National Marine Fisheries Service
Endangered Species Act Section 7
Conference and Biological Opinion

Title:	Conference and Biological Opinion on Military Operations Proposed by the U.S. Air Force in the Eglin Gulf Test and Training Range for the 7-year mission period from 2023 to 2030, and the Issuance of a Marine Mammal Protection Act Letter of Authorization by the National Marine Fisheries Service
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Action Agency:	Eglin Air Force Base, U.S. Air Force, U.S. Department of Defense and the Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Publisher:	Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Approved:	DAMON RANDALL.KIMBERLY.BETH.1365821093 Digitally signed by DAMON RANDALL.KIMBERLY.BETH.1365821093 Date: 2023.04.05 10:48:38 -04'00' Kimberly Damon-Randall Director, Office of Protected Resources
Date:	4/5/23
Consultation Tracking number:	OPR-2021-02687
Digital Object Identifier (DOI):	https://doi.org/10.25923/2acv-y502

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

Page

1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concur with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

The Federal action agencies for this consultation are the U.S. Air Force (USAF), Eglin Air Force Base (EAFB), and NMFS' Permits and Conservation Division (Permits Division). The EAFB proposes to continue to conduct military testing and training operations in Eglin Gulf Test and Training Range (EGTTR) during the next 7-year mission period from 2023 to 2030. The Permits Division proposes to issue a Letter of Authorization (LOA) that would authorize non-lethal "takes" by Level A and B harassment (as defined by the Marine Mammal Protection Act [MMPA]) of marine mammals incidental to the proposed military testing and training operations in the EGTTR, pursuant to section 101(a)(5)(D) of the MMPA 16 U.S.C. 1371(a)(5)(D).

This consultation, biological opinion, and ITS, were completed in accordance with ESA section 7, associated implementing regulations (50 C.F.R. §§402.01-402.17), and agency policy and guidance. This consultation was conducted by the NMFS Office of Protected Resources ESA Interagency Cooperation Division (hereafter referred to as "we," "us," or "our").

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and ITS would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

This document represents our opinion on the effects of the proposed actions on endangered and threatened marine mammals, sea turtles, fishes, corals, and designated critical habitats. Section 7(a)(4) of the ESA provides for Federal action agencies to confer with NMFS to evaluate impacts to species proposed for listing and habitat proposed for designation as critical habitat. We have provided the results of a conference, for the same proposed actions as the formal consultation, with this biological opinion.

A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

The EGTTR is a readily accessible environment for military operations that is supported by maritime and land-based instrumentation and networking assets. The unique combinations of range attributes are not available to the U.S. military in other locations. Testing and training operations in the EGTTR are considered critical for achieving military readiness and the overall goals of the National Defense Strategy.

NMFS consulted on the current EGTTR operations for the EAFB 5-year mission period from 2018 to 2023. Most of the operations proposed for the next 7 years would be a continuation of current activities. Missions typically involve air-to-surface operations firing live or inert munitions (e.g., missiles, bombs, and gun ammunition) from aircraft at targets on the water surface. Targets include stationary, remotely controlled, and towed boats, inflatable targets, and marker flares. There is an expected increase in the annual quantities of all general categories of munitions except for live gun ammunition, which is proposed to be used less over the next mission period. The highest net explosive weight (NEW) of any single munition would continue to be 945 pounds, the same maximum NEW for the previous mission period.

In conjunction with this action, the Permits Division proposes the issuance of an LOA pursuant to the MMPA requirements for incidental takes of marine mammals that could occur during military operations in the EGTTR. This document represents our opinion on the effects of the these proposed federal actions on threatened and endangered species, and has been prepared in accordance with section 7(a)(2) of the ESA. The preceding opinion for year 2018 to 2023 EAFB mission period determined that the operations were not likely to jeopardize the continued existence of ESA-listed species.

1.2 Consultation History

A Biologist from the EAFB Natural Resources Office was the lead point of contact for communications regarding the proposed EGTTR operations. The consultation request submitted by EAFB included a Biological Assessment (BA) of the proposed operations in the EGTTR during the next 7-year mission period from 2023 to 2030. The Permits Division provided a draft copy of the proposed LOA prepared pursuant to the MMPA, with their consultation request. Our communication with EAFB and the Permits Division regarding this consultation was conducted through email and is summarized as follows:

- **October 13, 2021:** EAFB submitted a consultation request with a BA and cover letter to us for review.
- **November 12, 2021:** We provided questions and comments regarding the BA to EAFB.
- **December 6, 2021:** EAFB provided us with responses and some revisions to the BA.
- **January 20, 2022:** After review of the responses, we reached out to staff with ESA-listed Rice's whale expertise in the NMFS Southeast region to clarify the area considered core habitat for Rice's whale occurrence.
- **February 3, 2022**: We received confirmation from the NMFS Southeast Fisheries Science Center indicating the Rice's whale core habitat area begins at the 100 meter (m) isobath in the northeast Gulf of Mexico and not at the 150 m isobaths as the EAFB had in their initiation package.
- **February 7, 2022**: After reviewing the revised BA, itemized comments were sent to EAFB. There were specific concerns expressed related to a discrepancy in recognition of Rice's whale core habitat area boundaries and disagreement with EAFB's determination of 'no effect' to the Rice's whale. We cited the *Rice's Whale Recovery Outline*[1] for the species' range in the northeastern Gulf of Mexico, De Soto Canyon area, along the continental shelf break between 100 m and 400 m depth.
- **February 15, 2022**: EAFB requested guidance on how to calculate take estimates for the Rice's whale.
- **February 18, 2022:** We confirmed with NMFS Southeast region staff that the best available estimates of Rice's whale density was Roberts et al. (2016).
- **February 24, 2022:** We advised EAFB that the probability of Rice's whale occurrence model should be used to support estimation of exposure. The conservation importance of trying to avoid impacts to Rice's whale, considering the extremely low population of this endangered whale, was also expressed.
- **April 11, 2022**: We received a revised BA from EAFB.
- **April 14**, **2022**: We received spreadsheets with take estimates from EAFB.

[1] https://media.fisheries.noaa.gov/2021-08/RIWH-Recovery-Outline-Final-508-Compliant.pdf.pdf

- **April 26, 2022**: We requested new Rice's whale Zone of Influence and setback figures; the image resolution was hard to interpret. New images with improved clarity were provided by the end of the day.
- **April 28, 2022**: We discussed the review of the LOA application with the Permits Division.
- **May 2, 2022**: We provided comments for April revisions and responses from EAFB. We suggested extending the gunnery restriction to behind the 100-m isobath for consistency across all missions to improve conservation.
- **May 24, 2022**: EAFB responded that they could plan to move the gunnery missions to behind the 100-m isobath.
- **May 31, 2022**: We met with the Permits Division to discuss gunnery mission monitoring, potential exposure, and take estimates.
- **June 1, 2022**: We expressed concerns to EAFB because we did not agree the proposed gunnery mission monitoring would be 100% effective (day or night) throughout an area with a 9 kilometer (km) radius of potential exposure, meaning no take would be accounted for there. This was not how take exposure estimates were being handled for other missions that included potential take estimates in a monitored area, and for conservation consistency, we would need to know the potential exposure for take estimates that included the monitored area for gunnery missions. In addition, to be consistent across missions with potential take from detonation-sourced acoustic impacts, a setback would be needed to keep the potential Permanent Threhold Shift (PTS) sound level shoreward of the 100 m isobath.
- **June 7, 2022**: EAFB responded, stating a setback to keep PTS threshold-level sound from gunnery mission munitions shoreward of the 100 m isobath can be utilized to be consistent with the other missions and that new take estimates would be provided for potential exposure in the monitored area for gunnery missions.
- **June 13, 2022**: We requested the most recent documents regarding range assessment and resource plan.
- **June 16, 2022**: EAFB supplied a revised BA with revised gunnery mission take estimates for the whole area of potential exposure with a PTS setback.
- **July 18, 2022**: EAFB provided a draft Environmental Assessment for the range.
- **July 19, 2022**: We sent questions to EAFB regarding high-velocity (aka hypersonic) munitions. EAFB provided responses by the end of the day.
- **July 29, 2022**: We provided some follow up questions to EAFB regarding high-velocity munition impacts and monitoring.
- **August 1, 2022**: EAFB provided responses to the high-velocity munition follow up questions.
- **August 5, 2022**: We requested that EAFB provide clarity regarding monitoring distance threshold statements in the BA. EAFB responded later that day.

