DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 96TH TEST WING (AFMC)
EGLIN AIR FORCE BASE FLORIDA

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DEC 3 2015

Ms. Jolie Harrison
Division Chief, Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Dear Ms. Harrison:

This letter is being submitted to request an Incidental Harassment Authorization (IHA) pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) for Maritime Weapon Systems Evaluation Program (WSEP) testing activities planned to begin on 4 February 2016. The proposed action for 2016 missions is considered a military readiness activity and is identical to what was authorized in 2015.

On 10 November, 2015, Eglin Natural Resources submitted a Letter of Authorization (LOA) request to consolidate all Eglin Gulf Test and Training Range (EGTTR) testing and training activities into one authorization for five years. Based on discussions with the National Marine Fisheries Service (NMFS), Office of Protected Resources, the plan is for NMFS to issue the EGTTR LOA by January 2017. While the goal of the LOA is to provide long-term coverage for all of Eglin's testing and training programs in the EGTTR, the rule-making process will not be completed in time to support Maritime WSEP's 2016 missions. Eglin Natural Resources is therefore requesting this IHA as an interim coverage for 2016 missions while the EGTTR LOA undergoes NMFS review. All future (2017 – 2022) Maritime WSEP missions will be covered in the EGTTR LOA. Eglin Natural Resources believes under these assumptions, the "Stop Gap EGTTR IHA" submitted to NMFS on 11 November 2015 is no longer required and can be rescinded. Eglin Natural Resources and NMFS Office of Protected Resources have coordinated and believe this is the best course of action to provide mission flexibility for the Air Force and minimize workload for NMFS. However, if at any time it becomes evident that the EGTTR LOA will not be issued in time to cover 2017 missions, Eglin Natural Resources may request an additional IHA to prevent any gaps in mission coverage.

Previous Maritime WSEP missions were conducted between February 9 – 12, and March 16 – 19, 2015 with no reported impacts to the environment or marine mammals. The proponent needs to continue the same mission activities in 2016 as was authorized in 2015. Eglin Natural Resources is requesting NMFS to re-authorize the Maritime WSEP IHA dated 6 February 2015 so these critical missions at Eglin AFB can be accomplished. Eglin Natural Resources also requests that this IHA be valid for one year from the date of signature. Total numbers of munitions proposed for 2016 are identical to the 2015 IHA indicated in Table 1.

Table 1. Munitions Authorized for Maritime WSEP Operational Testing Activities in 2015 and Requested for 2016 (exactly the same for both years)

Type of Munition	NEW (lbs)	Detonation Type	Total # in IHA
GBU-10 or GBU-24	945	Surface	2
GBU-12 or GBU- 54 (LJDAM)	192	Surface	6
AGM-65 (Maverick)	86	Surface	6
CBU-105 (WCMD)	83	Airburst	4
GBU-38 (Laser Small Diameter Bomb)	37	Surface	4
AGM-114 (Hellfire)	20	Subsurface (10 ft depth)	15
AGM-176 (Griffin)	13	Surface	10
2.75 Rockets	12	Surface	100
PGU-12 HEI 30 mm	0.1	Surface	1,000

AGL = above ground level; AGM = air-to-ground missile; CBU = Cluster Bomb Unit; GBU = Guided Bomb Unit; JDAM = Joint Direct Attack Munition; LJDAM = Laser Joint Direct Attack Munition; mm = millimeters; msec = millisecond; lbs = pounds; PGU = Projectile Gun Unit; HEI = high explosive incendiary

In the IHA issued on 6 February 2015, NMFS authorized the incidental take of bottlenose dolphins and Atlantic spotted dolphins by Level A (Permanent Threshold Shift [PTS]) and Level B (Temporary Threshold Shift [TTS] or behavioral) harassment as shown in Table 2. No mortality takes were authorized for this mission. Pre-mission surveys from 2015 missions resulted in 15 sightings of approximately 156 dolphins. However, missions were not conducted until the 5.1-kilometer radius monitoring area was clear of all protected species (some missions were delayed until protected species were confirmed outside of the monitoring area). No marine mammals were observed during the post-mission surveys; therefore, no takes of any marine mammal species were documented from 2015 Maritime WSEP missions. A Final Report was completed and submitted to NMFS on August 28, 2015 summarizing all Maritime WSEP Operational Testing activities and protected species survey results.

Table 2. Authorized Takes Associated with Maritime WSEP Activities in the EGTTR

Species	Level A Harassment (PTS)	Level B Harassment (TTS or Behavioral)
Bottlenose dolphin	33	796
Atlantic spotted dolphin	5	137
Unidentified bottlenose/Atlantic spotted dolphins	0	9

TTS = temporary threshold shift; PTS = permanent threshold shift

Mitigation measures and monitoring procedures included in Section 4 and 5 of the 2015 IHA will continue to be implemented for the 2016 missions. Since proposed testing in 2016 will be conducted during the same season, there will be no change in marine mammal densities compared to what was analyzed in the IHA. Furthermore, overall munition allocations in the IHA will not be increased; therefore potential impacts and associated takes from completing Maritime WSEP Operational Testing in 2016 will not exceed what was authorized in 2015. All conclusions and take calculations developed by NMFS under the 2015 IHA should remain valid as the scope of the activity and associated potential impacts will not be exceeded and no additional takes are being requested. Eglin Natural Resources understands that changes or increases in mission activity outside the scope of this request would require a re-initiation of consultation under Section 101(a)(5)(D) of the MMPA.

If NMFS agrees with the reasoning described in this letter, please indicate your concurrence by issuing the 2016 Maritime WSEP IHA no later than 4 February 2016. If you have any questions regarding this request or any portion of the proposed action, please do not hesitate to contact either Mr. Rodney Felix at (850) 883-1155 or myself at (850) 882-8391.

Sincerely,

BRUCE W. HAGEDORN, GS-13
Chief, Eglin AFB Natural Resources

REQUEST FOR AN INCIDENTAL HARASSMENT AUTHORIZATION OF MARINE MAMMALS RESULTING FROM MARITIME WEAPON SYSTEMS EVALUATION PROGRAM OPERATIONAL TESTING

EGLIN AIR FORCE BASE, FLORIDA

Submitted To:

Office of Protected Resources
National Marine Fisheries Service (NMFS)
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FINAL

Submitted By:

Department of the Air Force
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REVISED

DECEMBER 2014

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

96 TW	96th Test Wing
AFB	Air Force Base
AGL	Above Ground Level
AGM	Air-To-Ground Missile
BA	Biological Assessment
CBU	Cluster Bomb Unit
CV	Coefficient of Variation
dB re 1 μPs^2-s	Decibel referenced to one squared microPascal-second
E	Endangered
EA	Environmental Assessment
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EGTTR	Eglin Gulf Test and Training Range
EO	Executive Order
ESA	Endangered Species Act
FMC	Fishery Management Council
FMP	Fishery Management Plan
ft	Feet
GBU	Guided Bomb Unit
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GSMFC	Gulf States Marine Fisheries Commission
HAPC	Habitat Area of Particular Concern
HEI	High Explosive Incendiary
in	Inch
in-lb/in^2	Inch-pound per square inch
J/in^2	Joules per square inch
kg	Kilogram
KIAS	Knots Indicated Air Speed
km	Kilometer
km^2	Square Kilometer
lbs	Pounds
m	Meters
mi	Mile
min	Minute
mm	Millimeter
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEW	Net Explosive Weight
NM	Nautical Mile
NM^2	Square Nautical Mile
NMFS	National Marine Fisheries Service
Pa-s	Pascal-second
PGU	Projectile Gun Unit
Psi-msec	Pounds per square inch-millisecond
SEFSC	Southeast Fisheries Science Center
SEL	Sound exposure level
SPL	Sound pressure level
SST	Sea Surface Temperature
T	Threatened
TA	Test Area
TTP	Tactics, Techniques, and Procedures
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance
WSEP	Weapon Systems Evaluation Program
ZOI	Zone of Impact

EXECUTIVE SUMMARY

With this revised submittal, Eglin Air Force Base requests an Incidental Harassment Authorization (IHA) for the incidental taking, but not intentional taking (in the form of noise-related and/or pressure-related impacts), of marine mammals incidental to Maritime WSEP Operational Testing within the Eglin Gulf Test and Training Range (EGTTR), as permitted by the Marine Mammal Protection Act (MMPA) of 1972, as amended. Maritime WSEP Operational Testing is a military readiness activity and high priority for the Department of Defense (DoD). The Maritime WSEP missions are firmly scheduled to begin on 6 February 2015. An application was originally submitted to NMFS on August 5, 2014. Revisions to the application were deemed necessary based on updated acoustic thresholds and criteria for explosive sources as well as other items that were identified during consultation with NMFS to ensure adequacy and completeness of the application.

The missions may expose cetaceans within the EGTTR to noise or pressure levels currently associated with mortality, Level A harassment, and Level B harassment. Noise and pressure metrics associated with exploding ordnance were determined to be the only activities during Maritime WSEP missions with potential for significant impacts to marine species, as analyzed in the associated Environmental Assessment (U.S. Air Force, 2014; in preparation). Maritime WSEP missions involve the use of multiple types of live munitions against small boat targets in the EGTTR (Gulf of Mexico). Net explosive weight of the weapons ranges from 0.1 to 945 pounds, and detonations will occur above the water surface, at the water surface, and below the water surface. Maritime WSEP Operational Testing includes deployment of 45 live bombs/missiles, 100 rockets, and 6,000 live gunnery rounds (30 millimeter [mm] and 7.62 mm) over a timeframe of a few weeks in February and March 2015, with multiple munitions being released per day. All ordnance will be delivered by multiple types of aircraft including fighter jets, bombers, and gunships. The targets would consist of stationary, towed, and remotely controlled high speed boats. Some boats would contain simulated crews made of plywood. The mission location is approximately 17 miles offshore of Santa Rosa Island, in a water depth of 35 meters (115 feet).

The potential takes outlined in Section 6 represent the maximum expected number of animals that could be affected. Mitigation measures will be employed to substantially decrease the number of animals potentially affected. Using the most applicable density estimates for each species, the zone of influence (ZOI) of each type of ordnance deployed, and the total number of planned detonations, an estimate of the potential number of animals exposed to noise and/or pressure thresholds is analyzed using the most recent guidance provided by the Navy (Finneran and Jenkins, 2012). Without mitigation measures in place, the total number of marine mammals potentially exposed to the acoustic impulse levels associated with mortality is less than one animal, including about 0.47 bottlenose dolphins and 0.11 Atlantic spotted dolphins. A maximum of up to approximately 40 marine mammals (all species combined) could potentially be exposed to injurious (PTS) Level A harassment. A maximum of approximately 482 marine mammals could potentially be exposed to non-injurious (TTS) Level B harassment. Approximately 1,014 animals could potentially be exposed to noise corresponding to the behavioral threshold of 167 decibels (dB) sound exposure level. It is anticipated that mitigation measures, identified in Chapter 11, will reduce the probability of all forms of take, specifically mortality, thus an IHA is being requested as opposed to a Letter of Authorization (LOA).

Marine mammal species potentially affected by Maritime WSEP activities include four bottlenose dolphin stocks and one Atlantic spotted dolphin stock. The Maritime WSEP test site is located in an area associated with the Northern Gulf of Mexico spotted dolphin stock, which is not considered strategic. The test site is located within a depth range corresponding to the Northern Gulf of Mexico Continental Shelf stock of bottlenose dolphins (20 to 200 meters depth), which is not a strategic stock. However, other strategic stocks are defined in relatively close proximity and could possibly enter the test area. Three bay, sound, and estuary stocks, as well as the Northern Coastal stock (shoreline to 20 meters water depth), occur near the Maritime WSEP location and are considered strategic. Individuals from the Oceanic stock, which is not considered strategic, are unlikely to enter the test area, as this stock is defined beyond the 200 meter isobath.

The information and analyses provided in this application are presented to fulfill the permit request requirements of Title I, Sections 101(a)(5)(A) and 101(a)(5)(F) of the MMPA.

1. DESCRIPTION OF ACTIVITIES

This section describes Air Force Maritime Weapon System Evaluation Program (WSEP) Operational Testing activities conducted in the Eglin Gulf Test and Training Range (EGTTR) that could result in takes under the Marine Mammal Protection Act (MMPA) of 1972, as amended. The actions include air-to-surface test missions involving detonations of live munitions above the water, at the water surface, and below the water surface with the potential to affect cetaceans that may be present within the action area. The mission is described in the following sections.

1.1 INTRODUCTION

The Eglin Air Force Base (86th Fighter Weapons Squadron [86 FWS]) seeks the ability to conduct live ordnance testing and training in the Gulf of Mexico (GOM) as part of the Maritime WSEP Operational Testing. The proposed missions are very similar to Maritime Strike Operations (Maritime Strike Incidental Harassment Authorization issued 13 August 2013). The Maritime WSEP test objectives are to evaluate maritime deployment data, evaluate tactics, techniques and procedures (TTPs), and to determine the impact of TTPs on Combat Air Force training. The results of this test will be used to develop publishable TTPs for inclusion in Air Force TTP 3-1 series manuals. The need to conduct this type of testing has arisen in response to increasing threats at sea posed by operations conducted from small boats. There has been limited Air Force (AF) aircraft and munitions testing on engaging and defeating small boat threats. Small boats can carry a variety of weapons, can be employed in large or small numbers by many nations and groups, and may be difficult to locate, track, and engage in the marine environment. Therefore, the Air Force proposes to employ live munitions against boat targets in the GOM in order to continue development of TTPs to train U.S. Air Force strike aircraft to counter small maneuvering surface vessels.

1.2 MISSION DESCRIPTION

Maritime WSEP activities include the release of multiple types of inert and live munitions in the GOM against small boat targets. Maritime WSEP Operational Testing will occur within the EGTTR, in Warning Area 151 (W-151) (Figure 1-1). The specific planned mission location is approximately 17 miles offshore from Santa Rosa Island, in nearshore waters of the continental shelf. Water depth is about 35 meters (115 feet). Test events and training missions will be conducted in various sea states and weather conditions, up to a wave height of four feet.

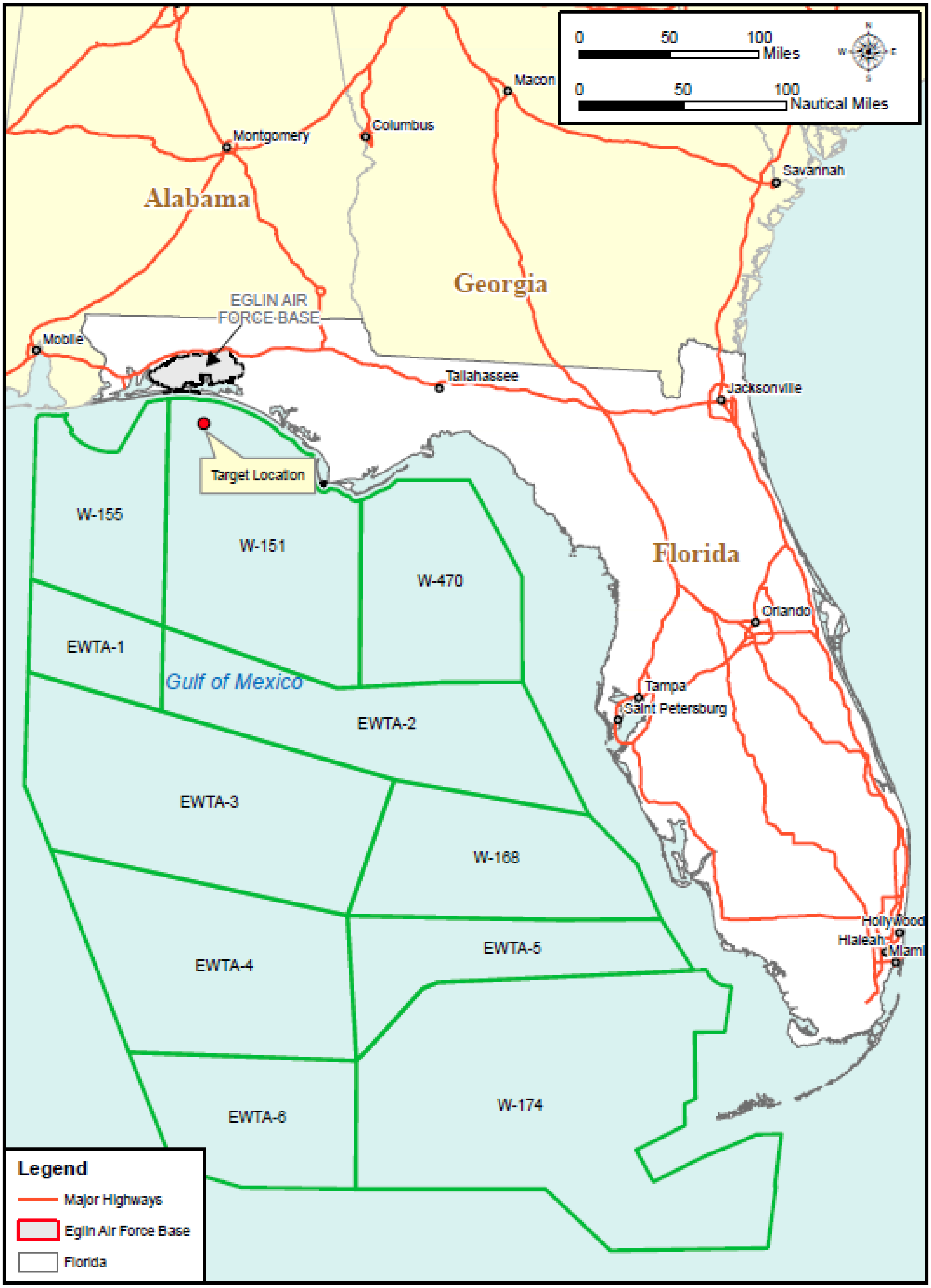

Figure 1-1. Eglin Gulf Test and Training Range (EGTTR)

Multiple munitions and aircraft will be used to meet the objectives of the Maritime WSEP Operational Tests (Table 1-1). Munition types include bombs, missiles, and gunnery rounds. Because the tests will focus on weapon/target interaction, no particular aircraft will be specified for a given test as long as it meets the delivery parameters. The munitions will be deployed against static, towed, and remotely controlled boat targets. Static and controlled targets consist of stripped boat hulls with plywood simulated crews and systems. Damaged boats will be recovered for data collection. Test data collection and operation of remotely controlled boats will be conducted from an instrumentation barge known as the Gulf Range Armament Test Vessel (GRATV) that is anchored on-site and will also provide a platform for cameras and weapon-tracking equipment. Target boats will be positioned approximately 600 feet from the GRATV, depending on the munition.

