impacted in unsurveyed areas.	
10	187	MMS	4	4.4.4.1	Page 4-155, lines 1-7, states there will be no significant impact to cultural resources. Again, without proper survey coverage prior to seafloor impacts and ordnance operations, it is impossible to make this determination.	NSWC PCD changed the sentence to read "…no significant impact to known cultural resources."
10	188	MMS	5	5.4	Page 5-9, lines 14-15, identifies proposed consultation with appropriate agencies when avoidance of historic properties is not possible; however, this does not take into account potential impacts to unexpected finds.	NSWC PCD added the statement saying unexpected finds would be reported to SHPO.
10	189	MMS	5	5.6	Page 5-9, lines 32-33, states bottom disturbance activities will not occur over shipwreck sites. This only takes into account known locations.	NSWC PCD changed the sentence to read "…would not occur over artificial reefs or known shipwrecks.
10	190	MMS	5	5.7	Page 5-11, lines 5-6, states no detonations with bottom disturbance will occur over shipwrecks. Again, this only takes into account known shipwreck locations.	NSWC PCD changed the sentence to read "will occur over known shipwrecks…"
10	191	MMS	6	6.4.12	Page 6-40, lines 11-12, states "Effects to cultural resources in the marine environment are unlikely as the submerged resources are protected under the bottom sediment by sediment from wave action." This statement is only partially true. While archaeological resources that are buried under suffiecient sediment would be protected from seafloor disturbing activities, any resources that are above the sediment, or only minimally covered by sediment, would have the potential for impact from seafloor distrubing activities. Given the limited amount of remote-sensing survey data in the project area and the fact that this area has a high potential for both prehistoric and histroic archaeological resources, the potential for impacts is much greater than expressed in this Draft EIS/OEIS.	NSWC PCD ensured all references to shipwreck sites state "known" and included information about mitigating for unknown sites (i.e., notification of SHPO and ceasing activities).

Table 7-3. Responses to Comments on the Draft EIS/OEIS (Cont'd)

Letter Number	Comment Number	Organization	Chapter Number	Section Number	Comment	Resolution
					Unless remote-sensing surveys are conducted and an archaeological assessment of these data completed prior to seafloor disturbing activities, the potential for impacts is possible.	
10	192	MMS	3	3.5.4	Page 3-47, lines 18-19, states that the Abandoned Shipwreck Act of 1987 (ASA) gives the title and jurisdiction over historic shipwrecks to the Federal Government out to the EEZ. This statement is not accurate. The ASA give title to historic ships in State waters to the Federal Government, which then cedes them back to the State. The ASA has no effect in Federal waters whatsoever.	NSWC PCD updated the section with the information provided.

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