- **September 12, 2022**: EAFB inquired on any additional information needs and we shared recent awareness of new species density models available for the action area and that, when the draft proposed LOA is received from the Permits Division, we should be able to initiate consultation.
- **September 19, 2022:** The Permits Division submitted their initiation package to the ESA Interagency Cooperation Division for review. The ESA Interagency Cooperation Division reviewed the package, determined it was complete, and initiated consultation on the same date. We also determined there was sufficient information as of September 19, 2022, to initiate a formal consultation with EAFB.
- **October 18, 2022**: EAFB sent a revised BA with updated take requests based on new density estimates.
- **October 26, 2022**: We sent EAFB questions regarding new take estimates due to miscalculations in Rice's whale take estimates and contradictions with statements in the BA.
- **October 28, 2022**: EAFB sent corrected estimates.
- **November 2, 2022**: We sent a copy of the proposed action section of the draft opinion to EAFB for review.
- **November 8, 2022**: EAFB sent a question regarding new information they had and the Permits Division and us responded.
- **November 10, 2022**: EAFB sent new mitigation language regarding changes to the pre-mission survey area distance.
- **November 17, 2022**: EAFB revised the BA and LOA application with updated language for mitigation survey distances and a change in a proposed mission that resulted in recalculated take estimates.
- **November 18 and 22, 2022**: We had exchanges with EAFB on vessel transit measures and pre-mission survey procedures for inert munitions. EAFB replied with additional info related to the human safety zone and vessel procedures.
- **December 13, 2022**: We sent questions to EAFB regarding sea turtle take estimates. EAFB responded on 12/16/22, we reviewed that information and asked clarifying questions that same day. We received additional clarifying information on 12/21/22.
- **January 19, 2023**: The Permits Division shared a revised draft proposed rule - MMPA authorization that was submitted for publication to the federal register.
- **March 27, 2023**: We received a draft final rule – MMPA authorization from the Permits Division that was being submitted for publication to the federal register.

2 THE ASSESSMENT FRAMEWORK

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species (50 C.F.R. §402.02).

An ESA section 7(a)(2) opinion involves the following steps:

Description of the Proposed Action (Section 3): We describe the activities being proposed by the action agencies, including conservation measures to reduce the effects to ESA-listed resources.

Action Area (Section 4): We describe the action area with the spatial extent of the potential stressors from the action. Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.

Potential Stressors (Section 5): We identify the potential stressors that may result from the proposed action.

Endangered Species Act Resources in the Action Area (Section 6): We identify the ESA-listed species and designated or proposed critical habitat under NMFS' jurisdiction that may occur within the action area and therefore could be affected by the proposed action.

We identify the *Species and Critical Habitat Not Likely to be Adversely Affected* (Section 7) by the proposed action and its stressors.

Status of Species and Critical Habitat Likely to be Adversely Affected (Section 8): We examine the status of the ESA-listed species and critical habitat that are likely to be adversely affected by the proposed action.

*Environmental Baseline (*Section 9): We describe the environmental baseline in the action area as the condition of the ESA-listed species and designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to ESA-listed species from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Effects of the Action (Section 10): Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

We include a section (Section 10.1) for stressors that are not likely to adversely affect ESA-listed resources. We then identify the stressors (Section 10.2) that are likely to adversely affect ESA-listed resources. These are broken into analyses of exposure and response (Section 10.3) as described below for the species that are likely to be adversely affected by the action.

In the exposure analysis, we identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or sub-populations to which those individuals belong. We also identify the unit(s) of designated critical habitat that is likely to be exposed.

In the response analysis, we evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond to the stressors given their probable exposure. We also consider how critical habitat could change in terms of function.

Cumulative Effects (Section 11): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integrated Risk Assessment (Section 12): We assess the consequences of individual responses, from exposure to stressors of the action, to the populations those individuals represent, and the species those populations comprise. We also assess the consequences of changes in function of critical habitat and how that may affect the conservation value of designated critical habitat. We then integrate consequences from the action with the species' status and the environmental baseline to assess risk. We then consider additional risk from any cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; and/or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

Conclusion (Section 13): The results of our jeopardy and destruction or adverse modification analyses are summarized in this section. If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or result in the destruction or adverse modification of critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (50 C.F.R. §402.14(h)(2)).

An *Incidental Take Statement* (Section 14) is included for those actions for which incidental take of ESA-listed species is reasonably certain to occur (see 50 C.F.R. §402.14(g)(7), §402.14(i)). The ITS specifies the amount or extent of take, reasonable and prudent measures to minimize the impact of the take, measures for marine mammals that are necessary to comply with section 101(a)(5) of the MMPA and applicable regulations with regard to such taking, and terms and conditions to implement the reasonable and prudent measures (ESA section 7 (b)(4); 50 C.F.R. §402.14(i)).

We also provide discretionary *Conservation Recommendations* (Section 15) that may be implemented by action agency (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which the action agency is required to request *Reinitiation of Consultation* (Section 16; 50 C.F.R. §402.16).

2.1 Evidence Available for the Consultation

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of Google Scholar and literature cited sections of peer-reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- Information submitted by the USAF and the Permits Division;
- Government reports (including NMFS biological opinions and stock assessment reports);
- NOAA technical memos; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed and proposed species, and designated and proposed critical habitat, under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

3 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas.

Two actions were evaluated in this consultation. The first action is proposed military operations in the EGTTR. The second action is the Permits Division's issuance of an LOA authorizing non-lethal MMPA "takes" pursuant to section 101(a)(5)(D) of the MMPA for the proposed military operations.

3.1 Overview of Eglin Gulf Test and Training Range Operations

The EGTTR is used by military units at EAFB for various types of testing and training operations. The EAFB is proposing to conduct testing and training operations in the EGTTR during the next 7-year mission period from 2023 to 2030. Most operations during this period would be a continuation of the same operations conducted by the same military units during the previous mission period. Most missions in the EGTTR are air-to-surface operations that involve firing live or inert munitions, including missiles, bombs, and gun ammunition, from aircraft at designated targets on the water surface. The EGTTR missions also include various types of air-to-air, surface-to-air, surface-to-surface, vessel, and in-water operations. Although EAFB could use any portion of the EGTTR, the majority of testing and training operations are proposed to occur in Warning Area W-151 (Figure 2, Action Area). Live missions would be conducted in the existing Live Impact Area (LIA), where the use of live (explosive detonation) munitions is currently authorized, which is mostly within W-151 of the EGTTR (Figure 3, Action Area). The Gulf Range Armament Test Vessel (GRATV) is a barge with mission supporting instrumentation anchored centrally within the LIA.

Certain missions may also be conducted in the proposed East LIA, which would be a new, separate area, supported by land-based instrumentation, within the EGTTR where live munitions would be used (Figure 3, Action Area). Establishment of the East LIA would allow EAFB to maximize the flight range for large footprint weapons and minimize the distance, time, and cost of deploying support vessels and targets. Based on these factors, the East LIA would allow testing of weapon systems and flight profiles that cannot be conducted within the constraints of the existing LIA. Missions conducted in the East LIA will be required to implement the same established range procedures for public safety and protected species as those implemented in the existing LIA.