Table 1-1. Live Munitions and Aircraft

Munitions	Aircraft (not associated with specific munitions)
GBU-10 laser-guided Mk-84 bomb	F-16C fighter aircraft
GBU-24 laser-guided Mk-84 bomb	F-16C+ fighter aircraft
GBU-12 laser-guided Mk-82 bomb	F-15E fighter aircraft
GBU-54 Laser Joint Direct Attack Munition, laser-guided Mk-82 bomb	A-10 fighter aircraft
CBU-105 (WCMD)	B-1B bomber aircraft
AGM-65 Maverick air-to-surface missile	B-52H bomber aircraft
GBU-38 Small Diameter Bomb II (Laser SDB)	MQ-1/9 unmanned aerial vehicle
AGM-114 Hellfire air-to-surface missile	AC-130 gunship
AGM-175 Griffin air-to-surface missile	
2.75 Rockets	
PGU-13/B high explosive incendiary 30 mm rounds	
7.62 mm/.50 Cal	

AGM = air-to-ground missile; Cal = caliber; CBU = Cluster Bomb Unit; GBU = Guided Bomb Unit; Mk = Mark; mm = millimeters; PGU = Projectile Gun Unit

Maritime WSEP testing will include three fuzing options: detonation above the water surface, at the water surface, and below the water surface. The number of each type of munition, height or depth of detonation, explosive material, and net explosive weight (NEW) of each munition is provided in Table 1-2. The quantity of live munitions tested is considered necessary to provide the intended level of tactics and weapons evaluation, including a number of replicate tests sufficient for an acceptable statistical confidence level regarding munitions capabilities.

Table 1-2. Maritime WSEP Munitions

Type of Munition	Total # of Live Munitions	Detonation Type	Warhead – explosive material	Net Explosive Weight per Munition
GBU-10 or GBU-24	2	Surface	MK-84 - Tritonal	945 lbs
GBU-12 or GBU- 54 (LJDAM)	6	Surface	MK-82 - Tritonal	192 lbs
AGM-65 (Maverick)	6	Surface	WDU-24/B penetrating blast-fragmentation warhead	86 lbs
CBU-105 (WCMD)	4	Airburst	10 BLU-108 sub-munitions each containing 4 projectiles parachute, rocket motor and altimeter	83 lbs
GBU-38 (Laser Small Diameter Bomb)	4	Surface	AFX-757 (Insensitive munition)	37 lbs
AGM-114 (Hellfire)	15	Subsurface (10 msec delay)	High Explosive Anti-Tank (HEAT) tandem anti-armor metal augmented charge	20 lbs
AGM-176 (Griffin)	10	Surface	Blast fragmentation	13 lbs
2.75 Rockets	100	Surface	Comp B-4 HEI	Up to 12 lbs
PGU-12 HEI 30 mm	1,000	Surface	30 x 173 mm caliber with aluminized RDX explosive. Designed for GAU-8/A Gun System	0.1 lbs
7.62 mm/.50 cal	5,000	Surface	N/A	N/A

AGL = above ground level; AGM = air-to-ground missile; CBU = Cluster Bomb Unit; GBU = Guided Bomb Unit; JDAM = Joint Direct Attack Munition; LJDAM = Laser Joint Direct Attack Munition; mm = millimeters; msec = millisecond; lbs = pounds; PGU = Projectile Gun Unit; HEI = high explosive incendiary

A human safety zone will be established around the area prior to each live mission, and will be enforced by a large number of safety boats (approximately 20 to 25). The size of this zone will vary, depending upon the particular munition used in a given test event or training mission. A composite safety footprint was developed, which incorporates all munitions being deployed and averages them out. The composite safety footprint consisted of approximately a 19 mile-wide diameter (9.5 mile-wide radius from the detonation point). Non-participating vessels (such as recreational and commercial fishermen) will be excluded from entering the safety footprint while it is active, which is expected to be up to four hours per mission on test days. The Eglin Safety Office will position the safety support vessels around the safety footprint to ensure commercial and recreational boats do not accidentally enter the area. Before delivering the ordnance, mission aircraft may make a dry run over the target area to ensure that it is clear of non-participating vessels, although this action would not necessarily be performed before all releases.

In addition, measures designed to avoid or minimize impacts to protected marine species have been developed in cooperation with the National Marine Fisheries Service (NMFS). A separate zone around the target will be established for marine species protection, based on the distance to which energy- and pressure-related impact zones could extend for the various types of ordnance listed in Tables 1-2 and 1-3. This zone will not necessarily be the same size as the human safety zone. Trained marine species observers will survey the species protection zone before and after each mission. In addition, AF personnel will be within the mission area performing various tasks and will observe for protected marine species as feasible throughout test preparation. A detailed description of mitigation measures is provided in Chapter 11.

At least two ordnance delivery aircraft will participate in each live weapon release mission. Prior to the test, AF pilots aboard mission aircraft may make a dry run over the target area to ensure it is clear of non-participating vessels before ordnance is deployed. Due to the limited flyover duration and potentially high speed and altitude, pilots will not survey for marine species.

In addition to surveys conducted from boats, three video cameras will be positioned on the GRATV anchored on-site. The camera(s) will be used to document the weapons' performance against the targets and to monitor for the presence of protected species. An Eglin Natural Resources representative will be located in the Eglin's Central Control Facility (CCF), along with mission personnel, to view the video feed before and during test activities. Missions would not proceed until the target area is clear of protected marine species. Furthermore, if the cameras are not operational for any reason, the mission will not be conducted. A detailed description of mitigation measures is provided in Chapter 11.

After each mission, a team of AF personnel would collect debris and retrieve damaged targets from the mission site. These vessels would be separate from dedicated protected species observer vessels that would conduct the post-mission surveys to assess potential impacts from the mission. On test days involving the release of CBU-105s, the Eglin Air Force Explosive Ordnance Disposal (EOD) team would be on hand to inspect floating targets and identify and render safe any unexploded ordnance (UXO), including fuzes, classified components, or intact munitions. In the rare instance that UXO cannot be removed, proper disposal methods would be employed; however these types of scenarios are not considered likely. Once the area has been cleared by the Eglin EOD team (typically one hour after the release of CBU-105s), the range will be re-opened for the debris clean-up team and the protected species survey vessels.

2. DURATION AND LOCATION OF THE ACTIVITIES

Maritime WSEP missions are scheduled to occur over an approximate two- to three-week period in February/March 2015. Missions would occur on weekdays during daytime hours only with multiple live munitions being released each day. All activities would take place within the EGTTR, which is defined as the airspace over the GOM controlled by Eglin AFB, beginning at a point three NM from shore. The EGTTR is subdivided into blocks consisting of Warning Areas W-155, W-151, W-470, W-168, and W-174, as well as Eglin Water Test Areas 1 through 6 (Figure 2-1). Warning Area W-155, which is controlled by the Navy, is used occasionally to support Eglin missions. Over 102,000 square nautical miles (NM^2) of GOM surface waters exist under the EGTTR air space. However, activities described in this document will occur only in W-151, and specifically in sub-area W-151A (Figure 2-1). Descriptive information for all of W-151 and for W-151A is provided below.

W-151

The inshore and offshore boundaries of W-151 are roughly parallel to the shoreline contour. The shoreward boundary is 3 NM from shore, while the seaward boundary extends approximately 85 to 100 NM offshore, depending on the specific location. W-151 covers a surface area of approximately 10,247 NM^2 (35,145 square kilometers [km^2]), and includes water depths ranging from about 20 to 700 meters. This range of depth includes continental shelf and slope waters. Approximately half of W-151 lies over the shelf.

W-151A

W-151A extends approximately 60 NM offshore and has a surface area of 2,565 NM^2 (8,797 km^2). Water depths range from about 30 to 350 meters and include continental shelf and slope zones. However, most of W-151A occurs over the continental shelf, in water depths less than 250 meters. Maritime WSEP missions will occur in the shallower, northern inshore portion of the sub-area, in a water depth of about 35 meters (115 feet).

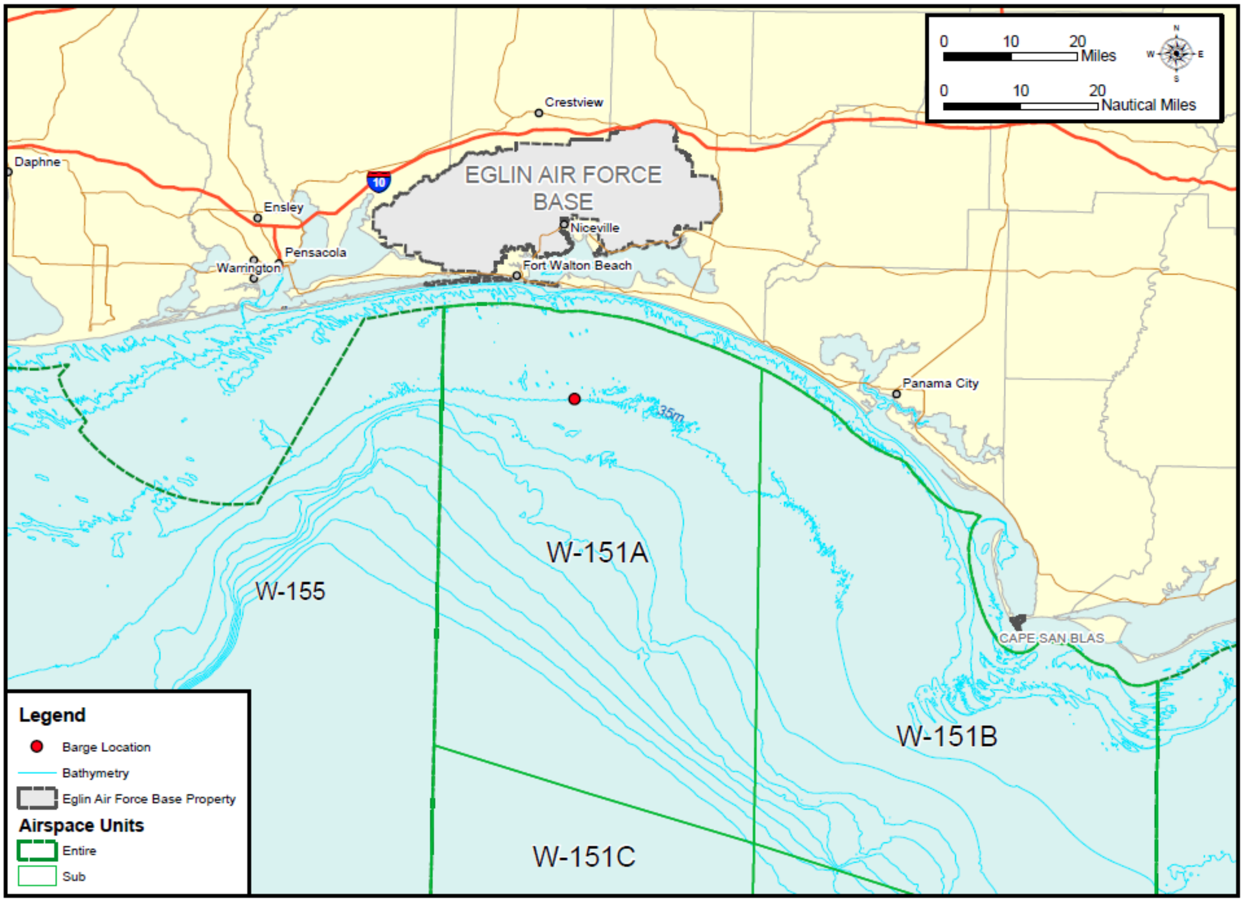

Figure 2-1. Maritime WSEP Operational Testing Location in W-151A

3. MARINE MAMMAL SPECIES AND NUMBERS

Marine mammals that potentially occur within the northeastern GOM include numerous species of cetaceans and one sirenian, the Florida manatee (*Trichechus manatus latirostris*). Manatees primarily inhabit coastal and inshore waters, and are rarely sighted offshore. Maritime WSEP missions will be conducted approximately 17 miles off the coast. Therefore manatee occurrence is considered unlikely, and further discussion of marine mammal species is limited to cetaceans.

Up to 28 cetacean species occur in the northern GOM. However, species with likely occurrence in the test area, and therefore evaluated in this document, are limited to the bottlenose dolphin (*Tursiops truncatus*) and Atlantic spotted dolphin (*Stenella frontalis*). These two species are frequently sighted in the northern Gulf over the continental shelf, in a water depth range that encompasses the Maritime WSEP testing location (Garrison, 2008; DON, 2007; Davis et al., 2000). Dwarf sperm whales (*Kogia sima*) and pygmy sperm whales (*Kogia breviceps*) are occasionally sighted over the shelf, but are not considered regular inhabitants (Davis et al., 2000). The remaining cetacean species are primarily considered to occur at and beyond the shelf break (water depth of approximately 200 meters), and are therefore not included.

Bottlenose and spotted dolphin density estimates used in this document were obtained from two sources. Bottlenose dolphin estimates were obtained from a habitat modeling project conducted for portions of the EGTTR, including the Maritime WSEP mission area, as described in Garrison (2008). As part of the modeling effort, personnel from NOAA Fisheries' Southeast Fisheries Science Center (SEFSC) conducted line transect aerial surveys of the continental shelf and coastal waters of the eastern GOM during winter (February 2007; water temperatures of 12-15°Celsius) and summer (July/August 2007; water temperatures >26°Celsius). The surveys covered nearshore and continental shelf waters (to a maximum depth of 200 meters), with the majority of effort concentrated in waters from the shoreline to 20 meters depth. Marine species encounter rates during the surveys were corrected for sighting probability and the probability that animals were available on the surface to be seen. The survey data were combined with remotely sensed environmental data/habitat parameters (water depth, sea surface temperature [SST], and chlorophyll-*a* concentration) to develop habitat models. The technical approach, described as Generalized Regression and Spatial Prediction, spatially projects the species-habitat relationship based on distribution of environmental factors, resulting in predicted densities for un-sampled locations and times. The spatial density model can therefore be used to predict relative density in unobserved areas and at different times of year based upon the monthly composite SST and chlorophyll datasets derived from satellite data. Similarly, the spatial density model can be used to predict relative density for any sub-region within the surveyed area.

Garrison (2008) produced bottlenose dolphin density estimates at various spatial scales within the EGTTR. At the largest scale, density data were aggregated into four principal strata categories: North-Inshore, North-Offshore, South-Inshore, and South-Offshore. Densities for these strata were provided in the published survey report. Unpublished densities were also provided for smaller blocks (sub-areas) corresponding to airspace units, and a number of these sub-areas were combined to form larger zones. Densities in these smaller areas were provided to Eglin AFB in Excel© spreadsheets by the report author.

For both large areas and sub-areas, regions occurring entirely within waters deeper than 200 meters were excluded from predictions, and those straddling the 200 meter isobath were clipped to remove deep water areas. In addition, because of limited survey effort, density estimates beyond 150 meters water depth are considered invalid. The environmental conditions encountered during the survey periods (February and July/August) do not necessarily reflect the range of conditions potentially encountered throughout the year. In particular, the transition seasons of spring (April-May) and fall (October-November) have a very different range of water temperatures. Accordingly, for predictions outside of the survey period or spatial range, it is necessary to evaluate the statistical variance in predicted values when attempting to apply the model. The coefficient of variation (CV) of the predicted quantity is used to measure the validity of model predictions. According to Garrison (2008), the best predictions have CV values of approximately 0.2. When CVs approach 0.7, and particularly when they exceed 1.0, the resulting model predictions are extremely uncertain and are considered invalid.

Based upon the preceding discussion, the bottlenose dolphin density estimate used in this document is the median density corresponding to sub-area 137 (Figure 3-1). The planned Maritime WSEP test area lies within this sub-area. Within this block, Garrison (2008) provided densities based upon one year (2007) and five-year monthly averages for SST and chlorophyll. The five year average is considered preferable. Only densities with a CV rounded to 0.7 or lower (i.e., 0.64 and below) were considered. Maritime WSEP test activities could occur any time during February or March. Accordingly, the density estimate associated with the highest monthly five-year average with an acceptable corresponding CV value was used for this analysis. Density estimate of bottlenose dolphins for February is 1.019 and for March is 1.194, therefore the higher of the two estimates was used in this analysis. The CV for March in this particular block is 0.28.

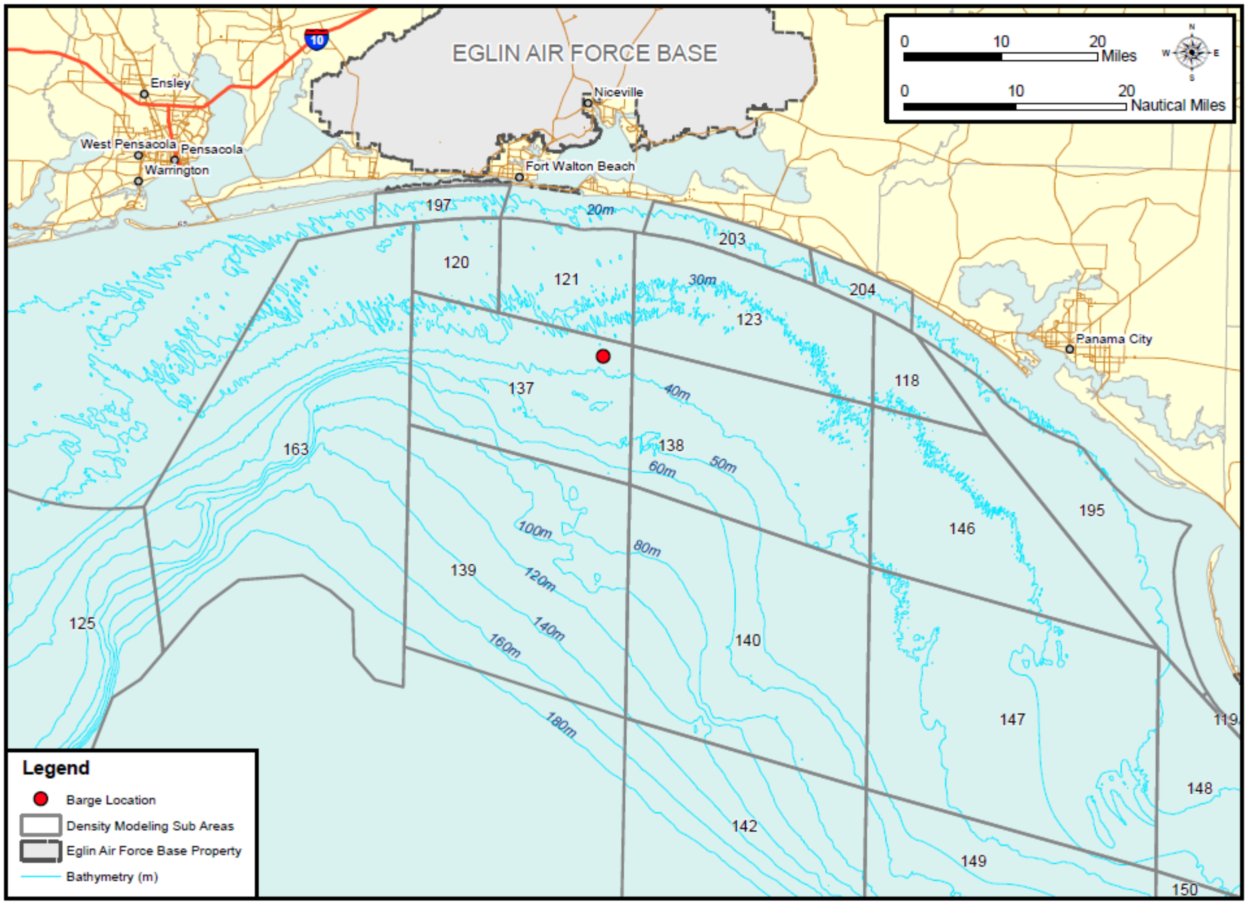

Figure 3-1. Sub-Areas Included in Garrison (2008)

Atlantic spotted dolphin density was derived from Fulling et al. (2003), which describes the results of mammal surveys conducted in association with fall ichthyoplankton surveys from 1998 to 2001. The surveys were conducted by SEFSC personnel from the U.S.-Mexico border to southern Florida, in water depths of 20 to 200 meters. Using the software program DISTANCE©, density estimates were generated for East and West regions, with Mobile Bay as the dividing point. The East region is used in this document. Densities were provided for Atlantic spotted dolphins and unidentified *T. truncatus*/*S. frontalis* (among other species). The unidentified *T. truncatus*/*S. frontalis* category is treated as a separate species group with a unique density. Density estimates from Fulling et al. (2003) were not adjusted for sighting probability (perception bias) or surface availability (availability bias) [g(0) = 1] in the original survey report, likely resulting in underestimation of true density. Perception bias refers to the failure of observers to detect animals, although they are present in the survey area and available to be seen. Availability bias refers to animals that are in the survey area, but are not able to be seen because they are submerged when observers are present. Perception bias and availability bias result in the underestimation of abundance and density numbers (negative bias).