The munitions proposed to be used during the operations, including munition type, category, NEW, detonation scenario, and annual quantity proposed to be expended in the EGTTR can be found in Table 1 of Appendix A. The NEW applies to live munitions and is the total mass of the explosive substances in a given munition, without packaging, casings, bullets, or other non-explosive components of the munition. There are three detonation scenarios for live munitions: (1) in the air a few feet (ft) above the water surface, referred to as airburst or height of burst (HOB); (2) instantaneously upon contact with the water or target on the water surface; or (3) after a slight delay, up to 10 milliseconds, after impact, which would correspond to a subsurface detonation at a water depth of approximately 5 to 10 ft (1.5 to 3 m). The proposed annual expenditures of munitions are the quantities determined necessary to meet the mission requirements of the user groups and may include a sufficient number of munitions for replicate tests to provide an acceptable confidence level regarding munitions capabilities.

Live missions that involve only airburst or aerial target detonations could continue to be conducted in or outside the LIA in any portion of the EGTTR. Use of inert munitions and live air-to-surface gunnery operations could also continue to occur in or outside the LIA, with new mitigation measures to prevent impacts to the Rice's whale (see Section 3.3, Conservation Measures).

There is potential for parachutes (decelerators) to be used to deliver munitions or mission-related equipment from aircraft. Such parachutes allow delivery of munitions, test equipment, and other items from aircraft to a designated location on the sea surface at a slow speed via the drag provided by the parachute. These parachutes are used extensively by the U.S. Navy to deploy sonobuoys and various types of munitions from aircraft. Parachutes used for aircraft-launched items typically range in diameter from 1.5 ft to 19 ft (0.46 to 5.8 m); much larger parachutes, up to 82 ft (25 m) in diameter, are used to decelerate drones (Navy 2018). Currently, no EGTTR missions that would involve the use of parachutes are planned; however, parachutes may be used during certain missions in the EGTTR during the 2023–2030 period. Based on past use such chutes can be used up to twice per year, but also with some years not used at all. Parachutes are weighted and sink readily to the seafloor (Navy 2018).

Range clearance procedures are followed during all EGTTR missions for public safety. Prior to each mission, a human safety zone appropriate for the mission is established around the target area. The size of the safety zone varies depending on the munition type and delivery method. A composite safety zone is often developed for missions that involve multiple munition types and delivery methods. A typical composite human safety zone is octagon-shaped to make it easier to monitor by mission-support boats and easier to interpret by the public when it is overlaid on maps with latitude and longitude coordinates (Figure 1). The perimeter of a typical composite human safety zone extends out to approximately 13 nautical miles (NM) (24 km) from the center of the zone. The safety zone is continuously monitored by up to 25 mission-support boats to ensure it is free of any non-participating vessels before and during the mission, typically from sunrise to noon. The range-clearing boats are typically at their guard stations by sunrise before commercial and recreational boaters have an opportunity to enter the safety zone. Two range-clearing boats are stationed in Destin Pass to distribute flyers and maps to civilian boaters as they exit the pass and enter the Gulf of Mexico, informing them of the area closures. Before mission aircraft release munitions, the aircraft often fly over the target area to ensure that it is clear of non-participating vessels. Additional support aircraft may be used to monitor the safety zone during certain missions. The Eglin Safety Office remotely monitors real-time activity of vessels in the area to make clear-to-arm and clear-to-fire calls for the mission. The Eglin Safety Office also requests that the U.S. Coast Guard (USCG) issue a Notice to Mariners in advance of the mission to inform the public about the location and restrictions of the safety zone.

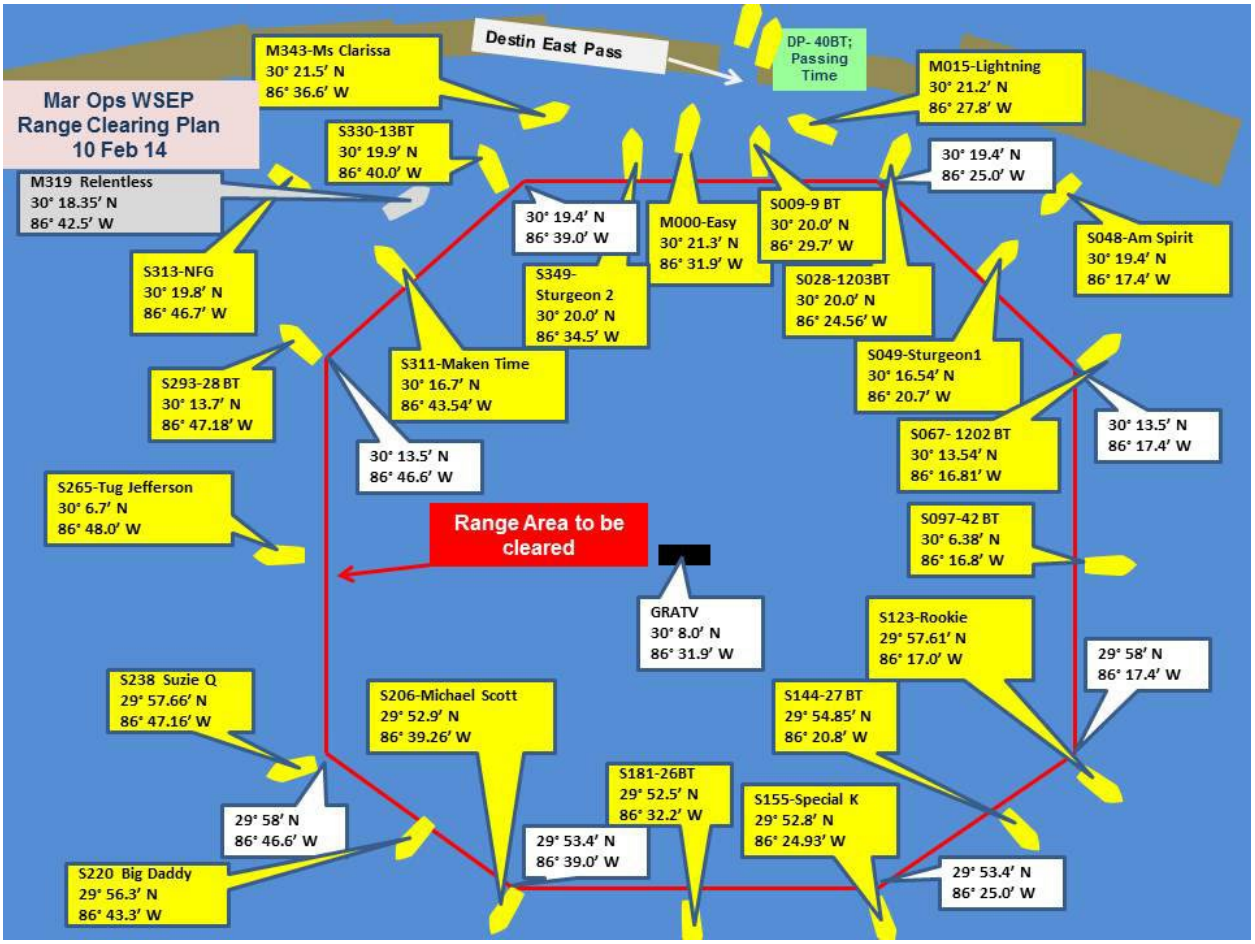

Figure 1. Example of human safety zone.

Prior to each mission, a separate zone for protected species is established around the target area. This zone is based on the distances from the detonation where impacts to marine species could occur, as determined by underwater acoustic modeling, associated analyses, and established thresholds. The species protection zone is typically smaller than the human safety zone. Trained marine species observers survey the species protection zone before each mission and inform mission personnel if marine species or their potential indicators are present in the zone. Missions are conducted only when the zone is confirmed to be free of protected species. The monitoring and mitigation measures implemented by Eglin AFB for the protection of marine species in the EGTTR are provided in greater detail in Section 3.3, Conservation Measures.

Post-mission activities primarily include removal of any unexploded ordinances (UXOs) and mission-related debris from the target area and post-mission monitoring for protected species. UXO removal is accomplished by USAF Explosive Ordnance Disposal (EOD) personnel, who may need to detonate in place any potential UXO item that remains, such as onboard a boat target. UXOs are not detonated by EOD personnel in the water. Some unexploded bombs, missiles, and other large munitions sink to the seafloor and are not recovered or detonated. After EOD operations are completed, other mission-support personnel remove debris and conduct post-mission surveys. Large, mostly intact, damaged target vessels may be towed, while smaller debris items are netted or lifted aboard vessels and taken to shore for disposal. Post-mission protected species surveys are provided in greater detail in Section 3.3, Conservation Measures.

The subsections that follow provide a summary of each military unit's proposed EGTTR operations.

3.1.1 53rd Weapons Evaluation Group

The 53rd Weapons Evaluation Group (53 WEG) conducts the USAF's air-to-ground Weapons System Evaluation Program (WSEP) known as Combat Hammer and the USAF's air-to-air WSEP known as Combat Archer. All of the munitions proposed for 53 WEG missions can be found in Table 1, Appendix (App) A.

Combat Archer
Combat Archer involves live air-to-air missile testing on QF-16 Full-Scale Aerial Targets (resembles a regular sized fighter jet) and BOM-167 Subscale Aerial Targets (less than half the size of fighter jet) to evaluate the effectiveness of missile delivery techniques. Combat Archer missions involve several types of fighter aircraft: F-15, F-16, F-18, F-22, F-35, and A-10. These missions also include firing inert gun ammunition and releasing flares and chaff from aircraft. Decoy flares and chaff are the primary aerial countermeasures released by aircraft to prevent attack by enemy defense systems. Decoy flares are typically composed of magnesium pellets that burn at high temperatures intended to attract heat-seeking missiles toward the flares and away from the aircraft. Chaff serves as a radar countermeasure and consists of aluminum-coated glass fibers. When released from aircraft, clouds of chaff fibers are designed to confuse radar-guided missiles and prevent them from attacking the aircraft.

Combat Hammer
Combat Hammer involves testing various types of live and inert munitions (including rockets, missiles, bombs, and gun ammunition) to develop tactics, techniques, and procedures (TTP) that USAF aircraft use to counter small, maneuvering, hostile vessels. Live munitions would be deployed against static (anchored), remotely controlled, and towed targets. Static and remotely controlled targets would consist of stripped boat hulls with simulated systems and, in some cases, heat sources. Towed targets would be towed by remotely controlled High-Speed Maneuverable Surface Target (HSMST) boats. The HSMST boats would be remotely controlled from a facility on Eglin Main Base and would follow set track lines with specific waypoints at least 2 to 3 NM (3.7 to 5.6 km) from the GRATV. Test data would be collected by instrumentation on the GRATV and through inspections of the damaged targets used during the tests. Support aircraft would provide aerial video of the mission site, including weapon impacts on targets, and assist with range clearance activities. Combat Hammer missions would be controlled from the Eglin Central Control Facility (CCF). Combat Hammer missions would involve the use of the same fighter aircrafts as Combat Archer, as well as AC-130 gunships, B-1, B-2, and B-52 bombers, and MQ-1 and MQ-9 drone aircraft. The USAF, Air National Guard, and U.S. Navy units would support these missions.

Swarm exercises may be conducted in association with Combat Hammer missions. During swarm exercises, aircrews employ various targeting and attack techniques against groups of fast moving, manned boats, referred to as swarms. No live or inert munitions are expended during swarm exercises.

Among the munitions proposed for Combat Hammer Missions, the CBU-105D is unique as it contains 10 submunitions that each have a small parachute (8 inches in diameter) to slow their descent. Eglin proposed to use up to eight CBU-105Ds annually (Table 1, App A).

3.1.2 Air Force Special Operations Command Training

The Air Force Special Operations Command (AFSOC) training primarily involves air-to-surface gunnery, bomb, and missile exercises. All of the munitions proposed for AFSOC training missions can be found in Table 1, App A.

AFSOC gunnery training in the EGTTR primarily involves firing live rounds from AC-130 gunships at Mark (Mk)-25 floating flares and inflatable targets (approximately 20 ft [6 m] long) on the water surface. Mk-25 flares provide a visual marker on the water surface with a burn time of approximately 10 to 20 minutes. AFSOC proposes to conduct 25 daytime gunnery missions and 45 nighttime gunnery missions per year.

During AC-130 gunnery training missions, gun firing can last up to 90 minutes but typically lasts approximately 30 minutes. Live firing is continuous, with pauses usually lasting well under one minute and rarely up to 5 minutes. Firing pauses would exceed 10 minutes only in one of the following situations: (1) a non-participating vessel or protected species causes the mission to relocate; (2) aircraft, gun, or target system malfunction occurs; or (3) more flares need to be deployed. The Eglin Safety Office has reported that 95 percent of the rounds strike the water within 5 m of the target during AC-130 gunnery missions (USAF 2015).

Range clearance procedures for public safety and protected species during live air-to-surface gunnery missions differ in some aspects to those implemented for other live missions. For public safety, AC-130 aircrews conduct a search out to 5 NM (9.3 km) from each potential target area to ensure it is clear of non-participating vessels prior to gunnery training. Protected species procedures during live air-to-surface gunnery missions are also different from other missions and are provided in more detail in Section 3.3, Conservation Measures.

The eighth Special Operations Squadron (8 SOS) under AFSOC also conducts gunnery training using the CV-22 Osprey tiltrotor aircraft. This CV-22 fires .50 caliber rounds, which are not explosive, at floating marker targets on the water surface. Flight procedures for CV-22 training are similar to those for AC-130 gunnery training, except that CV-22 aircraft typically operate at much lower altitudes, 100 to 1,000 ft (30 m to 305 m) AGL than AC-130 gunships 6,000 to 20,000 ft (1829 to 20000 m) AGL. The 8 SOS proposes to conduct 25 daytime missions and 25 nighttime CV-22 training missions per year.

In addition to gunnery training, AFSOC conducts air-to-surface training using various types of bombs and missiles to develop TTPs and train strike aircraft to counter small moving boats, similar to previously described for Combat Hammer operations by the 53 WEG.

3.1.3 96th Operations Group

Three units under the 96th Operations Group (96 OG) propose to conduct missions in the EGTTR during the 2023–2030 period: the 417th Flight Test Squadron (417 FLTS), 96th Operational Support Squadron (96 OSS), and 780th Test Squadron (780 TS). In addition to 417 FLTS, 96 OSS, and 780 TS missions, the 96 OG is expected to continue conducting testing missions involving inert bombs in the EGTTR during the 2023–2030 period. While detailed information on these missions is not available, they would involve only inert munitions that are typically directed at boat targets. All of the munitions proposed under the 96 OG training missions can be found in Table 1, App A.

417 Flight Test Squadron

The 417 FLTS proposes to continue to test equipment and instrumentation on AC-130 aircraft, including the Precision Strike Package (PSP) and Stand-Off Precision Guided Munitions (SOPGM) systems developed by the U.S. Special Operations Command. AC-130 gunnery testing conducted by the 417 FLTS will be conducted in the same manner as the AFSOC except the 417 FLTS does not propose to conduct gunnery testing at night. The PSP and SOPGM systems testing uses live missiles and precision guided bombs targeted at boats.

96th Operational Support Squadron

The 96 OSS proposes to conduct air-to-surface testing of missiles and precision-guided bombs in support of the MQ-9 Reaper Unmanned Aerial Vehicle (UAV) program. Munitions would be launched from MQ-9 at boats on the water surface.

780th Test Squadron

The 780 TS plans to lead or support various types of testing missions in the EGTTR, including missiles, guided bombs and hypersonic weapons. These missions would primarily include testing live and some inert munitions against targets on the water surface, such as vessels and barges, although some air-to-air and surface-to-air missile testing will also be conducted. Missions are often conducted with the Air Force Life Cycle Management Center and the U.S. Navy.