Fulling et al. (2003) did not collect data to correct density for perception and availability bias. However, in order to address this negative bias, Eglin AFB has adjusted density estimates based on information provided in available literature. There are no published g(0) correction factors for Atlantic spotted dolphins. However, Barlow (2006) estimated g(0) for numerous marine mammal species near the Hawaiian Islands, including offshore pantropical spotted dolphins (*Stenella attenuata*). Separate estimates for this species were provided for group sizes of 1 to 20 animals [g(0) = 0.76], and greater than 20 animals [g(0) = 1.00]. Although Fulling et al. (2003) sighted some spotted dolphin groups of more than 20 individuals, the 0.76 value is used as a more conservative approach. Barlow (2006) provides the following equation for calculating density:

$$\text{Density (\# animals/km}^2\text{)} = \frac{(n)\,(S)\,(f_0)}{(2L)\,(g_0)}$$

Where n = number of animal group sightings on effort
S = mean group size
f(0) = sighting probability density at zero perpendicular distance (influenced by species detectability and sighting cues such as body size, blows, and number of animals in a group)
L = transect length completed (km)
g(0) = probability of seeing a group directly on a trackline (influenced by perception bias and availability bias)

Because (n), (S), and (f_0) cannot be directly incorporated as independent values due to lack of the original information, we substitute the variable $X_{species}$ which incorporates all three values, such that $X_{species}$ = (n)(S)(f_0) for a given species. This changes the density equation to:

$$D = \frac{X_{species}}{(2L)\,(g_0)}$$

Using the minimum density estimates provided in Fulling et al. (2003) for Atlantic spotted dolphins and solving for $X_{SpottedDolphin}$:

$$0.201 = \frac{X_{Spotted\ Dolphin}}{(2)\,(816)\,(1.0)}$$

$$X_{SpottedDolphin} = 328.032.$$

Placing this value of $X_{SpottedDolphin}$ and the revised g(0) estimate (0.76) in the original equation results in the following adjusted density estimate for Atlantic spotted dolphin:

$$D_{Adjusted} = \frac{328.032}{(2)(816)(0.76)}$$

$$D_{Adjusted} = 0.265$$

Using the same method, adjusted density for the unidentified *T. truncatus*/*S. frontalis* species group is 0.009 animals/km^2. There are no variances attached to either of these recalculated density values, so overall confidence in these values is unknown.

Table 3-1 shows the densities for each species and species group used in this document to calculate potential takes.

Table 3-1. Marine Mammal Density Estimates

Species	Adjusted Density (animals/km^2)
Bottlenose dolphin[1]	1.194
Atlantic spotted dolphin[2]	0.265
Unidentified bottlenose dolphin/Atlantic spotted dolphin[2]	0.009

[1]Source: Garrison, 2008; adjusted for observer and availability bias by the author
[2]Source: Fulling et al., 2003; adjusted for negative bias based on information provided by Barlow (2003; 2006)

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

Information on each dolphin species, including general descriptions, status, and occurrence, is provided below. Descriptions include Potential Biological Removal (PBR). PBR is defined as the maximum number of animals that may be removed, not including natural mortalities, from a stock while allowing that stock to reach or maintain its optimal sustainable population. In addition, the NMFS has identified certain cetacean stocks as strategic. A "strategic stock" is a marine mammal stock considered likely to be listed under the Endangered Species Act of 1973 (ESA), currently listed under the ESA, currently listed as depleted under the MMPA, or for which the level of non-natural mortality or serious injury (e.g. from commercial fishing) exceeds the PBR level.

Distribution of cetaceans in the Gulf is influenced by hydrographic and bathymetric features. The dominant hydrographic feature in the Gulf is the Loop Current that, though generally south of the continental slope, can generate anti-cyclonic (clockwise circulating) and cyclonic (counterclockwise) eddies that move onto or influence the slope and shelf regions. Davis et al. (2000) noted during 1997-98 surveys of the northern Gulf of Mexico that cetaceans were concentrated along the continental slope and in or near cyclonic eddies. Cetaceans may also be associated with seafloor features such as the DeSoto Canyon, Florida Escarpment, Mississippi Canyon, and Mississippi River Delta. These and other bathymetric features are shown on Figure 4-1.

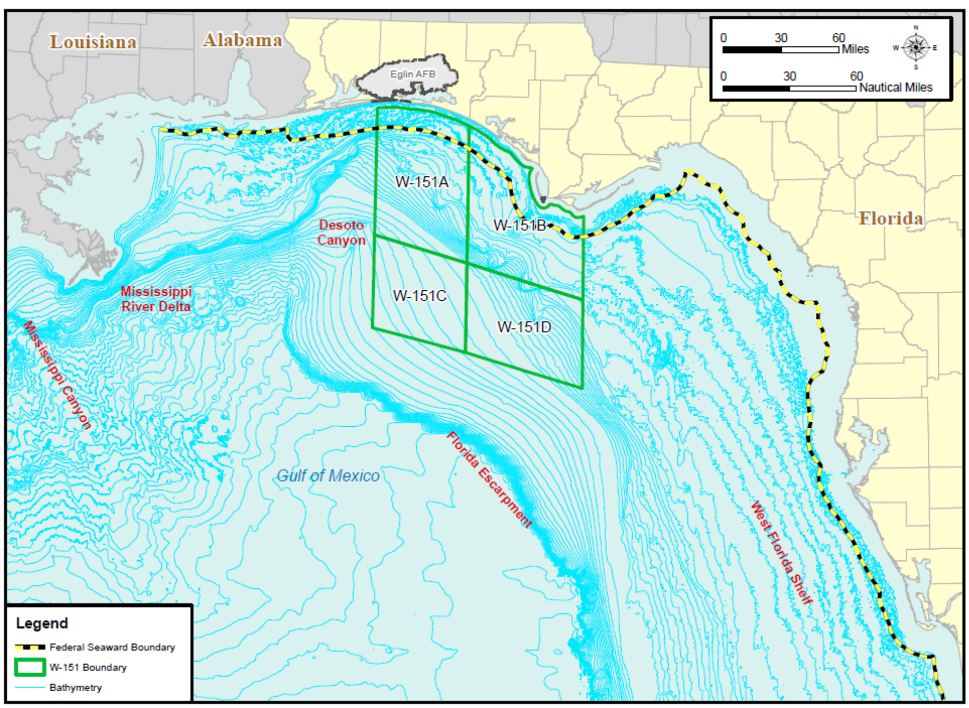

Figure 4-1. Topographical Features of the Gulf of Mexico in Relation to W-151

4.1 BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

4.1.1 Description

Bottlenose dolphins are large and robust, varying in color from light gray to charcoal. The genus *Tursiops* is named for its short, stocky snout that is distinct from the melon (Jefferson et al., 1993). The dorsal fin is tall and falcate. There are regional variations in body size, with adult lengths from 1.9 to 3.8 m (6.2 to 12.5 ft) (Jefferson et al., 1993).

Scientists currently recognize a nearshore (coastal) and an offshore form of bottlenose dolphins, which are distinguished by external and cranial morphology, hematology, diet, and parasite load (Duffield et al., 1983; Hersh and Duffield, 1990; Mead and Potter, 1995; Curry and Smith, 1997). There is also a genetic distinction between nearshore and offshore bottlenose dolphins worldwide (Curry and Smith, 1997; Hoelzel et al., 1998). It has been suggested that the two forms should be considered different species (Curry and Smith, 1997; Kingston and Rosel, 2004), but no official taxonomic revisions have been made.

4.1.2 Status

In the northern GOM, there are coastal stocks; a continental shelf stock; an oceanic stock; and 32 bay, sound, and estuarine stocks (Waring et al., 2006). Sellas et al. (2005) reported the first evidence that the coastal stock off west central Florida is genetically separated from the adjacent inshore areas. Table 4-1 summarizes information on bottlenose dolphin stocks that occur in the north-central Gulf of Mexico, although not all these stocks have an equal probability of occurrence in the Maritime WSEP test area. More detailed descriptions follow the table. Descriptions were obtained from stock assessment reports available on the NMFS website.

Table 4-1. Bottlenose Dolphin Stocks in the North-Central Gulf of Mexico

Stock		Distribution	Strategic Stock	Estimated Abundance	PBR
Bay, Sound, & Estuarine Stocks:	Choctawhatchee Bay	Areas of contiguous, enclosed, or semi-enclosed water bodies	Yes	179 resident, 53 transient	1.7
	Pensacola/East Bay		Yes	33	U
	St. Andrew Bay		Yes	124	U
Gulf of Mexico Northern Coastal		Waters from shore to the 20-meter (66-foot) isobath, from the Mississippi River delta to the Florida Big Bend region	Yes	2,473	20
Northern Gulf of Mexico Continental Shelf		Waters between the 20- and 200-meter (66- and 656-foot) isobaths, from Texas to Key West	No	17,777	U
Northern Gulf of Mexico Oceanic		Waters from the 200-meter (656-foot) isobath to the seaward extent of the U.S. Exclusive Economic Zone	No	5,806	42

PBR = Potential Biological Removal; U = undetermined

Genetic, photo-identification, and tagging data support the concept of relatively discrete bay, sound, and estuarine stocks. The NMFS has provisionally identified 32 such stocks which inhabit areas of contiguous, enclosed, or semi-enclosed water bodies adjacent to the northern GOM. The stocks are based on a description of dolphin communities in some areas of the Gulf coast. A community is generally defined as resident dolphins that regularly share a large portion of their range; exhibit similar distinct genetic profiles; and interact with each other to a much greater extent than with dolphins in adjacent waters. Although the shoreward boundary of W-151 is beyond these environments, individuals from these stocks could potentially enter the study area. Movement between various communities has been documented (Waring et al., 2009), and Fazioli et al. (2006) reported that dolphins found within bays, sounds, and estuaries on the west central Florida coast move into the nearby Gulf waters used by coastal stocks. Maritime WSEP activities will occur seaward of the area considered to be occupied by the Choctawhatchee Bay stock. The best abundance estimate for this stock, as provided in the Stock Assessment Report, is 179 resident dolphins, with an additional 232 transient dolphins. Stocks immediately to the west and east of Choctawhatchee Bay include Pensacola/East Bay and St. Andrew Bay stocks. PBR for the Choctawhatchee Bay stock is 1.7 individuals. NMFS considers all 32 stocks to be strategic.

Three coastal stocks have been identified in the northern GOM, occupying waters from the shore to the 20-meter (66-foot) isobath: Eastern Coastal, Northern Coastal, and Western Coastal stocks. The Western Coastal stock inhabits nearshore waters from the Texas/Mexico border to the Mississippi River Delta. The Northern Coastal stock's range is considered to be from the Mississippi River Delta to the Big Bend region of Florida (approximately 84°W). The Eastern Coastal stock is defined from 84°W to Key West, Florida. Of the coastal stocks, the Northern Coastal is geographically most closely associated with the Maritime WSEP mission area. PBR is 20 individuals. Prior to 2012, this stock was not considered strategic. However, the Draft 2012 Stock Assessment Report identifies an ongoing Unusual Mortality Event of unprecedented size and duration (since February 2012) that has resulted in NMFS' reclassification of this stock as strategic.

The Northern GOM Continental Shelf stock is defined as bottlenose dolphins inhabiting the waters from the Texas/Mexico border to Key West, Florida, between the 20- and 200-meter (66- and 656-foot) isobaths. The continental shelf stock probably consists of a mixture of coastal and offshore ecotypes. PBR is undetermined, and the stock is not considered strategic.

The Oceanic stock is provisionally defined as bottlenose dolphins inhabiting waters from the 200-meter (656-foot) isobath to the seaward extent of the U.S. Exclusive Economic Zone. This stock is believed to consist of the offshore form of bottlenose dolphins. The continental shelf stock may overlap with the oceanic stock in some areas and may be genetically indistinguishable. PBR is 42 individuals, and the stock is not considered strategic.

4.1.3 Diving Behavior

Dive durations as long as 15 minutes are recorded for trained individuals (Ridgway et al., 1969). Typical dives, however, are more shallow and of a much shorter duration. Mean dive durations of Atlantic bottlenose dolphins typically range from 20 to 40 seconds at shallow depths (Mate et al., 1995) and can last longer than 5 minutes during deep offshore dives (Klatsky et al., 2005). Offshore bottlenose dolphins regularly dive to 450 meters (1,476 feet) and possibly as deep as 700 meters (2,297 feet) (Klatsky et al., 2005).

4.1.4 Acoustics and Hearing

Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated. Clicks and whistles have a dominant frequency range of 110 to 130 kiloHertz (kHz) and a source level of 218 to 228 decibels referenced to one micropascal-meter (dB re 1 μPa-m peak-to-peak) (Au, 1993) and 3.4 to 14.5 kHz and 125 to 173 dB re 1 μPa-m peak-to-peak, respectively (Ketten, 1998). Whistles are primarily associated with communication and can serve to identify specific individuals (i.e., signature whistles) (Caldwell and Caldwell, 1965; Janik et al., 2006). Up to 52 percent of whistles produced by bottlenose dolphin groups with mother-calf pairs can be classified as signature whistles (Cook et al., 2004). Sound production is also influenced by group type (single or multiple individuals), habitat, and behavior (Nowacek, 2005). Bray calls (low-frequency vocalizations; majority of energy below 4 kHz), for example, are used when capturing fishes in some regions (Janik, 2000). Additionally, whistle production has been observed to increase while feeding (Acevedo-Gutiérrez and Stienessen, 2004; Cook et al., 2004). Furthermore, both whistles and clicks have been demonstrated to vary geographically in terms of overall vocal activity, group size, and specific context (e.g., feeding, milling, traveling, and socializing) (Jones and Sayigh, 2002; Zaretsky et al., 2005; Baron, 2006).

Bottlenose dolphins can hear within a broad frequency range of 0.04 to 160 kHz (Au, 1993; Turl, 1993). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and another for lower-frequency sounds, such as whistles (Ridgway, 2000). Scientists have reported a range of highest sensitivity between 25 and 70 kHz, with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). Recent research on the same individuals indicates that auditory thresholds obtained by electrophysiological methods correlate well with those obtained in behavior studies, except at lower (10 kHz) and higher (80 and 100 kHz) frequencies (Finneran and Houser, 2006).

Temporary threshold shifts (TTS) in hearing have been experimentally induced in captive bottlenose dolphins using a variety of noises (i.e., broad-band, pulses) (Ridgway et al., 1997; Schlundt et al., 2000; Nachtigall et al., 2003; Finneran et al., 2005; Mooney et al., 2005; Mooney, 2006). For example, TTS has been induced with exposure to a 3 kHz, one-second pulse with sound exposure level (SEL) of 195 decibels referenced to one squared micropascal per second (dB re 1 μPa^2-s) (Finneran et al., 2005), one-second pulses from 3 to 20 kHz at 192 to 201 decibels referenced to one microPascal-meter (dB re 1μPa-m) (Schlundt et al., 2000), and octave band noise (4 to 11 kHz) for 50 minutes at 179 dB re 1 μPa-m (Nachtigall et al., 2003). Preliminary research indicates that TTS and recovery after noise exposure are frequency dependent and that an inverse relationship exists between exposure time and sound pressure level associated with exposure (Mooney et al., 2005; Mooney, 2006). Observed changes in behavior were induced with an exposure to a 75 kHz one-second pulse at 178 dB re 1 μPa-m (Ridgway et al., 1997; Schlundt et al., 2000). Finneran et al. (2005) concluded that a SEL of 195 dB re 1 μPa^{2-}s is a reasonable threshold for the onset of TTS in bottlenose dolphins exposed to mid-frequency tones.

4.1.5 Distribution

Bottlenose dolphins are distributed worldwide in tropical and temperate waters. The species occurs in all three major oceans and many seas. In the western North Atlantic, bottlenose dolphins occur as far north as Nova Scotia but are most common in coastal waters from New England to Florida, the Gulf of Mexico, the Caribbean, and southward to Venezuela and Brazil (Würsig et al., 2000). Bottlenose dolphins occur seasonally in estuaries and coastal embayments as far north as Delaware Bay (Kenney, 1990) and in waters over the outer continental shelf and inner slope, as far north as Georges Bank (CETAP, 1982; Kenney, 1990).

The bottlenose dolphin is by far the most widespread and common cetacean in coastal waters of the GOM (Würsig et al., 2000). Bottlenose dolphins are frequently sighted near the Mississippi River Delta (Baumgartner et al., 2001) and have even been known to travel several kilometers up the Mississippi River.

Gulf of Mexico

Bottlenose dolphins are abundant in continental shelf waters throughout the northern GOM (Fulling et al., 2003; Waring et al. (2006), including the outer continental shelf, upper slope, nearshore waters, the DeSoto Canyon region, the West Florida Shelf, and the Florida Escarpment. Mullin and Fulling (2004) noted that in oceanic waters, bottlenose dolphins are encountered primarily in upper continental slope waters (less than 1,000 meters in bottom depth) and that highest densities are in the northeastern Gulf. Significant occurrence is expected near all bays in the northern Gulf.

The results of a recent survey effort of nearshore and continental shelf waters of the eastern GOM (Garrison, 2008) identified four areas where bottlenose dolphins were clustered in winter: nearshore waters off Louisiana, the Florida Panhandle, north of Tampa Bay, and southwestern Florida. Dolphins were also common over the entire shelf. In summer, the number of group sightings was comparatively lower than in winter (162 versus 281), and bottlenose dolphins were more evenly distributed throughout coastal and shelf waters.