Testing for Precision Strike Weapons (PSW) will use JASSMs, an air-launched cruise missile, and Guided Bomb Units (GBUs). The JASSMs and GBUs would be launched at targets on the water surface within approximately 1,000 ft (305 m) of the GRATV. Two types of targets are typically used for PSW tests: Container Express (CONEX) targets and hopper barge targets. CONEX targets typically consist of up to five CONEX containers strapped, braced, and welded together to form a single structure. Each CONEX container is 8 ft by 8 ft by 40 ft (2.4 m by 2.4 m by 12 m) and filled with approximately 200 sealed 55-gallon steel drums to provide buoyancy. A hopper barge is a common type of barge that cannot move itself; a typical hopper barge measures approximately 30 ft by 12 ft by 125 ft (9 m by 3.7 m by 38 m). PSW targets are held in place by a four-point anchoring system using cables. They are anchored at the target location 2 to 3 days prior to the test. Depending on the test schedule, the target may remain anchored for up to one month. Surface debris resulting from each target strike is collected by post-test cleanup crews. If the target is severely damaged and determined to be unsafe to retrieve, the target remains may be scuttled (non-explosively) by flooding the interior airspaces of the target in coordination with the USCG and U.S. Army Corps of Engineers.

The JASSM would be launched from aircraft more than 200 NM (370 km) from the target location at altitudes greater than 25,000 ft (7620 m) AGL. The JASSM would cruise at altitudes greater than 12,000 ft (3658 m) AGL for most of the flight profile until its terminal descent toward the target. Live JASSMs would detonate at a HOB of approximately 5 (1.5 m) ft; however, these detonations are assumed to occur at the surface for the impact analysis.

The GBUs could be launched from aircraft more than 50 NM (92.6 km) from the target location at altitudes greater than 5,000 ft (1524 m) AGL. The bomb would travel via a non-powered glide to the intended target. Instrumentation in the bomb self-controls the bomb's flight path. The GBUs would detonate either at a HOB of approximately 7 to 14 ft (2 to 4.3 m) or upon impact with the target (surface). For simultaneous Small Diameter Bomb (SBD) launches, two GBU-39 SDBs would be launched from the same aircraft at approximately the same time to strike the same target. The SDBs would strike the target within approximately 5 seconds or less of each other. Such detonations would be considered a single event, with the associated NEW being doubled for a conservative impact analysis. Chase aircraft such as the F-15, F-16, and/or T-38 would follow the test items during captive carry and free flight but not below a predetermined altitude as directed by Flight Safety. Other support aircraft may include E-9 turboprop aircraft and tanker aircraft such as the KC-10 and KC-135. The GBU-39 (SBD1) is the only GBU proposed for simultaneous launch. Other proposed guided bomb testing includes GBU: 10, 24, 31, and 53 (SDB II).

An Mk-84, General Purpose (GP) 2,000 pounds (lb), is typically an unguided bomb but a Joint Direct Attack Munition (JDAM) kit modification in the tail section converts it to a guided bomb. Detonation is proposed as airburst. Testing an inert version of the Mk-84, without a modification for guidance, is proposed to continue.

Air-to-air missile testing is used for Joint Advanced Tactical Missile (JATM) missions, which involve the use of the AIM-260, AIM-9X Sidewinder, and AIM-120 AMRAAM missiles; all missiles used in these tests would be inert. The AIM-9X Sidewinder is a short-range, infrared seeking, air-to-air missile. The AIM-120 AMRAAM is a widely used beyond-visual-range missile and it is expected to be replaced eventually by the AIM-260 JATM, which is being developed by the USAF and U.S. Navy to have increased range and effectiveness over existing air-to-air missiles.

Joint Air-to-Ground Missile (JAGM) testing missions use the AGM-114L Longbow and AGM-179A. These missiles are launched from an AH-64D Apache helicopter. The missiles would be launched approximately 0.9 to 4.3 NM (1.7 to 8 km) from targets. Testing will also use the Spike

Non-Line-of-Sight (NLOS) air-to-surface tactical missile system in support of the U.S. Army's initiative to incorporate the Spike NLOS missile system onto the AH-64E Apache helicopter. The missiles would be launched approximately 10.8 to 20.5 NM (20 to 38 km) from targets. The test targets would be static and remotely controlled vessels, including the 25 foot (ft) (7.6 m) HSMST (foam-filled) and 41 ft (12.5 m) Coast Guard Utility Boat (metal hull).

Surface-to-air missile testing uses the Patriot Advanced Capability (PAC)-2 and PAC-3. These missiles are expected to be fired from the A-15 launch site on Santa Rosa Island at UAVs in the EGTTR.

Hypersonic weapons are capable of traveling at least five times the speed of sound, referred to as Mach 5. Conventional weapons typically rely on explosive warheads to inflict damage on a target, whereas hypersonic weapons can utilize kinetic energy from high-velocity impact to inflict damage on targets. For the purpose of impact assessment, the kinetic energy of a hypersonic weapon can be correlated to energy released in units of ft-lb or trinitrotoluene (TNT) equivalency. Hypersonic weapon technology is in early development; the Department of Defense (DoD) is developing hypersonic weapons with support from other agencies. The 780 TS supports high-priority rapid development hypersonic weapon programs, including the Hypersonic Attack Cruise Missile (HACM) and the Precision Strike Missile (PrSM).

The HACM is a developmental air-breathing hypersonic cruise missile that uses scramjet technology for propulsion. Up to one HACM test per year is proposed. A live HACM would be air launched from the southern portion of the EGTTR through a north–south corridor, expected to be 300 to 400 NM (556 to 741 km) in total length, at a target on the water surface in either the existing LIA or proposed East LIA. Test Site D-3 on Cape San Blas would provide land-based instrumentation and monitoring to support the terminal phase of the test.

The PrSM is being developed by the U.S. Army as a surface-to-surface, long-range, precision-strike guided missile to be fired from the M270A1 Multiple Launch Rocket System and the M142 High Mobility Artillery Rocket System. The 780 TS in coordination with the U.S. Army proposes to conduct up to two live and two inert PrSMs tests annually in the EGTTR. PrSMs will be surface launched from the A-15 launch site on Santa Rosa Island. The flight corridor is preliminarily expected to be 162 to 270 NM (300 to 500 km) in total length. For tests that involve a live warhead on the PrSM, the PrSM would be preset to detonate at a specific height above the water surface (HOB/airburst). Airburst PrSM tests could be fired into portions of the EGTTR outside the LIAs. Inert PrSM tests could also occur outside the LIAs, with exceptions to prevent impacts to the Rice's whale (see Section 3.3, Conservation Measures). A combination of UAVs and fighter aircraft would provide airborne instrumentation, monitoring, range clearance, and communications relay.

The 780 TS proposes to conduct up to two SINKEX exercises per year in coordination with the Air Force Research Laboratory. Exercises would involve the sinking of vessels, approximately 200 to 400 ft (61 to 122 m) in length, in the existing LIA. Vessels to be sunk will be prepared and cleaned to remove materials of environmental and safety concern such as fuels, oils, and loose debris. The specific types of munitions that would be used for SINKEX testing is controlled information and therefore not provided, but EAFB was able to confirm a mission-day category for acoustic impact analysis (see App A, Table 2) which is discussed in more detail in Section 3.3, Conservation Measures.

3.1.4 Naval School Explosive Ordnance Disposal

Naval School Explosive Ordnance Disposal (NAVSCOLEOD) training missions include Mine Countermeasures (MCM) exercises to teach NAVSCOLEOD students techniques for neutralizing mines underwater. Underwater MCM training exercises are conducted approximately 5 NM (9.3 km) offshore of Santa Rosa Island, in the EGTTR. Exercises primarily involve diving and placing small explosive charges adjacent to inert mines by hand; the detonation of such charges is what would disable a live mine.

Up to eight MCM training missions would be conducted annually, with four underwater charge detonations adjacent to inert mines, for a total of 32 annual detonations. The MCM neutralization charges consist of C-4 explosives, detonation cord, non-electric blasting caps, time fuzes, and fuze igniters; each charge has a NEW of approximately 20 lb. During each mission, a maximum of four charges would detonate with a delay no greater than 20 minutes between shots. After the final detonation, or a delay of greater than 20 minutes, a 30-minute environmental observation would be conducted. One large safety vessel and two inflatable boats are typically used to support the minimum vessel requirements for these missions. All underwater MCM training missions would be conducted during the daytime. In addition to underwater MCM training missions, NAVSCOLEOD proposes to conduct up to 80 floating mine training missions annually, which would involve detonations of charges on the water surface; these charges would have a NEW of approximately 5 lb. These missions would also be conducted only during the daytime.

3.2 National Marine Fisheries Service's Proposed Letter of Authorization

On January 18, 2022, the Permits Division received an application from EAFB to take marine mammals incidental to military testing and training activities in the EGTTR. The request was for the incidental (i.e., not intentional) harassment of small numbers of 3 species of marine mammals by MMPA Level A and Level B harassment that could occur during proposed military operations.

On June 17, 2022 the Permits Division deemed the application to be adequate and complete. The Permits Division is proposing to issue an LOA authorizing non-lethal "takes" under MMPA that are the equivalent of harassment (Level B) under the ESA for the endangered Rice's whale (*Balaenoptera ricei*). The proposed LOA identifies requirements that the applicants must comply with as part of its authorization, which are incorporated in Section 3.3, Conservation Measures.

On February 7, 2023, Permits Division published a notice of proposed LOA and request for comments on proposed incidental harassment authorization and possible renewal in the *Federal*

Register (88 FR 8146). The public comment period closed on March 9, 2023. The Permits Division expects to issue the final LOA in April of 2023 and it would be effective for 7 years.

3.3 Conservation Measures

Under the ESA, the action agencies (USAF and the Permits Division) are obligated to reduce the likelihood of adverse effects to ESA-listed marine species or adverse effects on their designated critical habitats. Measures intended to conserve ESA-listed resources typically include mitigation and monitoring. Mitigation is a measure that avoids or reduces the severity of the effects of the action. Monitoring observes and checks the progress of the mitigation over time, ensuring that any measures implemented to reduce or avoid adverse effects on ESA-listed species are successful.

Under the MMPA, the Permits Division will require the action agencies to implement mitigation and monitoring measures, to have their action result in the least practicable adverse impact on marine mammal species or MMPA stocks.

The following types of mitigation and monitoring measures listed below are proposed by the USAF and the Permits Division for the next EGTTR mission period (2023-2030) and described in subsequent sections:

- Mission-day Categories
- Mission Monitoring
  - Marine Species Observers;
  - Pre-mission and Post-mission Surveys;
  - Zone of Influence and Survey Areas;
  - Monitoring Platforms: Vessel, Aerial, Video;
- Mission Delay and Suspension for Protected Species;
- Mission Setbacks and Exclusion Area for Rice’s whale;
- Gunnery Rounds and Ramp-up procedures;
- Vessel Strike Avoidance
- Annual Reporting

Additional details for the mitigation and monitoring measures required by the Permits Division can be found in Federal Register notice of proposed LOA and request for comments (88 FR 8146).

3.3.1 Mission-Day Categories

Following the issuance of the 2017 Biological Opinion for the preceding EGTTR mission period, NMFS requested that future acoustic impact analyses be based on the total number of detonations conducted during a given mission instead of each individual detonation to account for the accumulated energy from multiple detonations over a 24-hour period. In response to this request, the USAF developed mission-day categories for each user group for the munitions proposed to be used in the 2023-2030 mission period. Each mission-day represents a separate event that includes the munitions assigned to the category to provide mission-day scenarios of varying intensities with respect to total energy released.

It is important to note that only acoustic energy metrics (SEL)[2] are affected by the accumulation of energy over a 24-hour period. Pressure metrics (e.g., peak SPL[3] and positive impulse[4]) do not accumulate and are based on the highest impulse pressure value within the 24-hour period. As indicated in Table 2 in App A, a total of 19 mission-day categories (A through S) were developed for the proposed action. The physical impact of each munition and the unconsumed propellant in certain munitions is added to the NEW of the warhead to derive the NEW at impact (NEWi) for each live munition (see Air-to-Surface munitions, Section 10.2.1 in the Effects, for more detail on physical impact). Based on the categories developed, the NEWi per mission-day would range from 2,413.6 to 30.4 lb. For the purpose of analysis, SINKEX exercises are assigned to mission category J, which represents a single subsurface detonation of 946.8 lb NEWi, which SINKEX exercises would not exceed. The two annual SINKEX exercises are added to the other eight annual missions involving subsurface detonations of these bombs, resulting in 10 total annual missions under mission-day category J (Table 2, App A).

Although the mission-day categories may not represent the exact manner in which munitions would be used, they provide a conservative range of mission scenarios to account for accumulated energy from multiple detonations. The mission-day categories are utilized to determine the potential for effects to protected species and conservation measures needed to monitor and mitigate operations, such as survey areas and mission setbacks that are described in subsequent sections.

3.3.2 Mission Monitoring

Marine Species Observers

All personnel who will conduct protected species monitoring are required to complete Eglin's Marine Species Observer Training Course. Personnel from Eglin Natural Resources provide the training, which was developed with guidance from NMFS, and maintain the training records. This training covers applicable environmental laws and regulations, consequences of non-compliance, observer roles and responsibilities, photographs and descriptions of protected species and indicators, survey methods, monitoring requirements, and reporting procedures. Any person who will serve as an observer for protected species on a particular mission must have completed the training within a year prior to that mission.

---

[2] Sound exposure level (SEL) accounts for both sound intensity and duration. This metric provides a measure of cumulative exposure from multiple detonations over a 24-hour period. In water, the units are in dB referenced to 1 μPa-squared second (dB re 1 μPa2·s).

[3] Sound pressure level (SPL) is the ratio of the absolute sound pressure and a reference level. In water, the units are in decibels (dB) referenced to 1 micropascal (μPa) (dB re 1 μPa).

[4] Positive impulse is the time integral of the initial positive phase of the pressure impulse. This metric provides a measure of energy in the form of time-integrated pressure. Units are typically pascal seconds (Pa·s) or pounds per square inch (psi) per millisecond (msec) (psi·msec).

Pre-mission and Post-mission Surveys

Pre- and post-mission monitoring for protected species is conducted for every mission. The purpose of pre-mission monitoring is to (1) evaluate the mission site for environmental suitability and (2) verify that the Zone of Influence (ZOI, see subsequent section) is free of visually detectable protected species and indicators that protected species could be present, such as aggregations of jellyfish or floating vegetation (e.g., *Sargassum*) for sea turtles, or schools of fish or flock of birds feeding at the surface for dolphins. The duration of pre-mission surveys depends on the area required to be surveyed, the type of survey platforms used (vessels versus aircraft).

Observers document all protected species sightings, including the species (if possible), number, location, and behavior of the observed animals on report forms that are submitted to Eglin Natural Resources after each mission. Missions may be postponed, relocated, or canceled based on the presence of protected species within the survey areas. For missions that require multiple survey platforms (e.g., vessel and aerial) to cover a large area, a Lead Biologist is designated to lead the monitoring and coordinate sighting information with the Test Director or Safety Officer.

During post-mission monitoring, observers survey the mission site for any dead or injured protected species for at least 30 minutes, concentrating on the area down current of the test site. Support vessels will spend additional time, up to several hours, in this area to collect debris from damaged targets. The duration of post-mission surveys is based on the survey platforms used and any potential time lapse between the last detonation and the beginning of the post-mission survey. A time lapse can occur when survey vessels stationed on the perimeter of the human safety zone are required to wait until the range has been declared clear before they can begin the survey. All protected species sightings during post-mission surveys are documented on report forms that are submitted to Eglin Natural Resources after the mission.