4.2 ATLANTIC SPOTTED DOLPHIN (*STENELLA FRONTALIS*)

4.2.1 Description

The Atlantic spotted dolphin has features that resemble the bottlenose dolphin. In body shape, it is typically somewhat larger than the inshore bottlenose dolphin ecotype, with a moderately long, thick beak. The dorsal fin is tall and falcate and there is generally a prominent spinal blaze. Adults are up to 2.3 meters (7.5 feet) long and can weigh as much as 143 kilograms (315 pounds) (Jefferson et al., 1993). Atlantic spotted dolphins are born spotless and develop spots as they age (Perrin et al., 1994; Herzing, 1997). Some individuals become so heavily spotted that the dark cape and spinal blaze are difficult to see (Herzing, 1997).

There is marked regional variation in adult body size of the Atlantic spotted dolphin (Perrin et al., 1987). In addition, there are two forms: a robust, heavily spotted form that inhabits the continental shelf, usually found within 250 to 350 km (135 to 189 NM) of the coast, and a smaller, less-spotted form that inhabits offshore waters (Perrin et al., 1994). The largest body size occurs in waters over the continental shelf of North America (East Coast and Gulf of Mexico) and Central America (Perrin, 2002). The smaller, offshore form is not known to occur in the GOM.

4.2.2 Status

The most recent abundance estimate, as provided in the 2012 Draft Stock Assessment Report, is 37,611 individuals in the northern GOM (outer continental shelf and oceanic waters). The northern GOM population is considered genetically differentiated from the western North Atlantic populations. PBR for this species is undetermined. This is not considered a strategic stock

4.2.3 Diving Behavior

Information on diving depth for this species is available from a satellite-tagged individual in the Gulf of Mexico (Davis et al., 1996a). This individual made short, shallow dives to less than 10 meters (33 feet) and as deep as 60 meters (197 feet), while in waters over the continental shelf on 76 percent of dives.

4.2.4 Acoustics and Hearing

A variety of sounds including whistles, echolocation clicks, squawks, barks, growls, and chirps have been recorded for the Atlantic spotted dolphin. Whistles have dominant frequencies below 20 kHz (range: 7.1 to 14.5 kHz) but multiple harmonics extend above 100 kHz, while burst pulses consist of frequencies above 20 kHz (dominant frequency of approximately 40 kHz) (Lammers et al., 2003). Other sounds, such as squawks, barks, growls, and chirps, typically range in frequency from 0.1 to 8 kHz (Thomson and Richardson, 1995). Recorded echolocation clicks had two dominant frequency ranges at 40 to 50 kHz and 110 to 130 kHz, depending on source level (i.e., lower source levels typically correspond to lower frequencies and higher frequencies to higher source levels (Au and Herzing, 2003). Echolocation click source levels as high as 210 dB re 1 μPa-m peak-to-peak have been recorded (Au and Herzing, 2003). Spotted dolphins in The Bahamas were frequently recorded during agonistic/aggressive interactions with bottlenose dolphins (and their own species) to produce squawks (0.2 to 12 kHz broad band burst pulses; males and females), screams (5.8 to 9.4 kHz whistles; males only), barks (0.2 to 20 kHz burst pulses; males only), and synchronized squawks (0.1-15 kHz burst pulses; males only in a coordinated group) (Herzing, 1996).

Hearing ability for the Atlantic spotted dolphin is unknown. However, odontocetes are generally adapted to hear high-frequencies (Ketten, 1997).

4.2.5 Distribution

Atlantic spotted dolphins are distributed in warm-temperate and tropical Atlantic waters from northern New England to Venezuela, including the GOM and the Caribbean Sea (Perrin et al., 1987). Atlantic spotted dolphins may occur in both continental shelf and offshore waters (Perrin et al., 1994). In oceanic waters, this species usually occurs near the shelf break and upper continental slope waters (Davis et al., 1998; Mullin and Hansen, 1999).

Gulf of Mexico

Atlantic spotted dolphins in the northern GOM are abundant in continental shelf waters (Fulling et al., 2003; Waring et al., 2006). In the GOM, Atlantic spotted dolphins are most abundant east of Mobile Bay (Fulling et al., 2003). On the West Florida shelf, spotted dolphins are more common in deeper waters than bottlenose dolphins (Griffin and Griffin, 2003); Griffin and Griffin (2004) reported higher densities of spotted dolphins in this area during November through May.

In winter, there may be occurrence in waters over the continental shelf and along the shelf break throughout the entire northern GOM. Stranding data suggest that this species may be more common than the survey data demonstrate.

Occurrence during spring is primarily in the vicinity of the shelf break from central Texas to southwestern Florida. Sighting data reflect high usage of the Florida Shelf by this species.

In summer, occurrence is primarily in waters over the continental shelf, along the shelf break throughout the entire northern GOM, and over the Florida Escarpment. Sighting data shows increased usage of the Florida Shelf, as well as the Florida Panhandle and inshore of DeSoto Canyon. An additional area of increased occurrence is predicted in shelf waters off western Louisiana.

In fall, the sighting data demonstrate occurrence in waters over the continental shelf and along the shelf break throughout the entire northern GOM. There are numerous sightings in the Mississippi River delta region and Florida Panhandle. This is the season with the least amount of systematic survey effort, and inclement weather conditions can make sighting cetaceans difficult during this time of year.

5. TAKE AUTHORIZATION REQUESTED

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 for two levels thereof, Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act of fiscal year 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 Maritime WSEP activities occurring in the EGTTR mission area. The amended definition of harassment for military readiness activities 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.

Pursuant to Section 101(a)(5), an Incidental Harassment Authorization (IHA) for the incidental taking (but not intentional taking) of marine mammals is requested for Maritime WSEP Operational Testing activities within the EGTTR. Take is requested for harassment only, including Level A and Level B (physiological and behavioral) harassment. Taking into consideration the mitigation measures identified in Chapter 11, no takes in the form of mortality are anticipated or requested. The subsequent analyses in this request will identify the applicable types of take.

6. NUMBERS AND SPECIES TAKEN

Cetaceans spend their entire lives in the water and are entirely submerged below the surface most of the time (greater than 90 percent for most species). When at the surface, unless engaging in behaviors such as jumping, spyhopping, etc., the body is almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This can make cetaceans difficult to locate visually and also exposes them to underwater noise, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface. Marine mammals may be potentially injured or harassed due to noise or pressure waves from detonation of live ordnance during Maritime WSEP tests. The potential numbers and species taken are assessed in this section. Appendix A includes a description of the acoustic modeling methodology used to estimate exposures as well as model results.

Three key sources of information are necessary for estimating potential noise effects on marine mammals: 1) the zone of influence, which is the distance from the explosion to which a particular energy or pressure threshold extends; 2) the density of animals potentially occurring within the zone of influence; and 3) the number of events.

6.1 ZONE OF INFLUENCE

The zone of influence (ZOI) is defined as the area or volume of ocean in which marine mammals could potentially be exposed to various noise thresholds associated with exploding ordnance. Marine mammals may be affected by certain energy and pressure levels resulting from the detonations. Criteria and thresholds generally used for impact assessment were originally developed for the shock trials of the *USS SEAWOLF* and *USS Winston S. Churchill* (DDG-81) and modified over the years as the science became better understood. The analysis of potential impacts to marine mammals adopts criteria and thresholds presented in Finneran and Jenkins (2012), which have been recently adopted by NMFS.

The paragraphs below provide a general discussion of the various metrics, criteria, and thresholds used for impulsive or explosive noise impact assessment of marine mammals. More information on this topic is provided in Appendix A.

6.2 METRICS

Standard impulsive and acoustic metrics were used for the analysis of underwater energy and pressure waves in this document. Several different metrics are important for understanding risk assessment analysis of impacts to marine mammals.

SPL (Sound pressure level): A ratio of the absolute sound pressure and a reference level. Units are in decibels re 1 micro Pascal (dB re 1µPa).

SEL (Sound exposure level): SEL is a measure of sound intensity and duration. When analyzing effects on marine animals from multiple moderate-level sounds, it is necessary to have a metric that quantifies cumulative exposures (American National Standards Institute 1994). SEL can be thought of as a composite metric that represents both the intensity of a sound and its duration. SEL is determined by calculating the decibel level of the cumulative sum-of-squared pressures over the duration of a sound, with units of dB re 1 micro Pascal-squared seconds ($\mu Pa^2 \cdot s$) for sounds in water.

Positive Impulse: This is the time integral of the pressure over the initial positive phase of an arrival. This metric represents a time-averaged pressure disturbance from an explosive source. Units are typically Pascal-second (Pa·s) or pounds per square inch per millisecond (psi·msec). There is no decibel analog for impulse.

6.3 CRITERIA AND THRESHOLDS

6.3.1 Mortality

Whereas a single mortality threshold was previously used in acoustic impacts analysis, species specific thresholds are used today. Thresholds are based on the level of underwater blast noise that would cause extensive lung injury from which 1% of animals exposed would not recover (Finneran and Jenkins, 2012). The threshold is conservative in that it represents the onset of mortality, and 99% of animals exposed would be expected to survive. The lethal exposure level of blast noise, associated with the positive impulse pressure of the blast, is expressed as Pa·s and determined using the Goertner (1982) modified positive impulse equation. This equation considers factors of sound propagation, source/animal depths and the mass of a newborn calf for a given species. The threshold is conservative because animals of greater mass can withstand greater pressure shock waves, and newborn calves typically make up a very small percentage of any cetacean group.

For the Proposed Action, two species are expected to occur within the study area, the bottlenose dolphin and the Atlantic spotted dolphin. Finneran and Jenkins (2012) provide known or surrogate masses for newborn calves of several cetacean species. For the bottlenose dolphin, this value is 14 kg; for the Atlantic spotted a surrogate species, the striped dolphin is used and the mass value of a newborn calf is 7 kg. Impacts analysis for unidentified dolphins conservatively used the mass of the smaller Atlantic spotted dolphin, as this species category is assumed to be comprised of both bottlenose and Atlantic spotted dolphins. The Goertner equation as presented in Finneran and Jenkins, and used in the acoustic model to develop impacts analysis in this IHA request is as follows:

$$I_M(M,D) = 91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$$

$I_M(M,D)$ mortality threshold, expressed in terms of acoustic impulse (Pa·s)

M Animal mass (Table D-1)

D Water depth (m)

6.3.2 Injury (Level A Harassment)

The latest NMFS-endorsed guidance recognizes three types of blast related injury: gastrointestinal tract injury, slight lung injury and irrecoverable auditory damage. The injury categories are all types of Level A Harassment as defined in the MMPA.

6.3.2.1 *Gastrointestinal Tract Injuries*

Gastrointestinal (GI) tract injuries are correlated with peak pressure of an underwater detonation. For recoverable injury observed during experiments with small charges in the 1970s, the peak pressure of the shock wave was the causal agent of contusions in the GI tract (Richmond et al., 1973 in Finneran and Jenkins, 2012). The experiments found that a peak SPL of 237 dB re 1μPa predicts the onset of GI tract injuries, which are independent of an animal's mass or size. Therefore, the unweighted peak SPL of 237 dB re 1 μPa is used in explosive impacts assessments as the threshold for slight GI tract injury for all marine mammals.

6.3.2.2 *Slight Lung Injury*

Thresholds for slight lung injury to marine mammals exposed to underwater blasts are defined as a survivable occurrence of slight lung injury, from which all animals would survive. As with the mortality determination, the metric is positive impulse and the equation for determination is that of the Goertner injury model (1982), which is defined as:

$$I_S(M,D) = 39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2},$$

where M is the animal mass (kg), D is the animal depth (m), and the units of I_S are Pa·s.

As the equation incorporates species specific body masses, the mass of a newborn calf for bottlenose and Atlantic spotted dolphins will apply to the Maritime WSEP study area. For unidentified dolphins the mass of Atlantic spotted dolphins is used as it was with the mortality equation.

6.3.2.3 *Auditory Damage (Permanent Threshold Shift)*

Another type of injury, permanent threshold shift or PTS is auditory damage that does not recover, and results in a permanent decrease in hearing sensitivity. As there have been no studies to determine the onset of PTS in marine mammals this threshold is estimated from available information. Jenkins and Finneran define PTS thresholds differently for three groups of cetaceans based on their hearing sensitivity: low-frequency, mid-frequency and high-frequency. Bottlenose and Atlantic spotted dolphins that are the subject of the Maritime WSEP acoustic impacts analysis both fall within the mid-frequency hearing category. The PTS thresholds use a dual criterion, one based on SEL and one based on SPL of an underwater blast. For a given analysis the more conservative of the two is applied to afford the most protection to marine mammals. The mid-frequency cetacean criteria for PTS are:

- SEL (mid-frequency weighted) of 187 dB re 1 $\mu Pa^2 \cdot s$ and
- Peak SPL (unweighted) of 230 dB re 1 μPa.

6.3.3 Non-injurious Impacts (Level B Harassment)

Public Law 108-136 (2004) amended the definition of Level B harassment under the MMPA for military readiness activities (Maritime WSEP testing qualifies for this category of activity). For such activities, Level B harassment is 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." Thus, Level B harassment is limited to the non-injurious impacts, but physiological impact of temporary threshold shift (TTS), and behavioral impacts.

6.3.3.1 *Temporary Threshold Shift (TTS)*

According to Finneran and Jenkins (2012) the TTS onset thresholds for mid-frequency cetaceans are based on TTS data from a beluga whale exposed to an underwater impulse produced from a seismic watergun (Finneran et al., 2002). TTS thresholds also use a dual criterion and in a given analysis the more conservative of the two criteria is applied. The TTS thresholds for bottlenose and Atlantic spotted dolphins consist of the SEL of an underwater blast weighted to the hearing sensitivity of mid-frequency cetaceans, and a peak SPL measure of the same. The dual thresholds for TTS in mid-frequency cetaceans are:

- SEL (mid-frequency weighted) of 172 dB re 1 $\mu Pa^2 \cdot s$ and
- Peak SPL (unweighted) of 224 dB re 1 μPa.

6.3.3.2 *Behavioral Impacts*

Behavioral impacts are essentially disturbances that may occur at noise levels below those considered to cause TTS in marine mammals, particularly in cases of multiple detonations. Behavioral impacts may include decreased ability to feed, communicate, migrate, or reproduce, among others. Such effects, known as sub-TTS Level B harassment, are based on observations of behavioral reactions in captive dolphins and belugas to pure tones, a different type of noise than that produced from an underwater detonation (Finneran and Schlundt, 2004; Schlundt *et al.*, 2000). The behavioral impacts threshold for mid-frequency cetaceans exposed to multiple, successive detonations is:

- SEL (mid-frequency weighted) of 167 dB re 1 $\mu Pa^2 \cdot s$

Table 6-1 summarizes the thresholds and criteria discussed above and used in this document to estimate potential noise impacts to marine mammals. All criteria and thresholds for cetaceans are derived from Finneran and Jenkins (2012).

Table 6-1. Criteria and Thresholds Used for Impact Analyses

Mortality*	Level A Harassment			Level B Harassment	
	Slight Lung Injury*	GI Tract Injury	PTS	TTS	Behavioral
$91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	$39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	Unweighted SPL: 237 dB re 1 μPa	Weighted SEL: 187 dB re 1 $\mu Pa^2 \cdot s$	Weighted SEL: 172 dB re 1 $\mu Pa^2 \cdot s$	Weighted SEL: 167 dB re 1 $\mu Pa^2 \cdot s$
			Unweighted SPL: 230 dB re 1 μPa	Unweighted SPL: 224 dB re 1 μPa (23 psi peak pressure)	

*Expressed in terms of acoustic impulse (Pacsal – seconds [Pa·s]); *M* = Animal mass based on species (kilograms); *D* = Water depth (meters); PTS = permanent threshold shift; TTS = temporary threshold shift; SPL = sound pressure level; SEL = sound exposure level; dB re 1 μPa = decibels referenced to 1 microPascal; dB re 1 $\mu Pa^2 \cdot s$ = decibels reference to 1 microPascal-squared – seconds.

6.4 MARINE MAMMAL DENSITY

Density estimates for marine mammals occurring in the EGTTR are provided in Table 3-1. As discussed in Chapter 3, densities were derived from the results of published documents authored by NMFS personnel. Density is nearly always reported for an area (e.g., animals per square kilometer). Analyses of survey results may include correction factors for negative bias, such as the Garrison (2008) report for bottlenose dolphins. Even though Fulling et al. (2003) did not provide a correction for Atlantic spotted dolphins or unidentified bottlenose/spotted dolphins, Eglin AFB adjusted those densities based on information provided in other published literature (Barlow 2003; 2006). Although the study area 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 estimates usually assume that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Marine mammals are often clumped in areas of greater importance, for example, in areas of high productivity, lower predation, safe calving, etc. Density can occasionally be calculated for smaller areas, but usually there are insufficient data to calculate density for such areas. Therefore, assuming an even distribution within the prescribed area is the typical approach.

In addition, assuming that marine mammals are distributed evenly within the water column does not accurately reflect behavior. Databases of behavioral and physiological parameters obtained through tagging and other technologies have demonstrated that marine animals use the water column in various ways. Some species conduct regular deep dives while others engage in much shallower dives, regardless of bottom depth. Assuming that all species are evenly distributed from surface to bottom is almost never appropriate and can present a distorted view of marine mammal distribution in any region. Therefore, a depth distribution adjustment is applied to marine mammal densities in this document (Table 6-2). By combining marine mammal density with depth distribution information, a three-dimensional density estimate is possible. These estimates allow more accurate modeling of potential marine mammal exposures from specific noise sources.

Table 6-2. Depth Distribution for marine Mammals in the Maritime WSEP Test Area

Species	Depth Distribution	Reference
Bottlenose dolphin	Daytime: 96% at <50 m, 4% at >50 m; Nightime: 51% at <50 m, 8% at 50-100 m, 19% at 101-250 m, 13% at 251-450 m, and 9% at >450 m.	Klatsky et al. (2007)
Atlantic spotted dolphin	76% at <10 m, 20% at 10-20 m, and 4% at 21-60 m.	Davis et al. (1996)

m = meters

6.5 NUMBER OF EVENTS

The number of events for Maritime WSEP activities generally corresponds to the number of live weapons deployed, which is provided in Table 1-2. The 30 millimeter (mm) gunnery rounds were modeled as one burst each because it is the most conservative approach. The 7.62 mm/.50 cal rounds do not contain high explosives and therefore do not detonate and introduce energy or pressure into the water column.

6.6 EXPOSURE ESTIMATES

Refer to Appendix A for a description of the acoustic modeling methodology used in this analysis. Table 6-3 provides the maximum estimated winter range, or radius, from the detonation point to which the various thresholds extend for bottlenose and Atlantic spotted dolphins. This range is then used to calculate the total area of the ZOI. The calculated ZOIs are combined with density estimates (adjusted for depth distribution) and the number of live munitions to provide an estimate of the number of marine mammals potentially exposed to the various impact thresholds (**Error! Reference source not found.** 6-4). Final exposure estimates were obtained from the results of acoustic modeling. Appendix A contains a description of the acoustic model used to determine the numbers of marine species potentially impacted by Maritime WSEP activities. For metrics with two criteria (e.g., 187 dB SEL and 230 peak SPL for Level A harassment), the criterion that yielded the higher exposure estimates are presented and used for impact calculations and do not take into account the mitigation and monitoring measures described in Chapter 11.

Table 6-3. Winter Threshold Radii (in meters) for Maritime WSEP Ordnance

Munition	NEW (lbs)	Total #	Detonation Scenario	Mortality	Level A Harassment				Level B Harassment		
				Modified Goertner Model 1	Slight Lung Injury	GI Track Injury	PTS		TTS		Behavioral
					Modified Goertner Model 2	237 dB SPL	187 dB SEL	230 dB Peak SPL	172 dB SEL	224 dB Peak SPL	167 dB SEL
Bottlenose Dolphin											
GBU-10 or GBU-24	945	2	Surface	199	350	340	965	698	1582	1280	2549
GBU-12 or GBU-54	192	6	Surface	111	233	198	726	409	2027	752	2023
AGM-65 (Maverick)	86	6	Surface	82	177	150	610	312	1414	575	1874
GBU-39 (LSDB)	37	4	Surface	59	128	112	479	234	1212	433	1543
AGM-114 (Hellfire)	20	15	(10 ft depth)	110	229	95	378	193	2070	354	3096
AGM-175 (Griffin)	13	10	Surface	38	83	79	307	165	1020	305	1343
2.75 Rockets	12	100	Surface	36	81	77	281	161	1010	296	1339
PGU-13 HEI 30 mm	0.1	1000	Surface	0	7	16	24	33	247	60	492
Atlantic Spotted Dolphin and Unidentified Dolphin[1]											
GBU-10 or GBU-24	945	2	Surface	237	400	340	965	698	1582	1280	2549
GBU-12 or GBU-54	192	6	Surface	138	274	198	726	409	2027	752	2023
AGM-65 (Maverick)	86	6	Surface	101	216	150	610	312	1414	575	1874
GBU-39 (LSDB)	37	4	Surface	73	158	112	479	234	1212	433	1543
AGM-114 (Hellfire)	20	15	(10 ft depth)	135	277	95	378	193	2070	354	3096
AGM-175 (Griffin)	13	10	Surface	47	104	79	307	165	1020	305	1343
2.75 Rockets	12	100	Surface	45	100	77	281	161	1010	296	1339
PGU-13 HEI 30 mm	0.1	1000	Surface	0	9	16	24	33	247	60	492

AGM = air-to-ground missile; cal = caliber; CBU = Cluster Bomb Unit; ft = feet; GBU = Guided Bomb Unit; HEI = high explosive incendiary; lbs = pounds; mm = millimeters; N/A = not applicable; NEW = net explosive weight; PGU = Projectile Gun Unit; SDB = small diameter bomb; PTS = permanent threshold shift; TTS = temporary threshold shift; WCMD = wind corrected munition dispenser

[1]Unidentified dolphin can be either bottlenose or Atlantic spotted dolphin. Mortality and slight lung injury criteria are conservatively based on the mass of a newborn Atlantic spotted dolphin.

Table 6-4 indicates the potential for lethality, injury, and non-injurious harassment (including behavioral harassment) to marine mammals in the absence of mitigation measures. The numbers represent total impacts for all detonations combined. Mortality was calculated as less than half an animal (0.47) for bottlenose dolphin**s,** 0.11 animals for Atlantic spotted dolphin and zero animals for unidentified dolphins. It is expected that, with implementation of the mitigation and monitoring measures outlined in Chapter 11, potential impacts would be mitigated to the point that there would be no mortality takes.

Table 6-4. Number of Marine Mammals Potentially Affected by Maritime WSEP Test Missions

Species	Mortality	Level A Harassment (PTS)	Level B Harassment (TTS)	Level B Harassment (Behavioral)
Bottlenose dolphin	0.47	33.10	405.32	862.53
Atlantic spotted dolphin	0.11	6.58	74.15	146.41
Unidentified bottlenose dolphin/Atlantic spotted dolphin	0.00	0.22	2.52	4.97
TOTAL	**0.58**	**39.90**	**481.99**	**1,013.91**

7. IMPACTS TO MARINE MAMMAL SPECIES OR STOCKS

Based on the low mortality exposure estimates calculated by the acoustic model combined with the implementation of mitigation measures identified in Chapter 11, zero marine mammals are expected to be affected by acoustic impulse levels associated with mortality. Therefore, Eglin AFB is requesting an IHA, as opposed to an LOA.

A maximum of up to approximately 40 marine mammals could potentially be exposed to injurious Level A harassment (approximately 33 bottlenose dolphins and 7 Atlantic spotted dolphins). Level A harassment could result from acoustic impulse resulting in slight lung injury, peak SPL resulting in GI track injury, or one of the thresholds resulting in the onset of PTS. Since the threshold with the highest exposure estimates was used to determine takes, impacts are associated with the 187 dB SEL threshold, which corresponds to the onset of PTS, or a permanent decrease in hearing sensitivity.

A maximum of approximately 482 marine mammals could potentially be exposed to non-injurious (TTS) Level B harassment. TTS results from fatigue or damage to hair cells or supporting structures and may cause disruption in the processing of acoustic cues. However, hearing sensitivity is recovered within a relatively short time. Similar to Level A harassment, SEL metric (172 dB re 1 $\mu Pa^2 \cdot s$) results in higher exposure estimates compared to the peak SPL metric (224 dB re 1 μPa).

Approximately 1,014 animals could potentially be exposed to noise corresponding to the behavioral threshold of 167 dB SEL during Maritime WSEP missions. Behavioral harassment occurs at distances beyond the range of structural damage and hearing threshold shift. Possible behavioral responses to a detonation include panic, startle, departure from an area, and disruption of activities such as feeding or breeding.

None of the above estimates take into account the mitigation measures outlined in Chapter 11, which may significantly reduce the number of exposures.

Atlantic spotted dolphins potentially affected by Maritime WSEP test activities are part of the Northern Gulf of Mexico stock, which is considered to occur over the continental shelf from 10 to 200 meters depth, and onto the continental slope. This stock is not considered strategic. Four bottlenose dolphin stocks occur in the north-central GOM and could theoretically be affected by test activities. The Choctawhatchee Bay stock occurs north of the test site and is considered strategic. It is not probable that large numbers of dolphins from this stock would be affected, given that Maritime WSEP activities will occur about 17 miles seaward of Choctawhatchee Bay. However, individuals may move into deeper water at times, and therefore potentially occur in the test area. In addition, individuals from other adjacent bay, sound, and estuarine stocks, such as the Pensacola/East Bay and St. Andrew Bay stocks (also considered strategic), could potentially transit through the area. Bottlenose dolphins affected by test activities are most likely to be associated with the Northern Coastal stock (shoreline to 20 meter depth; considered strategic) and Northern GOM Continental Shelf stock (20 meter to 200 meter depth; not considered strategic). Individuals from the Oceanic stock, which is not strategic, are unlikely to be affected because of their provisional distribution beyond the 200 meter isobath.

8. IMPACT ON SUBSISTENCE USE

Potential impacts resulting from the proposed activities will be limited to individuals of marine mammal species located in the Gulf of Mexico that have no subsistence requirements. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

9. IMPACTS TO MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

The primary sources of marine mammal habitat impact are noise and pressure waves resulting from live Maritime WSEP missions. However, neither the noise nor overpressure constitutes a long-term physical alteration of the water column or bottom topography. In addition, they are not expected to affect prey availability, are of limited duration, and are intermittent in time. Surface vessels associated with the missions are present in limited duration and are intermittent as well. Therefore, it is not anticipated that marine mammals will stop utilizing the waters of W-151, either temporarily or permanently, as a result of noise associated with mission activities.

Other factors related to Maritime WSEP activities that could potentially affect marine mammal habitat include the introduction of metals and chemical materials into the water column via spent munitions and explosive byproducts. The effects of each were analyzed in the Maritime WSEP Environmental Assessment (EA) (U.S. Air Force, 2014, in preparation) and were determined to be insignificant. The analysis in the EA is summarized in the following paragraphs.

Metals typically used to construct bombs, missiles, and gunnery rounds include copper, aluminum, steel, and lead, among others. Aluminum is also present in some explosive materials. These materials would settle to the seafloor after munitions are detonated. Metal ions would slowly leach into the substrate and the water column, causing elevated concentrations in a small area around munitions fragments. Some of the metals, such as aluminum, occur naturally in the ocean at varying concentrations and would not necessarily impact the substrate or water column. Other metals, such as lead, could cause toxicity in microbial communities in the substrate. However, such effects would be localized to a very small distance around munitions fragments and would not significantly affect the overall habitat quality of sediments in the northeastern Gulf. In addition, metal fragments would corrode, degrade, and become encrusted over time.

Chemical materials include explosive byproducts and also fuel, oil, and other fluids associated with remotely controlled target boats. Explosive byproducts would be introduced into the water column through detonation of live munitions. Explosive materials include 2,4,6-trinitrotoluene (TNT) and RDX, among others. Various byproducts are produced during and immediately after detonation of TNT and RDX. During the very brief time that a detonation is in progress, intermediate products may include carbon ions, nitrogen ions, oxygen ions, water, hydrogen cyanide, carbon monoxide, nitrogen gas, nitrous oxide, cyanic acid, and carbon dioxide (Becker, 1995). However, reactions quickly occur between the intermediates, and the final products consist mainly of water, carbon monoxide (CO), carbon dioxide (CO_2), and nitrogen gas, although small amounts of other compounds are typically produced as well.

Chemicals introduced to the water column would be quickly dispersed by waves, currents, and tidal action, and eventually become uniformly distributed. A portion of the carbon compounds such as CO and CO_2 would likely become integrated into the carbonate system (alkalinity and pH buffering capacity of seawater). Some of the nitrogen and carbon compounds, including petroleum products, would be metabolized or assimilated by phytoplankton and bacteria. Most of the gas products that do not react with the water or become assimilated by organisms would be released to the atmosphere. Due to dilution, mixing, and transformation, none of these chemicals are expected to have significant impacts on the marine environment.

Explosive material that is not consumed in a detonation could sink to the substrate and bind to sediments. However, the quantity of such materials is expected to be inconsequential. Research has shown that if munitions function properly, nearly full combustion of the explosive materials will occur, and only extremely small amounts of raw material will remain. In addition, any remaining materials will be naturally degraded. TNT decomposes when exposed to sunlight (ultraviolet radiation), and is also degraded by microbial activity (Becker, 1995). Several types of microorganisms have been shown to metabolize TNT. Similarly, RDX is decomposed by hydrolysis, ultraviolet radiation exposure, and biodegradation.

10. IMPACTS TO MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

Based on the discussions in Section 9, marine mammal habitat will not be lost or modified.

11. MEANS OF AFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS

The potential takes discussed in Section 6 represent the maximum expected number of animals that could be exposed to particular noise and pressure thresholds. The impact estimates do not take into account measures that will be employed to minimize impacts to marine species (these measures will help ensure human safety of test participants and non-participants as well). Mitigation measures consist of visual monitoring to detect the presence of marine mammals and marine mammal indicators (large schools of fish and flocks of birds). Monitoring procedures are described in the following subsections.

11.1 VISUAL MONITORING

Visual monitoring will be required during Maritime WSEP missions from surface vessels and high-definition video cameras. A large number of range clearing boats (approximately 20 to 25) will be stationed around the test site to prevent non-participating vessels from entering the human safety zone. Based on the composite footprint, range clearing boats will be located approximately 15,289 meters (9.5 miles) from the detonation point (Figure 11-1). Actual distance will vary based on the size of the munition being deployed, but as a comparison tool, this distance is used for the mitigation plan.

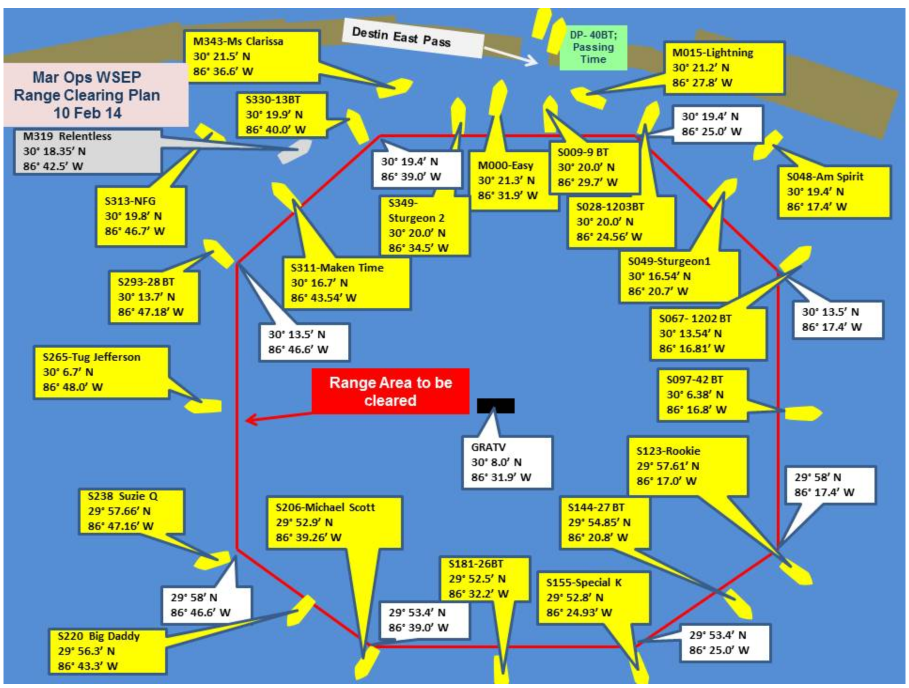

Figure 11-1. Range Area to be Cleared for Human Safety Zone

Trained marine species observers will be aboard five of these boats and will conduct protected species surveys before and after each test. The protected species survey vessels will be dedicated solely to observing for marine species during the pre-mission surveys while the remaining safety boats clear the area of non-authorized vessels.

11.1.1 Determination of Survey Areas

The ranges that are presented in Table 6-3 represent a radius of impact for a given threshold from a single detonation of each munition/detonation scenario. They do not consider accumulated energies from multiple detonation occurring within the same 24-hour time period. For calculating take estimates, the single detonation approach is considered more conservative as it multiplies the exposures from a single detonation by the number of munitions and assumes a fresh population of marine mammals is being impacted each time. This approach is taken because it is unknown exactly which munitions will be released on a given day. Multiple variables, such as weather, aircraft mechanical issues, munition malfunctions, target availability, etc… may prevent munitions to be released as planned. Therefore it is extremely difficult to state with full accuracy the number of munitions of each type will be released on any given day. By treating each detonation as a separate event and summing those impacts accordingly, the proponent will have maximum operational flexibility to conduct the missions without limitations on either the total number of munitions allowed to be dropped in a day, or on the specific combinations of munitions that can be released. While this methodology overestimates the overall potential takes presented in Chapter 6, the ranges do not accurately represent the actual area acoustically impacted for a given threshold from multiple detonations in a given mission day.

The total acoustic impact area for two identical bombs detonating within a given timeframe is less than twice the impact area of a single bomb's detonation. This has to do with the accumulated energy from multiple detonations occurring sequentially. When one weapon is detonated, a certain level of transmission loss is required to be calculated to achieve each threshold level which can then be equated to a range. By releasing a second munition in the same event (same place and close in time), even though the total energy is increased, the incremental impact area from the second detonation is slightly less than that of the first; however the impact range for the two munitions is larger than the impact range for one. Since each additional detonation adds energy to the SEL metric, all the energy from all munitions released in a day is accumulated. By factoring in the transmission loss of the first detonation added with the incremental increases from the second, third, fourth, etc… the range of the cumulative energy that is below each threshold level can be determined. Unlike the energy component, peak pressure is not an additive factor, therefore thresholds expressed as either acoustic impulse or peak SPL metrics (i.e., mortality, slight lung injury, G.I Tract Injury) are not considered in these calculations. A sample day has been created that would reflect the maximum number of munitions that could be released and that would result in the greatest impact in a single mission day. This scenario is only a representation and may not accurately reflect how actual operations will be conducted. However, it is used as the most conservative assumption to calculate the impact range for mitigation strategies. The sum of all energies from these detonations are combined and compared against thresholds with energy metric criteria to generate the accumulated energy ranges for this scenario. These ranges are shown in Table 11-1.

Table 11-1. Threshold Ranges (in meters) for an Example Mission Day

Munition	NEW (lbs)	Total # per Day	Detonation Scenario	Level A Harassment	Level B Harassment	
				PTS	TTS	Behavioral
				187 dB SEL	172 dB SEL	167 dB SEL
GBU-10 or GBU-24	945	1	Surface	5,120	12,384	15,960
GBU-12 or GBU-54	192	1	Surface			
AGM-65 (Maverick)	86	1	Surface			
GBU-39 (LSDB)	37	1	Surface			
AGM-114 (Hellfire)	20	3	(10 ft depth)			
AGM-175 (Griffin)	13	2	Surface			
2.75 Rockets	12	12	Surface			
PGU-13 HEI 30 mm	0.1	125	Surface			

AGM = air-to-ground missile; cal = caliber; CBU = Cluster Bomb Unit; ft = feet; GBU = Guided Bomb Unit; HEI = high explosive incendiary; lbs = pounds; mm = millimeters; N/A = not applicable; NEW = net explosive weight; PGU = Projectile Gun Unit; SDB = small diameter bomb; PTS = permanent threshold shift; TTS = temporary threshold shift; WCMD = wind corrected munition dispenser

Based on the ranges presented in Table 11-1 and factoring operational limitations associated with survey-based vessel support for the missions, the proposed area to be monitored during pre-mission surveys will be approximately 5 km (3.1 miles) from the target area, which corresponds to the Level A PTS threshold range. The same sized area will be surveyed for each mission day, regardless of the planned munition expenditures. By clearing the Level A PTS harassment range of protected species, animals that may enter the area after the pre-mission surveys have been completed and prior to detonation would not reach the smaller slight lung injury or mortality zones (presented in Table 6-3). Because of human safety issues, observers will be required to leave the test area at least 30 minutes in advance of live weapon deployment and move to a position on the safety zone periphery, approximately 9.5 miles (15 km) from the detonation point. Observers will continue to scan for marine mammals from the periphery, but effectiveness will be limited as the boat will remain at a designated station.