Any observations of dead or injured sea turtles or marine mammals would be reported immediately to Eglin Natural Resources. Observers would identify the species and location, collect information on the animal’s appearance, condition, and behavior, and, if practicable, take photographs and maintain visual contact with the animal. For marine mammals, Eglin Natural Resources would contact the local Marine Mammal Stranding Coordinator, and for sea turtles, Eglin Natural Resources would contact the Sea Turtle Stranding and Salvage Network state coordinator and the Wildlife Alert Hotline of the Florida Fish and Wildlife Conservation Commission (FWC). Available information on the affected animal, including the global positioning system (GPS) coordinates of the animal’s last known location, would be provided to the notified officials, who would potentially send a response team to the site.

Wind speed and the associated roughness of the sea surface influence the effectiveness of observer monitoring. Strong winds increase wave height and create whitecaps, both of which limit an observer’s ability to visually detect marine species at or near the surface. The sea state scale used for EGTTR pre-mission protected species surveys is presented in Table 1. Missions will be delayed or rescheduled if conditions exceed sea state 4, which is defined as moderate breeze, breaking crests, numerous white caps, wind speed of 11 to 16 knots (20 to 30 km per hour), and wave height of 3.3 to 6 ft (1 to 1.8 m). Marine species observers or the Lead Biologist will determine whether sea conditions are suitable for protective species monitoring.

Table 1. Sea state scale used for EGTTR pre-mission protected species surveys.

Sea State Number	Sea State Condition
0	Flat, calm, no waves or ripples
1	Light air, winds 1 to 2 knots; wave height to 1 foot; ripples without crests
2	Light breeze, winds 3 to 6 knots; wave height 1 to 2 feet; small wavelets, crests not breaking
3	Gentle breeze, winds 7 to 10 knots; wave height 2 to 3.5 feet; large wavelets, scattered whitecaps
4	Moderate breeze, winds 11 to 16 knots; wave height 3.5 to 6 feet; breaking crests, numerous whitecaps
5	Strong breeze, winds 17 to 21 knots; wave height 6 to 10 feet; large waves, spray possible

Zone of Influence and Survey Areas

The ZOI is the area or volume of ocean in which marine animals could be exposed to various pressure and impulsive noise levels generated by a surface or subsurface detonation. The ZOIs for the mission-day categories of proposed detonations were estimated using Version 2.3 of the dBSea[5] model for cumulative SEL and using explicit similitude equations for SPL and positive impulse. The dBSea model is a commercially available model for evaluating underwater acoustic transmission and it was used with the ray-tracing option for calculating the underwater transmission of impulsive noise represented in a time series. Details on the parameters and other inputs used for the model were provided by EAFB and can be found in Appendix B. The characteristics of the impulse noise at the source were calculated based on munition-specific data including munition mass at impact, munition velocity at impact, NEW of warheads, explosive-specific similitude data, and propellant data for missiles. The ZOI is based on multiple parameters including the acoustic characteristics of the detonation and sound propagation loss in the marine environment, which is influenced by a number of environmental factors including water depth and seafloor properties. Based on integration of these parameters, the dBSea model predicts the distances at which underwater sound would be at or above threshold criteria presented in the 2017 Navy Phase III Guidance (Navy 2017) for cetaceans and sea turtles, such as the onset of hearing threshold shifts and behavioral disturbance. These distances are referred

[5] Underwater noise prediction software. https://www.dbsea.co.uk/

to as threshold distances, and they vary by munition type and species because each species responds differently to the pressure and sound of the detonation. Acoustic thresholds are discussed in more detail in the Effects of the Action (see Exposure and Response Analysis, Section 10.3).

The EAFB is required to protect dolphins under the MMPA and therefore uses dolphin threshold distances to determine the size of pre-mission surveys. Dolphin threshold distances are greater than the distances for sea turtle thresholds; therefore, the resulting pre-mission surveys cover both dolphins and sea turtles. For any mission, other than gunnery missions, the pre-mission survey area will extend out to, at a minimum, double the MMPA Level A Harassment PTS criteria distance that applies to common bottlenose and Atlantic spotted dolphins (185 dB SEL). Depending on the mission-day category that best corresponds to the actual mission, the distance from the impact point to be monitored could vary between approximately 1356 m for mission-day category J and 272 m for mission-day category I (App A, Table 3a). The PTS criteria distances corresponding sea turtles are 505 m for mission-day category J and 72 m for mission-day category I (App A, Table 4a). Conducting the pre-mission surveys out to these distances is expected to minimize the potential for dolphins and sea turtles to be exposed to injurious levels of pressure and noise energy from munition impacts and detonations. When inert munitions are used, they are usually incorporated into live mission operations and share the same impact area, so the pre-mission survey would be performed for the greater ZOI distance required by the live mission. For the rare case any inert munitions that would not be a part of any live mission, the corresponding Level A PTS dolphin threshold distance for the inert munitions category (App A, Table 3b) would be doubled for the survey area resulting in a total of 70 m for the lowest inert energy class and up to 180 m for highest.

Vessel-Based Monitoring

Pre-mission surveys conducted from dedicated survey vessels are planned to begin at sunrise. Marine species observers monitor for protected marine species and potential indicators of their presence during the pre-mission surveys. For missions that require multiple vessels to cover a large survey area, a Lead Biologist will be designated to coordinate all survey efforts, compile sighting information from the other vessels, serve as the point of contact between the survey vessels and Tower Control, and provide final recommendations to the Safety Officer/Test Director on the suitability of the mission site based on environmental conditions and survey results. Survey vessels will run predetermined line transects, or survey routes, that will provide sufficient coverage of the survey area. Monitoring will be conducted from the highest point feasible on the vessels. There will be at least two dedicated observers on each vessel, and they will utilize binoculars with a minimum power zoom of eight to allow for sufficient observation of surfaced animals. Marine species observers typically aim to complete the pre-mission surveys at least 30 minutes prior to the mission start time to transit to safety.

Support vessels will be operated by a combination of USAF and civil service/civilian personnel responsible for mission site/target setup and range-clearing activities. For each mission, USAF personnel will be within the mission area (on boats and the GRATV) well in advance of initial munitions use, typically around sunrise. While in the mission area, they will perform a variety of tasks, such as target preparation and equipment checks, and will also observe for protected species and indicators when possible. Such observations are considered incidental and would occur only as time and schedule permit. Any sightings would be relayed to the Lead Biologist. The Eglin Safety Officer, in cooperation with the CCF and Tower Control at Santa Rosa Island, will coordinate and manage all range-clearing efforts and will be in direct communication with the survey vessel team, typically through the Lead Biologist. All support vessels will be in radio contact with each other and with Tower Control. The Safety Officer will monitor all radio communications, and Tower Control will relay messages between the vessels and the Safety Officer. The Safety Officer and Tower Control will also be in constant contact with the Test Director throughout the mission to convey information on range clearance and marine species surveys. Final decisions regarding mission execution, including possible mission delay or cancellation based on marine species sightings or civilian boat traffic will be the responsibility of the Safety Officer, with concurrence from the Test Director.

Aerial-Based Monitoring

Depending on the mission, the aerial survey team will consist of Eglin Natural Resources personnel or their designees aboard a non-mission aircraft or the mission aircrew who have completed the Marine Species Observer Training.