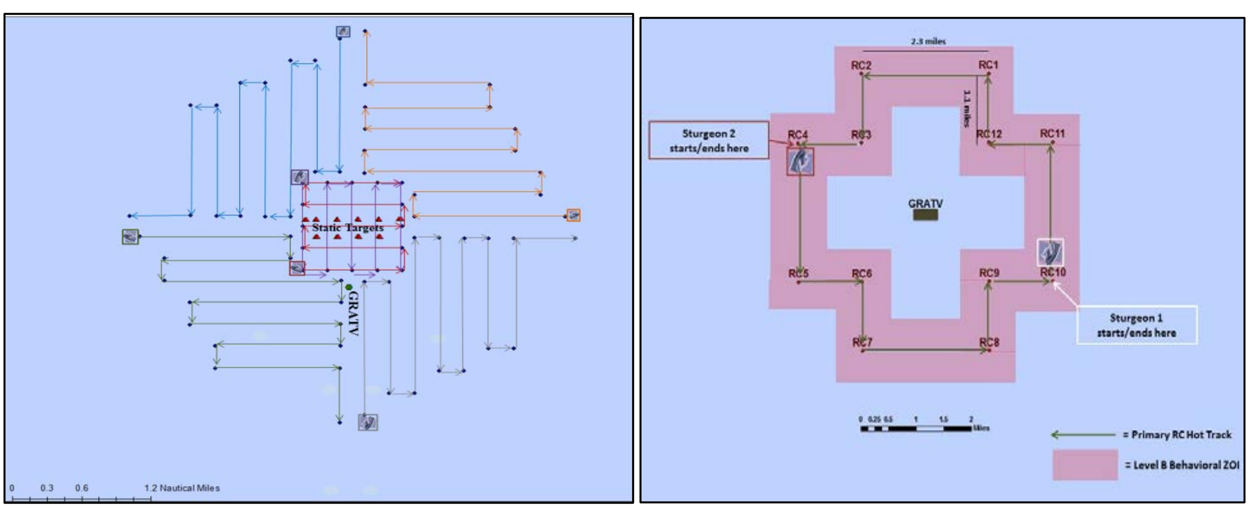

Figure 11-2. Example Routes Used During Maritime Strike Missions in 2013 and 2014.

11.1.2 Additional Monitoring Assets

AF personnel will be within the mission area (on boats and the GRATV) on each day of testing well in advance of weapon deployment, typically near sunrise. They will perform a variety of tasks including target preparation, equipment checks, etc., and will opportunistically observe for marine mammals and indicators as feasible throughout test preparation. However, such observations are considered incidental and would only occur as time and schedule permits. Any sightings would be relayed to the Lead Biologist, as described in the detailed mitigation procedures below.

In addition to vessel-based monitoring, three video cameras will be positioned on the GRATV anchored on-site, as described in Section 2.1.1, to allow for real-time monitoring for the duration of the mission. The camera configuration used would depend on specific mission requirements. In addition to monitoring the area for mission objective issues, the cameras will also be used to monitor for the presence of protected species. A trained marine species observer from Eglin Natural Resources would be located in Eglin's CCF, along with mission personnel, to view the video feed before and during test activities. The distance to which objects can be detected at the water surface by use of the cameras is considered generally comparable to that of the human eye. Targets would be positioned from several hundred meters up to 2.5 miles away from the GRATV. The mortality threshold ranges correspond to the modified Goertner model adjusted for the weight of an Atlantic spotted dolphin calf, and extend from 0 to 237 meters (0 to 778 feet) from the target, and the slight lung injury threshold ranges for both bottlenose and Atlantic spotted dolphins extend from 7 to 400 meters (23 to 1,312 feet [0.2 miles]) from the target, depending on the ordnance and harassment criterion. Given these distances, observers could reasonably be expected to view a substantial portion of the mortality zone in front of the camera, although a small portion would be behind or to the side of the camera view. Some portion of the Level A harassment zone could also be viewed, although it would be less than that of the mortality zone (a large percentage would be behind or to the side of the camera view). Representative screen shots from three different cameras are shown in Figures 11-3 through 11-5. If the situation arises such that no cameras are operational due to equipment malfunctions, weather impacts, or other issues, then the mission would not be conducted.

Figure 11-3. Representative Screen Shot, Camera 1

Figure 11-4. Representative Screen Shot, Camera 2

Figure 11-5. Representative Screen Shot, Camera 3

At least two ordnance delivery aircraft will participate in each live weapon release mission. Prior to the test, AF pilots aboard mission aircraft may make a dry run over the target area to ensure it is clear of non-participating vessels before ordnance is deployed. Observation effectiveness may vary among aircraft types. Jets will fly at a minimum speed of 300 knots indicated air speed (approximately 345 miles per hour, depending on atmospheric conditions) and at a minimum altitude of 1,000 feet (305 meters). Due to the limited flyover duration and potentially high speed and altitude, observation for marine species would probably be only marginally effective at best, and pilots would, therefore, not participate in species surveys.

11.2 ENVIRONMENTAL CONSIDERATIONS

Weather conducive for marine mammal monitoring is required to effectively implement the surveys. Wind speed and the resulting surface conditions of the GOM are critical factors affecting observation effectiveness. Higher winds typically increase wave height and create "white cap" conditions, both of which limit an observer's ability to locate marine species at or near the surface. Maritime WSEP missions will be delayed or rescheduled if the sea state is greater than number 4 of Table 11-1 at the time of the test. The Lead Biologist aboard one of the survey vessels will make the final determination of whether conditions are conducive for sighting protected species or not. In addition, the missions will occur no earlier than two hours after sunrise and no later than two hours prior to sunset to ensure adequate daylight for pre- and post-mission monitoring

Table 11-1. Sea State Scale for Maritime WSEP Surveys

Sea State Number	Sea Conditions
0	Flat calm, no waves or ripples.
1	Light air, winds 1-2 knots; wave height to 1 foot; ripples without crests.
2	Light breeze, winds 3-6 knots; wave height 1-2 feet; small wavelets, crests not breaking.
3	Gentle breeze, winds 7-10 knots; wave height 2-3.5 feet; large wavelets, scattered whitecaps.
4	Moderate breeze, winds 11-16 knots; wave height 3.5-6 feet; breaking crests, numerous whitecaps.

11.3 AIR FORCE SUPPORT VESSELS

AF support vessels will consist of a combination of Air Force and civil service/civilian personnel. Vessel-based and video monitoring will be conducted for all missions. The Eglin Range Safety Officer, in cooperation with the Santa Rosa Island Tower Control at Test Site A-13B and CCF, will coordinate and manage all range clearing and protected species observation efforts. All support vessels will be in radio contact with one another and with Tower Control on the government VHF channel 81a or 82a. CCF will monitor all radio communications, but Tower will relay messages between the vessels and CCF. The Safety Officer and Tower Control will also be in continual contact with the Test Director throughout the mission and will coordinate information regarding range clearing. Final decisions regarding mission execution, including possible mission delay or cancellation based on marine mammal sightings, will be the responsibility of the Safety Officer, with concurrence from the Test Director. Lines of communication for marine mammal surveys are shown in Figure 11-6. Responsibilities of each survey component are described in the following paragraphs.

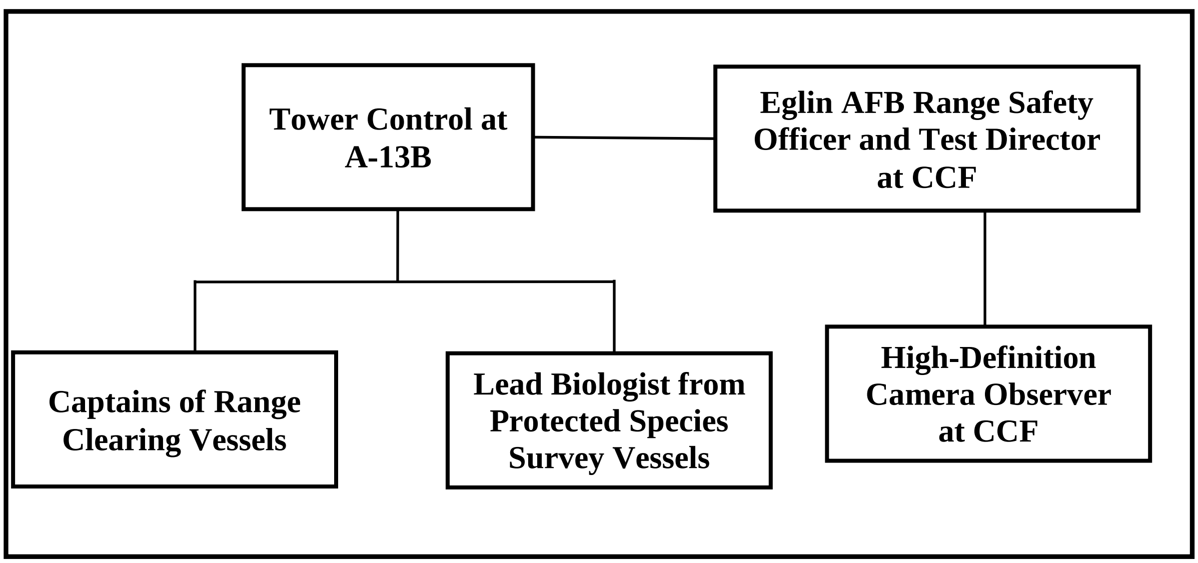

Figure 11-6. Marine Species Observer Lines of Communication

11.4 ROLES AND RESPONSIBILITIES OF DEDICATED OBSERVERS

The following subsections describe the roles and responsibilities of each component of the entire monitoring team. The overall objective of these efforts is to provide sufficient and continual monitoring support before, during, and after each mission that will enable effective observations without putting undue burden on the mission.

11.4.1 Protected Species Survey Vessels

Protected species and species indicator monitoring would be conducted from five surface vessels, with emphasis being focused on the mortality and slight lung injury zones. These survey vessels will run pre-determined line transects, or survey routes, that will provide sufficient coverage of the survey area within a one hour timeframe. Monitoring activities will be conducted from the highest point feasible on the vessels (Figure 11-7). Each vessel will have at least two dedicated observers who are trained in identifying protected marine species and indicators of protected species occurrence, such as large schools of fish and flocks of birds. One vessel will contain the Lead Biologist who will be the point of contact between all survey vessels and Tower Control.

Figure 11-7. Marine Species Observer Example

11.4.2 High-Definition Video Camera Observer

Maritime WSEP missions will be monitored from the GRATV via live high-definition video feed. Video monitoring would, in addition to facilitating assessment of the mission, make possible remote viewing of the area for determination of environmental conditions and the presence of marine species right up to the release of live munitions. For the duration of the mission, a trained marine species observer from Eglin Natural Resources will be in CCF monitoring all live video feed. Although not part of the surface vessel survey team, the Eglin Natural Resources representative will report any marine mammal sightings to the Range Safety Officer, who will also be sitting in CCF. The entire ZOI will not be visible through the video feed for all missions, however the targets and immediately surrounding areas will be in the field of view of the cameras and the observer will be able to identify any protected species that may enter the target area right before the detonations and determine if any were injured immediately following the detonations. Should a protected marine species be detected on the live video, the weapon release can be stopped almost immediately because the video camera observer is in direct contact with Test Director and Safety Officer at CCF. If all of the cameras are not operational for any reason, the mission will not be conducted.

11.5 LINES OF COMMUNICATION

The protected species survey vessels and the video camera observer will have open lines of communication to facilitate real-time reporting of marine mammals and other relevant information, such as safety concerns and presence of non-participating vessels in the human safety zone. Direct radio communication between all surface vessels, GRATV personnel, and the Tower Control will be maintained throughout the mission. The Range Safety Officer will monitor all radio communications from CCF and information between the Safety Officer and the support vessels will relayed via Tower Control. All sighting information from pre-mission surveys will be communicated to the Lead Biologist on a separate radio channel than the range clearing vessels to reduce overall radio chatter and potential confusion. After compiling all the sighting information from the other survey vessels, the Lead Biologist will inform Tower Control on whether the area is clear of protected species or not. If the range is not clear, the Lead Biologist will provide recommendations on whether the mission should be delayed or cancelled. A mission delay recommendation would occur, for example, if a small number of protected species are in the ZOI but appear to be on a heading away from the mission area. On the other hand, a mission cancellation recommendation could occur if one or more protected species in the ZOI are found and there is no indication that they would leave the area on their own preference within a reasonable timeframe. Tower Control will relay the Lead Biologist's recommendation to the Safety Officer in CCF. The Safety Officer and Test Director will collaborate regarding range conditions based on the information provided by the Lead Biologist and the status of range clearing vessels. Ultimately, the Safety Officer will have final authority on decisions regarding delays and cancellations of missions.

11.6 DETAILED MITIGATION PLAN

A 5-km radius area (from Table 11-1) will be monitored for the presence of marine mammals and indicators. Maritime WSEP mitigations will be regulated by AF safety parameters. Any mission may be delayed or cancelled due to technical issues or range clearing issues. Should a delay occur during pre-mission surveys, all mitigation procedures would continue either for the duration of the delay or until the mission is cancelled. To ensure the safety of survey personnel, the team will depart the mission area approximately 30 minutes to one hour before live ordnance delivery. Stepwise mitigation procedures for the Maritime WSEP missions are outlined below.

<u>Pre-mission Monitoring</u>: The purposes of pre-mission monitoring are to 1) evaluate the mission site for environmental suitability, and 2) verify that the ZOI is free of visually detectable marine mammals, as well as potential indicators of these species. On the morning of the mission, the Test Director and Safety Officer will confirm that there are no issues that would preclude mission execution and that weather is adequate to support mitigation measures.

(a) Sunrise or Two Hours Prior to Mission

AF range clearing vessels and protected species survey vessels will be on site at least two hours prior to the mission. Lead Biologist on board one survey vessel will assess the overall suitability of the mission site based on environmental conditions (sea state) and presence/absence of marine mammal indicators. This information will be communicated to Tower Control and relayed to the Safety Officer in CCF.

(b) One and One-Half Hours Prior to Mission

Vessel-based surveys will begin approximately one and one-half hours prior to live weapon deployment. Surface vessel observers will survey the ZOI and relay all marine species and indicator sightings, including the time of sighting, GPS location, and direction of travel, if known, to the Lead Biologist. The Lead Biologist will document all sighting information on report forms to be submitted to Eglin Natural Resources after each mission. Surveys will continue for approximately one hour. During this time, AF personnel in the mission area will also observe for marine species as feasible. If marine mammals or indicators are observed within the ZOI, the range will be declared "fouled," a term that signifies to mission personnel that conditions are such that a live ordnance drop cannot occur (e.g., protected species or civilian vessels are in the mission area). If no marine mammals or indicators are observed, the range will be declared clear of protected species.

(c) One-Half Hour Prior to Mission

At approximately 30 minutes to one hour prior to live weapon deployment, marine species observers will be instructed to leave the mission site and remain outside the safety zone, which on average will be 9.5 miles from the detonation point. The actual size is determined by weapon NEW and method of delivery. The survey team will continue to monitor for protected species while leaving the area. As the survey vessels leave the area, marine species monitoring of the immediate target areas will continue at CCF through the live video feed received from the high definition cameras on the GRATV. Once the survey vessels have arrived at the perimeter of the safety zone (approximately 30 minutes after being instructed to leave, depending on actual travel time) the range will be declared "green" and mission will be allowed to proceed, assuming all non-participating vessels have left the safety zone as well.

(d) Execution of Mission

Immediately prior to live weapon drop, the Test Director and Safety Officer will communicate to confirm the results of marine mammal surveys and the appropriateness of proceeding with the mission. The Safety Officer will have final authority to proceed with, postpone, or cancel the mission. The mission would be postponed if:

1. Any marine mammal is visually detected within the ZOI. Postponement would continue until the animal(s) that caused the postponement is
    a. Confirmed to be outside of the ZOI on a heading away from the targets or
    b. Not seen again for 30 minutes and presumed to be outside the ZOI due to the animal swimming out of the range
        i. Average swim speed of dolphins assumed to be 5.6 km/hour

ii. Distance traveled in 30 minutes would be approximately 2,800 meters

2. Large schools of fish or large flocks of birds feeding at the surface are observed within the ZOI. Postponement would continue until these potential indicators are confirmed to be outside the ZOI.
3. Any technical or mechanical issues related to the aircraft or target boats.
4. Non-participating vessels enter the human safety zone prior to weapon release.

In the event of a postponement, protected species monitoring would continue from CCF through the live video feed.

<u>Post-mission monitoring</u>: Post-mission monitoring is designed to determine the effectiveness of pre-mission mitigation by reporting sightings of any dead or injured marine mammals. Post-detonation monitoring surveys will commence once the mission has ended or, if required, as soon as EOD personnel declare the mission area safe. Vessels will move into the survey area from outside the safety zone and monitor for at least 30 minutes, concentrating on the area down-current of the test site. This area is easily identifiable because of the floating debris in the water from impacted targets. Up to 10 AF support vessels will be cleaning debris and collecting damaged targets from this area thus spending many hours in the area once the mission is completed. All vessels will be instructed to report any dead or injured marine mammals to the Lead Biologist. The protected species survey vessels will document any marine mammals that were killed or injured as a result of the mission and, if practicable, recover and examine any dead animals. The species, number, location, and behavior of any animals observed will be documented and reported to Eglin Natural Resources.

The NMFS maintains stranding networks along U.S. coasts to collect and circulate information about marine mammal standings. Local coordinators may report stranding data to state and regional coordinators. Any observed dead or injured marine mammal would be reported to the appropriate coordinator.

11.7 MITIGATION EFFECTIVENESS

The effectiveness of the mitigation measures described above depends largely on the ability to visually locate marine mammals at or near the water surface, as visual observation is the primary measure used. Aerial surveys are not feasible for Maritime WSEP missions due to airspace and mission complexity; therefore observation will occur primarily from vessels and video cameras. The NMFS has evaluated the effectiveness of visual observation for a similar previous AF action in the same area of the Gulf (Maritime Strike Incidental Harassment Authorization issued 13 August 2013). This qualitative analysis for mitigation effectiveness is largely based on the successes during Maritime Strike missions conducted in 2013.

In summary, 34 total sightings were reported during pre-mission surveys of between 179 and 189 individuals, including bottlenose dolphins, Atlantic spotted dolphins, and sea turtles. One mission day was cancelled due to sea state conditions that prevented a proper pre-mission survey and high numbers of marine mammals observed in the area. Two other mission days were delayed due to extended surveys to ensure marine mammals were clear of the area. Two sightings of dolphin pods were reported during post-mission surveys up to 4.5 hours after the last detonation; however all animals were swimming normally, displaying normal behaviors, and not showing any signs of distress or injury (Department of the Air Force, 2014). Although there was an average time lapse of 2 hours and 45 minutes between completion of pre-mission surveys and when the first munition is dropped that was not originally anticipated, monitoring the video camera feed from CCF provided real time surveillance up to the point of detonation while survey vessels transited to the safety zone perimeter.

The overall effectiveness of these measures in reducing take levels has not been quantified; however the high numbers of documented sightings during the pre-mission surveys indicate a significant level of success in executing the survey plans and identifying protected species in the area. Furthermore, there were no observed impacts to any protected species during post-mission surveys and none were identified in the days immediately following the end of all Maritime Strike missions. Therefore, Eglin believes the proposed mitigations will provide a large measure of protection to marine mammals from potential acoustic impacts while enabling the military mission.

12. MINIMIZATION OF ADVERSE EFFECTS ON SUBSISTENCE USE

Based on the discussion in Section 8, there are no impacts on the availability of species or stocks for subsistence use.

13. MONITORING AND REPORTING MEASURES

For Maritime WSEP missions, prospective mission sites will be monitored for marine mammal presence prior to commencement of activities. Vessel-based pre-mission monitoring will be conducted for at least one hour. Furthermore, after the survey vessels have exited the safety footprint, a trained marine species observer located in the CCF will continue monitoring the immediate target area through live video feed for the duration of the mission. Post-mission surveys will be carried out in all cases. If any marine mammals are detected during pre-mission surveys or the live video feed received from cameras on the GRATV, activities will be immediately halted until the area is clear of all marine mammals. Refer to Chapter 11 for a more detailed explanation of monitoring requirements.

In addition to monitoring for marine species before and after missions, the following monitoring and reporting measures will be required.

- All protected species observers will receive the Marine Species Observer Training Course developed by Eglin in cooperation with NMFS within a year of the planned missions.
- The Eglin Natural Resources Office will track use of the EGTTR and protected species observation results through the use of protected species observer report forms.
- A summary annual report of marine mammal observations and mission activities will be submitted to the NMFS Southeast Regional Office and the NMFS Office of Protected Resources either at the time of a request for renewal of the IHA, or 90 days after the

expiration of the current permit if a new permit is not requested. This annual report must include the following information:

  - Date and time of each exercise;
  - A complete description of the pre-exercise and post-exercise activities related to mitigating and monitoring the effects of mission activities on marine mammal populations;
  - Results of the monitoring program, including numbers by species/stock of any marine mammals noted injured or killed as a result of the missions, and number of marine mammals (by species if possible) that may have been harassed due to presence within the activity zone; and

- If any dead or injured marine mammals are observed or detected prior to mission activities, or injured or killed during mission activities, a report must be made to NMFS by the following business day.
- Any unauthorized takes of marine mammals (i.e., mortality) must be immediately reported to NMFS and to the respective stranding network representative.

14. RESEARCH

Although Eglin AFB does not currently conduct independent research efforts, Eglin's Natural Resources Section participates in marine animal tagging and monitoring programs lead by other agencies. Additionally, the Natural Resources Section has also supported participation in annual surveys of marine mammals in the GOM with NMFS. From 1999 to 2002, Eglin, through a contract representative, participated in summer cetacean monitoring and research efforts. The contractor participated in visual surveys in 1999 for cetaceans in the GOM, photographic identification of sperm whales in the northeastern Gulf in 2001, and as a visual observer during the 2000 Sperm Whale Pilot Study and the 2002 sperm whale Satellite-tag (S-tag) cruise. In addition, Eglin's Natural Resources Section has obtained Department of Defense funding for two marine mammal habitat modeling projects. The latest such project (Garrison, 2008) included funding for and extensive involvement of NMFS personnel so that the most recent aerial survey data could be utilized for habitat modeling and protected species density estimates in the northeastern GOM.

Eglin conducts other research efforts which utilize marine mammal stranding information as a potential means of ascertaining the effectiveness of mitigation techniques. Stranding data is collected and maintained for the Florida panhandle area as well as Gulf-wide. This task is undertaken through the establishment and maintenance of contacts with local, state, and regional stranding networks. Eglin AFB assists with stranding data collection by maintaining its own team of permitted stranding personnel. In addition to simply collecting stranding data, various analyses are performed. Stranding events are tracked by year, season, and NMFS statistical zone, both Gulf-wide and on the coastline in proximity to Eglin AFB. Stranding data may be analyzed in relation to records of EGTTR mission activity in each water range, and possible correlations examined. In addition to being used as a possible measure of the effectiveness of mitigations, stranding data can yield insight into the species composition of cetaceans in the region.

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APPENDIX A: ACOUSTIC MODELING METHODOLOGY

Eglin Air Force Base Maritime WSEP MMPA Acoustic Impact Modeling

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APPENDIX A
MMPA ACOUSTIC IMPACT MODELING

A.1 BACKGROUND AND OVERVIEW

A.1.1 Federal Regulations Affecting Marine Animals

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

Actions involving sound in the water include the potential to harass marine animals in the surrounding waters. Demonstration of compliance with MMPA, using best available science, has been assessed using criteria and thresholds accepted or negotiated, and described here.

Sections of the MMPA (16 U.S.C. 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity, other than commercial fishing, within a specified geographical region. Through a specific process, if certain findings are made and regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if National Marine Fisheries Service (NMFS) finds that the taking will have no more than a negligible impact on the species or stock(s), will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking, and requirements pertaining to the mitigation, monitoring and reporting of such taking are set forth.

NMFS has defined negligible impact in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to adversely affect the species or stock through effects on annual rates of recruitment or survival.

Subsection 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The National Defense Authorization Act of 2004 (NDAA) (Public Law 108-136) removed the small numbers limitation and amended the definition of "harassment" as it applies to a military readiness activity to read as follows:

> (i) *any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or*
> (ii) *any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding,*

or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].

The primary potential impact to marine mammals from underwater acoustics is Level B harassment from noise.

A.1.2 Development of Animal Impact Criteria

For explosions of ordnance planned for use in the Eglin Air Force Base (AFB) Maritime WSEP Exercise Area, in the absence of any mitigation or monitoring measures, there is a very small chance that a marine mammal could be injured or killed when exposed to the energy generated from an explosive force. Analysis of noise impacts is based on criteria and thresholds initially presented in U.S. Navy Environmental Impact Statements for ship shock trials of the Seawolf submarine and the Winston Churchill (DDG 81), and subsequently adopted by NMFS.

Non-lethal injurious impacts (Level A Harassment) are defined in those documents as permanent (auditory) threshold shift (PTS), gastro-intestinal (GI) tract damage, and the onset of slight lung injury. Two thresholds are used for PTS: a weighted sound energy level (SEL) and an un-weighted peak sound pressure level (SPL). Thresholds follow the approach of Southall et al. (2007). The threshold producing the largest Zone of Influence (ZOI) is then used as the more protective of the dual thresholds. In most cases, the weighted total SEL is more conservative than the largest energy flux density (EFD) in any single 1/3-octave band that was used in earlier models. Type II weighting functions are for each functional hearing group. The threshold for the Type II weighted SEL is 187 dB re 1 μPa^2·s; the threshold for peak pressure is 46 psi or 230 dB re 1 μPa peak SPL.

The criterion for slight injury to the GI tract was found to be a limit on peak pressure and independent of the animal's size (Goertner, 1982). A threshold of 103 psi (237 dB re 1 μPa peak SPL) is used for all marine mammals. This is the level at which slight contusions to the GI tract were reported from small charge tests (Richmond *et al.*, 1973).

The criteria for onset of slight lung injury were established using partial impulse because the impulse of an underwater blast wave was the parameter that governed damage during a study using mammals, not peak pressure or energy (Yelverton, 1981). Goertner (1982) determined a way to calculate impulse values for injury at greater depths, known as the Goertner "modified" impulse pressure. Those values are valid only near the surface because as hydrostatic pressure increases with depth, organs like the lung, filled with air, compress. Therefore the "modified" impulse pressure thresholds vary from the shallow depth starting point as a function of depth.

The shallow depth starting points for calculation of the "modified" impulse pressures are mass-dependent values derived from empirical data for underwater blast injury (Yelverton, 1981). During the calculations, the lowest impulse and body mass for which slight, and then extensive, lung injury found during a previous study (Yelverton et al, 1973) were used to determine the positive impulse that may cause lung injury. The Goertner model is sensitive to mammal weight such that smaller masses have lower thresholds for positive impulse so injury and harassment will be predicted at greater distances from the source for them. Species-specific masses are therefore used for determining mortality thresholds because they closely represent effects to individual species. Nominal body masses for each species are based on newborn individuals as a protective approach since the impulse threshold is lower for smaller masses and only a small percentage of a marine mammal population would consist of newborns. Where body masses are not available, surrogate species of comparable mass were utilized.

Level B (non-injurious) Harassment includes temporary (auditory) threshold shift (TTS), a slight, recoverable loss of hearing sensitivity. One criterion used for TTS, the total Type II weighted SEL is a threshold of 172 dB re 1 μPa^2·s for toothed whales (e.g., dolphins). A second criterion, a maximum allowable peak pressure of 23 psi (224 dB re 1 μPa peak SPL), has recently been established by NMFS to provide a more conservative range for TTS when the explosive or animal approaches the sea surface, in which case explosive energy is reduced, but the peak pressure is not. NMFS applies the more conservative of these two.

For multiple successive explosions, the acoustic criterion for non-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The threshold for behavioral disturbance is set 5 dB below the Type II weighted total SEL-based TTS threshold, or 167 dB re 1 μPa^2·s. This is based on observations of behavioral reactions in captive dolphins and belugas occurring at exposure levels ~ 5 dB below those causing TTS after exposure to pure tones (Finneran and Schlundt, 2004; Schlundt *et al.*, 2000).

Table A-2 summarizes the current threshold levels for analysis of explosives identified for use in the Eglin AFB Maritime WSEP exercise area.

Table A-2. Explosives Threshold Levels

Mortality*	Level A Harassment			Level B Harassment	
	Slight Lung Injury*	**GI Tract Injury**	**PTS**	**TTS**	**Behavioral**
$91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	$39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	Unweighted SPL: 237 dB re 1 μPa	Weighted SEL: 187 dB re 1 μPa^2·s	Weighted SEL: 172 dB re 1 μPa^2·s	Weighted SEL: 167 dB re 1 μPa^2·s
			Unweighted SPL: 230 dB re 1 μPa	Unweighted SPL: 224 dB re 1 μPa (23 psi peak pressure)	

*Expressed in terms of acoustic impulse (Pacsal – seconds [Pa·s]); *M* = Animal mass based on species (kilograms); *D* = Water depth (meters); PTS = permanent threshold shift; TTS = temporary threshold shift; SPL = sound pressure level; SEL = sound exposure level; dB re 1 μPa = decibels referenced to 1 microPascal; dB re 1 μPa^2·s = decibels reference to 1 microPascal-squared – seconds.

Work is ongoing in the community to refine the threshold criteria in response to new information about marine animal biology. The new modeling described here uses more conservative thresholds than were used in previous studies. Models were implemented in a way that allows the threshold criteria to be varied (over a realistic range of values). New results can be generated if the current criteria change.

A.2 EXPLOSIVE ACOUSTIC SOURCES

A.2.1 Acoustic Characteristics of Explosive Sources

The acoustic sources employed at the Eglin AFB Maritime WSEP exercise area are categorized as broadband explosives. Broadband explosives produce significant acoustic energy across several frequency decades of bandwidth. Propagation loss is sufficiently sensitive to frequency as to require model estimates at several frequencies over such a wide band.

Explosives are impulsive sources that produce a shock wave that dictates additional pressure-related metrics (peak pressure and positive impulse). Detailed descriptions of the sources in the Eglin AFB Maritime WSEP exercise area are provided in this subsection.

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive material, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of TNT required to produce an equivalent explosive power.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

A.2.2 Animal Harassment Effects of Explosive Sources

The harassments expected to result from these sources are computed on a per in-water explosive basis; to estimate the number of harassments for multiple explosives, consider the following. Let A represent the impact area (that is, the area in which the chosen metric exceeds the threshold) for a single explosive. The cumulative effect of a series of explosives is then dictated by the spacing of the explosives relative to the movement of the marine wildlife. If the detonations are spaced widely in time or space, allowing for sufficient animal movements as to ensure a different population of animals is considered for each detonation, the cumulative impact area of N explosives is merely NA regardless of the metric. This leads to a worst case estimate of harassments and is the method used in this analysis.

At the other extreme is the case where the detonations occur at essentially the same time and location (but not close enough to require the source emissions to be coherently summed). In this case, the pressure metrics (peak pressure and positive impulse) are constant regardless of the number of detonations spaced closely in time, while the energy metrics increase at a rate of $N^{½}$ (under spherical spreading loss only) or less.

The firing sequence for some of the munitions consists of a number of rapid bursts, often lasting a second or less. Due to the tight spacing in time, each burst can be treated as a single detonation. For the energy metrics the impact area of a burst is computed using a source energy spectrum that is the source spectrum for a single detonation scaled by the number of rounds in a burst. For the pressure metrics, the impact area for a burst is the same as the impact area of a single round. As with detonations, if bursts are spaced widely in time or space, allowing for sufficient animal movements as to ensure a different population of animals is considered for each detonation, the cumulative impact area of N bursts is merely NA, where A is the impact area of a single burst, regardless of the metric. This leads to a worst case estimate of harassments and is the method used in this analysis.

Explosives are modeled as detonating at depths ranging from the water surface to 10 feet below the surface, as provided by Government-Furnished Information. Impacts from above surface detonations were considered negligible and not modeled.

For sources that are detonated at shallow depths, it is frequently the case that the explosion may breach the surface with some of the acoustic energy escaping the water column. We model surface detonations as occurring one foot below the water surface. The source levels have not been adjusted for possible venting nor does the subsequent analysis attempt to take this into account.

A.3 ENVIRONMENTAL CHARACTERIZATION

A.3.1 Important Environmental Parameters for Estimating Animal Harassment

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. In turn, propagation loss as a function of range depends on a number of environmental parameters including:

- water depth
- sound speed variability throughout the water column
- bottom geo-acoustic properties, and
- surface roughness, as determined by wind speed

Due to the importance that propagation loss plays in Anti-Submarine Warfare, the Navy has, over the last four to five decades, invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases containing these environmental parameters, which are accepted as standards for Navy modeling efforts. **Table A-3** contains the version of the databases used in the modeling for this report.

Table A-3. Navy Standard Databases Used in Modeling

Parameter	Database	Version
Water Depth	Digital Bathymetry Data Base Variable Resolution	DBDBV 6.0
Ocean Sediment	Re-packed Bottom Sediment Type	BST 2.0
Wind Speed	Surface Marine Gridded Climatology Database	SMGC 2.0
Temperature/Salinity Profiles	Generalized Digital Environment Model	GDEM 3.0

The sound speed profile directs the sound propagation in the water column. The spatial variability of the sound speed field is generally small over operating areas of typical size. The presence of a strong oceanographic front is a noteworthy exception to this rule. To a lesser extent, variability in the depth and strength of a surface duct can be of some importance. If the sound speed minimum occurs within the water column, more sound energy can travel further without suffering as much loss (ducted propagation). But if the sound speed minimum occurs at the surface or bottom, the propagating sound interacts more with these boundaries and may become attenuated more quickly. In the mid-latitudes, seasonal variation often provides the most significant variation in the sound speed field. For this reason, both summer and winter profiles are modeled to demonstrate the extent of the difference.

Losses of propagating sound energy occur at the boundaries. The water-sediment boundary defined by the bathymetry can vary by a large amount. In a deep water environment, the interaction with the bottom may matter very little. In a shallow water environment the opposite is true and the properties of the sediment become very important. The sound propagates through the sediment, as well as being reflected by the interface. Soft (low density) sediment behaves more like water for lower frequencies and the sound has relatively more transmission and relatively less reflection than a hard (high density) bottom or thin sediment.

The roughness of the boundary at the water surface depends on the wind speed. Average wind speed can vary seasonally, but could also be the result of local weather. A rough surface scatters the sound energy and increases the transmission loss. Boundary losses affect higher frequency sound energy much more than lower frequencies.

A.3.2 Characterizing the Acoustic Marine Environment

The environment for modeling impact value is characterized by a frequency-dependent bottom definition, range-dependent bathymetry and sound velocity profiles (SVP), and seasonally varying wind speeds and SVPs. The bathymetry database is on a grid of variable resolution.

The sound velocity profile database has a fixed spatial resolution storing temperature and salinity as a function of time and location. The low frequency bottom loss is characterized by standard definition of geo-acoustic parameters for then given sediment type of sand. The high frequency bottom loss class is fixed to match expected loss for the sediment type. The area of interest can be characterized by the appropriate sound speed profiles, set of low frequency bottom loss parameters, high frequency bottom loss class, and HFEVA very-high frequency sediment type for modeled frequencies in excess of 10 kHz.

Generally seasonal variation is sampled by looking at summer and winter cases. However, for Maritime WSEP ordnance usage is planned only for winter environments.

Impact volumes in the operating area are then computed using propagation loss estimates and the explosives model derived for the representative environment.

A.3.3 Description of the Eglin AFB Maritime WSEP Exercise Area Environment

The Eglin AFB Maritime WSEP Exercise Area is located off the coast of Florida in the Gulf of Mexico. It is an area that slopes from shallow waters near the coast to deeper waters offshore. The bottom is characterized as sandy sediment according to the Bottom Sediments Type Database. Environmental values were extracted from unclassified Navy standard databases in a radius of 50 km around the center point at

N 30° 08.5' W 86° 28'

The Navy standard database for bathymetry has a resolution of 0.05 minutes in the Gulf of Mexico; see **Figure A-1**. Mean and median depths from DBDBV in the extracted area are 47 and 112 meters, respectively.

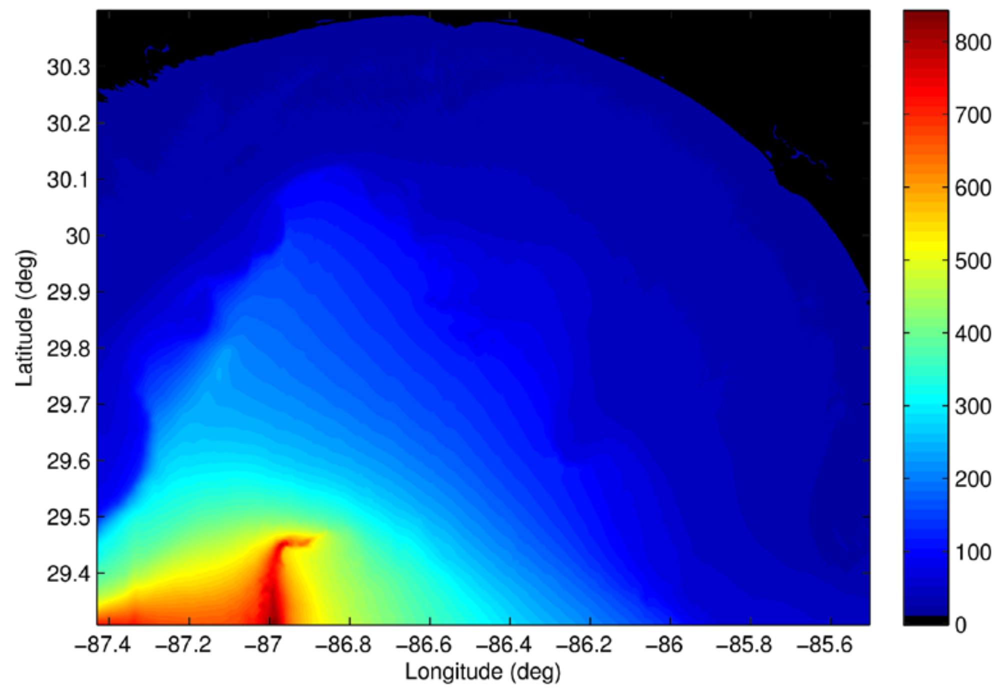

Figure A-1. Bathymetry (in meters) for Eglin AFB Maritime WSEP Exercise Area Representative Environment

The seasonal variability in wind speed was modeled as 8.6 knots in the summer and 13.02 knots in the winter.

Example input of range-dependent bathymetry is depicted in **Figure A-2** for the due-north bearing.

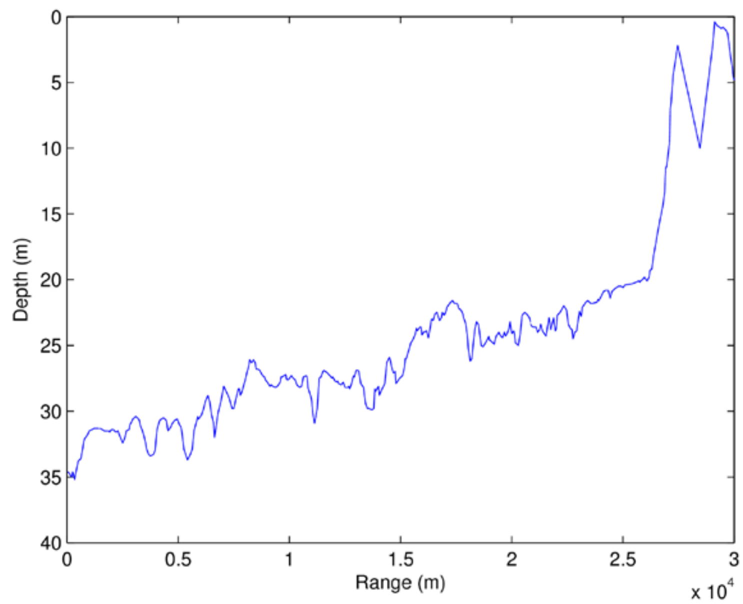

Figure A-2. Bathymetry due-North of Eglin AFB Maritime WSEP Exercise Area Center Point

A.4 MODELING IMPACT ON MARINE ANIMALS

Many underwater actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

Estimating the number of animals that may be injured or otherwise harassed in a particular environment entails the following steps.

- For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL calculations are also made over disjoint one-third octave bands for a wide range of frequencies with dependence in range, depth, and azimuth for bathymetry and sound speed. TL computations were sampled with 40 degree spacing in azimuth.
- The Type II weighted total accumulated energy within the waters where the source detonates is sampled over a volumetric grid. At each grid point, the received energy from each source emission is modeled as the effective energy source level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point and summed. For the peak pressure or positive impulse, the appropriate metric is similarly modeled for each emission. The maximum value of that metric over all frequencies and emissions, is stored at each grid point.
- The impact volume for a given threshold is estimated by summing the incremental volumes represented by each grid point sampled in range and depth for which the appropriate metric exceeds that threshold, and accumulated over all modeled bearings.

Histograms representing impact volumes as a function of (possibly depth-dependent) thresholds, are stored in a spreadsheet for dynamic changes of thresholds.

- Finally, the number of harassments is estimated as the inner-product of the animal density depth profile and the impact volume and scaled by user-specifiable surface animal densities.

This section describes in detail the process of computing impact volumes.

A.4.1 Calculating Transmission Loss

Transmission loss (TL) was pre-computed for both seasons for thirty non-overlapping frequency bands. Only the winter season was used for Maritime WSEP analysis. The 30 bands had one-third octave spacing around center frequencies from 50 Hz to approximately 40.637 kHz. In the previous report for Maritime Strike analysis in 2012, TL was computed at only seven frequencies. The broadband nature of the sources has been well covered in this report. The TL was modeled using the Navy Standard GRAB V3 propagation loss model (Keenan, 2000) with CASS v4.3

The transmission loss results were interpolated onto a variable range grid with logarithmic spacing. The increased spatial resolution near the source provided greater fidelity for estimates.

The transmission loss was calculated from the source depth to an array of output depths. The output depths were the mid-points of depth intervals matching GDEM's depth sampling. For water depths from surface to 10 m depth, the depth interval was 2 m. Between 10 m and 100 m water depth, the depth interval was 5 m. For waters greater than 100 m, the depth interval was 10 m. For the Eglin AFB Maritime WSEP exercise area environment, there were thirty depths (1, 3, 5, 7, 9, 12.5, 17.5, 22.5, 27.5, 32.5, 37.5, 42.5, 47.5, 52.5, 57.5, 62.5, 67.5, 72.5, 77.5, 82.5, 87.5, 92.5, 97.5, 105, 115, 125, 135, 145, 155, 160, all in meters) representing depth-interval midpoints. The output depths represent possible locations of the animals and are used with the animal depth distribution to better estimate animal impact. The depth grid is used to make the surface image interference correction and to capture the depth-dependence of the positive impulse threshold.

An important propagation consideration at low frequencies is the effect of surface-image interference. As either source or target approach the surface, pairs of paths that differ by a single surface reflection set up an interference pattern that ultimately causes the two paths to cancel each other when the source or target is at the surface. A fully coherent summation of the eigenrays produces such a result but also introduces extreme fluctuations that would have to be highly sampled in range and depth, and then smoothed to give meaningful results, and would be inappropriate in representing a broad one-third octave band of the spectrum. An alternative approach is to implement what is sometimes called a semi-coherent summation. A semi-coherent sum attempts to capture significant effects of surface-image interference (namely the reduction of the field due to destructive interference of reflected paths as the source or target approach the surface) without having to deal with the more rapid fluctuations associated with a fully coherent sum. The semi-coherent sum is formed by a random phase addition of paths that have already been multiplied by the expression:

$$\sin^2\left(\frac{4\pi f z_s z_a}{c^2 t}\right)$$

where f is the frequency, z_s is the source depth, z_a is the animal depth, c is the sound speed and t is the travel time from source to animal along the propagation path. For small arguments of the sine function this expression varies directly as the frequency and the two depths. It is this relationship that causes the propagation field to go to zero as the depths approach the surface or the frequency approaches zero.

A.4.2 Computing Impact Volumes

This section and the next provide a detailed description of the approach taken to compute impact volumes for explosives. The impact volume associated with a particular activity is defined as the volume of water in which some acoustic metric exceeds a specified threshold. The product of this impact volume with a volumetric animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. The acoustic metric can either be an energy term (weighted or un-weighted energy flux density, either in a limited frequency band or across the full band) or a pressure term (such as peak pressure or positive impulse). The thresholds associated with each of these metrics define the levels at which half of the animals exposed will experience some degree of harassment (ranging from behavioral change to mortality).

Impact volume is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range, which is defined as the maximum range at which a particular threshold is exceeded for a single source emission, defines the range to which marine mammal activity is monitored in order to meet mitigation requirements.

The effective energy source level is modeled directly for the sources to be used at the target area. The energy source level is comparable to the model used for other explosives (Arons (1954), Weston (1960), McGrath (1971), Urick (1983), Christian and Gaspin (1974)). The energy source level over a one-third octave band with a center frequency of f for a source with a net explosive weight of w pounds is given by:

$$\mathrm{ESL} = 10 \log_{10} (0.26 f) + 10 \log_{10} (2 p_{max}^2 / [1/\theta^2 + 4 \pi^2 f^2]) + 197 \text{ dB}$$

where the peak pressure for the shock wave at one meter is defined as

$$p_{max} = 21600 (w^{1/3} / 3.28)^{1.13} \text{ psi} \qquad \text{(B-1)}$$

and the time constant is defined as:

$$\theta = [(0.058) (w^{1/3}) (3.28 / w^{1/3})^{0.22}] / 1000 \text{ sec} \qquad \text{(B-2)}$$

For each season and explosive source, the amount of energy in the water column is calculated. The propagation loss for each frequency, expressed as a pressure term, modulates the sound energy found at each point on the grid of depth (uniform spacing) and range (logarithmic spacing). If a threshold is exceeded at a point, the impact volume at an annular sector is added to the total impact volume. The impact volume at a point is calculated exactly using the depth interval, the range interval of the point, and the slice of a sphere centered where the range is zero.

A.4.3 Effects of Metrics on Impact Volumes

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own thresholds. The energy (SEL) metric, the peak pressure (SPL) metric, and the "modified" positive impulse metric are discussed in this section. The energy metric, using the Type II weighted total energy, is accumulated after the explosive detonation. The other two metrics, peak pressure and positive impulse, are not accumulated but rather the maximum levels are taken.

Energy Metric

The energy flux density is sampled at several frequencies in one-third-octave bands. The total weighted energy flux at each range/depth combination is obtained by summing the product of the Type II frequency weighting function, $W_{II}(f)$, and the energy flux density at each frequency. The Type II weighting function in dB is given by:

$$W_{II}(f) = maximum\big(G_1(f), G_{12}(f)\big), \text{ where}$$

$$G_1(f) = K_1 + 20log_{10}\left[\frac{b_1^2 f^2}{(a_1^2+f^2)(b_1^2+f^2)}\right], \text{ and}$$

$$G_2(f) = K_2 + 20log_{10}\left[\frac{b_2^2 f^2}{(a_2^2+f^2)(b_2^2+f^2)}\right].$$

The component lower cutoff frequencies, a_1, upper cutoff frequencies, b, and gain, K, are a function of the functional hearing group. Parameters used for cetaceans are given in **Table A-4**.

Table A-4. Parameters used for Cetaceans

Functional Hearing Group	K_1(dB)	a_1(Hz)	b_1(Hz)	K_2(dB)	a_2(Hz)	b_2(Hz)
LF cetaceans	-16.5	7	22,000	0.9	674	12,130
MF cetaceans	-16.5	150	160,000	1.4	7,829	95,520
HF cetaceans	-19.4	200	180,000	1.4	9,480	108,820

Note that because the weightings are in dB, we will actually weight each frequency's EFD by $10^{(W_{II}(f)/10)}$, sum the EFDs over frequency and then convert the weighted total energy to back to dB, with level = 10 $\log_{10}$(total weighted EFD).

Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation at each range/animal depth combination. First, the transmission pressure ratio, modified by the source level in a one-third-octave band, is summed across frequency. This averaged transmission ratio is normalized by the total broadband source level. Peak pressure at that range/animal depth combination is then simply the product of:

- the square root of the normalized transmission ratio of the peak arrival,
- the peak pressure at a range of one meter (given by equation B-1), and
- the similitude correction (given by $r^{-0.13}$, where r is the slant range).

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

"Modified" Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner (Goertner, 1982). The Goertner model defines a "partial" impulse as

$$\int_0^{T_{min}} p(t)\, dt$$

where $p(t)$ is the pressure wave from the explosive as a function of time t, defined so that $p(t) = 0$ for $t < 0$. This similitude pressure wave is modeled as

$$p(t) = p_{max}\, e^{-t/\theta}$$

where p_{max} is the peak pressure at one meter (see, equation B-1), and θ is the time constant defined in equation A-2.

The upper limit of the "partial" impulse integral is

$$T_{min} = \min \{T_{cut}, T_{osc}\}$$

where T_{cut} is the time to cutoff and T_{osc} is a function of the animal lung oscillation period. When the upper limit is T_{cut}, the integral is the definition of positive impulse. When the upper limit is defined by T_{osc}, the integral is smaller than the positive impulse and thus is just a "partial" impulse. Switching the integral limit from T_{cut} to T_{osc} accounts for the diminished impact of the positive impulse upon the animals lungs that compress with increasing depth and leads to what is sometimes call a "modified" positive impulse metric.

The time to cutoff is modeled as the difference in travel time between the direct path and the surface-reflected path in an isovelocity environment. At a range of r, the time to cutoff for a source depth z_s and an animal depth z_a is

$$T_{cut} = 1/c\ \{ [r^2 + (z_a + z_s)^2]^{1/2} - [r^2 + (z_a - z_s)^2]^{1/2} \}$$

where c is the speed of sound.

The animal lung oscillation period is a function of animal mass M and depth z_a and is modeled as

$$T_{osc} = 1.17\, M^{1/3}\, (1 + z_a/33)^{-5/6}$$

where M is the animal mass (in kg) and z_a is the animal depth (in feet).

The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. So instead of the user specifying the threshold, it is computed as $K\,(M)^{1/3}\,(1 + z_a/33)^{1/2}$. The coefficient K depends upon the level of exposure. For the onset of slight lung injury, K is 39.1; for the onset of extensive lung hemorrhaging (1% mortality), K is 91.4.

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical dolphin calf (with an average mass of 12.2 kg). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi-msec; for the onset of extensive lung hemorrhaging (1% mortality), the threshold at the surface is approximately 31 psi-msec.

As with peak pressure, the “modified” positive impulse at each grid point is compared to the derived threshold. If the impulse is greater than that threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

A.5 ESTIMATING ANIMAL HARASSMENT

A.5.1 Distribution of Animals in the Environment

Species densities are usually reported by marine biologists as animals per square kilometer. This gives an estimate of the number of animals below the surface in a certain area, but does not provide any information about their distribution in depth. The impact volume vector specifies the volume of water ensonified above the specified threshold in each depth interval. A corresponding animal density for each of those depth intervals is required to compute the expected value of the number of exposures. The two-dimensional area densities do not contain this information, so three-dimensional densities must be constructed by using animal depth distributions to extrapolate the density at each depth.

The following bottle nose dolphin (summer profile) example demonstrates the method used to account for three-dimensional analysis by merging the depth distributions with user-specifiable surface densities. Bottle nose dolphins are distributed with:

- 19.2% in 0-10 m,
- 76.8% in 10-50 m,
- 1.7% in 50-100 m, and
- 2.3% in 100-165 m.

The impact volume vector is sampled at 30 depths over the maximally 165 meter water column. Since this is a finer resolution than the depth distribution, densities are apportioned uniformly over depth intervals. For example, 19.2% of bottlenose dolphins are in the 0-10 meter interval, so approximately

- 3.84% are in 0-2 meters,
- 3.84% are in 2-4 meters,
- 3.84% are in 4-6 meters,
- 3.84% are in 6-8 meters, and
- 3.84% are in 8-10 meters.

Similarly, 76.8% are in the 10-50 m interval, so approximately

- 9.60% are in 10 - 15 meters,
- 9.60% are in 15 - 20 meters,
- 9.60% are in 20 - 25 meters,
- etc.

A.5.2 Harassment Estimates

Impact volumes for all depth intervals are scaled by their respective depth densities, divided by their depth interval widths, summed over the entire water column and finally converted to square kilometers to create impact areas. The spreadsheet allows a user-specifiable surface density in animals per square kilometer, so the product of these quantities yields expected number of animals in ensonified water where they could experience harassment.

Since the impact volume vector is the volume of water at or above a given threshold per unit operation (e.g. per detonation, or clusters of munitions explosions), the final harassment count for each animal is the unit operation harassment count multiplied by the number of units deployed.

The detonations of explosive sources are generally widely spaced in time and/or space. This implies that the impact volume for multiple firings can be easily derived by scaling the impact volume for a single detonation. Thus the typical impact volume vector for an explosive source is presented on a per-detonation basis.

Table A-4 shows the model outputs (i.e., take estimates) for each species. For thresholds that contain more than one criterion, the one that yields the highest level of take is used for Eglin's request and is highlighted in yellow.

Table A-4. Number of Bottlenose Dolphins and Atlantic Spotted Dolphin Potentially Affected

Munition	NEW (lbs)	Total #	Detonation Scenario	Mortality	Level A Harassment				Level B Harassment		
				Modified Goertner Model 1	Slight Lung Injury	GI Track Injury	PTS		TTS		Behavioral
					Modified Goertner Model 2	237 dB SPL	187 dB SEL	230 dB Peak SPL	172 dB SEL	23 psi	167 dB SEL
Bottlenose Dolphin Exposure Estimates											
GBU-10 or GBU-24	945	2	Surface	0.03	0.05	0.24	2.54	0.86	10.54	2.73	16.28
GBU-12 or GBU-54	192	6	Surface	0.05	0.10	0.33	4.23	1.17	19.55	3.37	31.44
AGM-65 (Maverick)	86	6	Surface	0.04	0.07	0.23	2.99	0.82	15.43	2.28	24.97
GBU-39 (LSDB)	37	4	Surface	0.01	0.03	0.10	1.24	0.38	7.82	1.05	12.75
AGM-114 (Hellfire)	20	15	10	0.20	0.64	0.38	4.57	1.64	100.21	5.52	196.34
AGM-175 (Griffin)	13	10	Surface	0.01	0.05	0.14	1.55	0.58	13.85	1.69	22.97
2.75 Rockets	12	100	Surface	0.13	0.46	1.33	14.34	5.55	135.21	16.34	223.15
PGU-13 HEI 30 mm	0.1	1000	Surface	0.00	0.01	0.20	0.66	1.64	102.71	8.56	334.63
Atlantic Spotted Dolphin Exposure Estimates											
GBU-10 or GBU-24	945	2.00	Surface	0.00	0.01	0.02	0.39	0.05	1.78	0.12	2.79
GBU-12 or GBU-54	192	6	Surface	0.01	0.01	0.03	0.64	0.09	3.18	0.22	5.30
AGM-65 (Maverick)	86	6	Surface	0.00	0.01	0.02	0.45	0.07	2.50	0.18	4.13
GBU-39 (LSDB)	37	4	Surface	0.00	0.01	0.01	0.20	0.04	1.24	0.09	2.08
AGM-114 (Hellfire)	20	15	10	0.06	0.17	0.10	1.29	0.41	21.45	1.30	38.87
AGM-175 (Griffin)	13	10	Surface	0.00	0.01	0.02	0.28	0.07	2.14	0.17	3.70
2.75 Rockets	12	100	Surface	0.04	0.09	0.21	2.62	0.65	20.77	1.66	35.90
PGU-13 HEI 30 mm	0.1	1000	Surface	0.00	0.02	0.15	0.38	0.71	21.09	2.27	53.64
Unidentified[1] Dolphin Exposure Estimates											
GBU-10 or GBU-24	945	2.00	Surface	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.09
GBU-12 or GBU-54	192	6	Surface	0.00	0.00	0.00	0.02	0.00	0.11	0.01	0.18
AGM-65 (Maverick)	86	6	Surface	0.00	0.00	0.00	0.02	0.00	0.08	0.01	0.14
GBU-39 (LSDB)	37	4	Surface	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.07
AGM-114 (Hellfire)	20	15	10	0.00	0.01	0.00	0.04	0.01	0.73	0.04	1.32
AGM-175 (Griffin)	13	10	Surface	0.00	0.00	0.00	0.01	0.00	0.07	0.01	0.13
2.75 Rockets	12	100	Surface	0.00	0.00	0.01	0.09	0.02	0.71	0.06	1.22
PGU-13 HEI 30 mm	0.1	1000	Surface	0.00	0.00	0.00	0.01	0.02	0.72	0.08	1.82

[1]Unidentified dolphins can be either bottlenose or Atlantic spotted dolphin. Mortality and injury estimates in this table are conservatively based on the mass of a newborn Atlantic spotted dolphin.

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