For non-mission aircraft, the pilot will be instructed on marine species survey techniques and will be familiar with the protected species expected to occur in the area. One trained observer in the aircraft will record data and relay information on species sightings, including the species (if possible), location, direction of movement, and number of animals, to the Lead Biologist. The aerial team will also look for potential indicators of dolphin presence such as large schools of fish and large, active groups of birds, and potential indicators of sea turtle presence such as large aggregations of jellyfish and large floating mats of *Sargassum*. Pilots will fly the aircraft so that the entire ZOI is monitored. Marine species sightings from the aerial survey team will be compiled by the Lead Biologist and communicated to the Test Director or Safety Officer. As with vessel-based surveys, all non-mission personnel will be required to exit the human safety zone before the mission begins. Monitoring by non-mission aircraft would be conducted only for certain missions, when the use of such aircraft is practicable based on other mission-related factors.

Some mission aircraft have the capability to conduct aerial surveys for marine species immediately prior to releasing munitions. The primary mission aircraft that conduct aerial surveys visually scanning the sea surface and/or using onboard instrumentation to detect protected species are the AC-130 gunship and CV-22 Osprey used for gunnery operations. Missions involving air-to-surface gunnery operations survey areas based on previously established safety profiles and the ability to conduct aerial surveys of large areas from the types of aircraft used for these missions. The monitoring areas and altitudes for gunnery missions are identified in Table 2. A minimum ceiling of 1,000 ft (305 m)) and visibility of 3 NM (5.6 km) are required for effective monitoring efforts and flight safety. For some missions, other aerial platforms may be available to provide supplemental monitoring before and/or during the mission. The aircrews search the species protection zone for the presence of any protected marine species and if a protected species is sighted in the species protection zone, the location is abandoned and an alternative area is evaluated in the same manner. Firing pauses that last longer than 10 minutes will also require reinitiation of protected species surveys by the aircrews. If multiple gunnery missions are conducted during the same flight, marine species monitoring will be conducted separately for each mission.

After arriving at the mission site and before initiating gun firing, the aircraft will fly at least two complete orbits around the target area out to the applicable ZOI at a minimum safe airspeed and appropriate monitoring altitude. If no protected species or indicators are detected, the aircraft will then ascend to an operational altitude while continuing to orbit the target area as it climbs. The initial orbits typically last approximately 10 to 15 minutes. Monitoring for marine species and non-participating vessels continues throughout the mission. If a towed target is used, mission personnel will maintain the target in the center portion of the survey area to ensure gunnery impacts do not extend past the predetermined ZOI.

During the low-altitude orbits and climb, the aircrew will visually scan the sea surface for the presence of protected marine species. The visual survey will be conducted by the flight crew in the cockpit and personnel stationed in the tail observer bubble and starboard viewing window. During nighttime missions, crews will use night-vision goggles for these visual surveys. In addition to the visual surveys, the low-light electro-optical and infrared sensor systems on board the aircraft will also be used for protected species monitoring. Infrared sensors are capable of detecting differences in temperature from thermal energy (heat) radiating from living bodies or from reflected and scattered thermal energy. Infrared systems are equally effective during day or night. Nighttime missions during the 2023–2030 period would be conducted by AC-130s that have been upgraded recently with MX-25D sensor systems, which provide superior night-vision capabilities relative to earlier sensor systems. Protected species monitoring procedures for CV-22 training are similar to those described for AC-130 gunnery training, except that CV-22 aircraft typically operate at much lower altitudes than AC-130 gunships (Table 2). CV-22s have comparable electro-optical and infrared sensor systems that allow advanced detection capability during day and night.

Following each mission, aircrews will conduct a post mission survey beginning at the operational altitude and continuing through an orbiting descent to the designated monitoring altitude. The descent will typically last approximately 3 to 5 minutes. Aircrews will conduct visual and instrumentation-based scans during the post-mission survey as described for the pre-mission survey.

Table 2. Monitoring areas and altitudes for gunnery missions.

Aircraft	Gunnery Round	Monitoring Area	Monitoring Altitude	Operational Altitude
AC-30 Gunship	30 mm; 105 mm (FU and TR)	5 NM (9,260 m)	6,000 feet	15,000 to 20,000 feet
CV-22 Osprey	.50 caliber	3 NM (5,556 m)	1,000 feet	1,000 feet

FU = Full Up; m = meter(s); mm = millimeter(s); NM = nautical mile(s); TR = Training Round

Other than AFSOC gunnery training, HACM tests are the only other EGTTR missions currently proposed to be conducted at nighttime during the 2023–2030 period. HACM tests and any other missions that are actually conducted at nighttime during the mission period will be required to be supported by AC-130 aircraft with night-vision instrumentation or other platforms with comparable nighttime monitoring capabilities. Live HACMs would be fired into the existing LIA or proposed East LIA and the pre-mission survey area will extend out to, at a minimum, double the MMPA Level A Harassment PTS threshold distance that applies to both dolphin species (185 dB SEL). A HACM test would correspond to mission-day category K, which is estimated to have a PTS threshold distance of 0.26 km, extending the survey out to 0.52 km.

Video-Based Monitoring

Video-based monitoring is conducted via transmission of live, high-definition video feeds from the GRATV at the mission site to the CCF. These video feeds can be used to remotely view the mission site to evaluate environmental conditions and monitor for marine species up to the time munitions are used. There are multiple sources of video that can be streamed to multiple monitors within the CCF. A trained marine species observer from Eglin Natural Resources will monitor the live video feeds transmitted to the CCF and will report any protected marine species sightings to the Safety Officer, who will also be at the CCF. Video monitoring can mitigate the lapse in time between the end of the pre-mission survey and the beginning of the mission.

Four video cameras are typically operated on the GRATV for real-time monitoring and data collection during the mission. All cameras have a zoom capability of up to at least a 300 mm equivalent. At this setting, when targets are at a distance of 2 NM (3.7 km) from the GRATV, the field of view would be 195 by 146 ft. The cameras allow video observers to detect an item as small as 1 square ft up to 4,000 m away. The USAF is in the process of acquiring cameras with even greater zoom capability (up to a 1,200 mm zoom lens) to support future missions. The GRATV is typically located approximately 600 ft (183 m) from the target area.

Supplemental video monitoring can also be conducted via additional aerial assets, when available. Eglin's aerostat balloon provides aerial imagery of weapon impacts and instrumentation relay. When used, it is tethered to a boat anchored near the GRATV. The balloon can be deployed to an altitude of up to 2,000 ft. It is equipped with a high-definition camera system that is remotely controlled to pivot and focus on a specific target or location within the mission site. The video feed from the camera system is transmitted to the CCF. Eglin may also employ other assets such as intelligence, surveillance, and reconnaissance aircraft to provide real-time imagery or relay targeting pod videos from mission aircraft. UAVs may also be employed to provide aerial video surveillance. While each of these platforms may not be available for all missions, they typically can be used in combination with each other and with the GRATV cameras to supplement overall monitoring efforts. Even with a variety of platforms potentially available to supply video feeds to the CCF, the entire ZOI may not be visible for the entire duration of the mission. However, the targets and immediate surrounding areas will typically be in the field of view of the GRATV cameras, which will allow the observer to detect any protected species that may enter the target area before weapon releases. The cameras also allow the observer to readily inspect the target area for any signs that animals were injured. If a protected marine species is 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 the CCF.

The video camera observer will have open lines of communication with the observers on vessels to facilitate real-time reporting of marine species sightings and other relevant information, such as the presence of non-participating vessels near the human safety zone. Direct radio communication will be maintained between vessels, GRATV personnel, and Tower Control throughout the mission. The Safety Officer will monitor all radio communications from the CCF, and information between the Safety Officer and support vessels will be relayed via Tower Control.

3.3.3 Mission Delay and Suspension for Protected Species

All sighting information from pre-mission surveys will be communicated to the Lead Biologist on a pre-determined radio channel 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 zone of influence but appear to be on a heading away from the mission area. The delay would continue until the Lead Biologist has confirmed that the animals are no longer in the zone of influence and traveling on a heading away from the mission site. A mission delay recommendation would also occur if indicators, such as large aggregations of jellyfish, large floating mats of *Sargassum*, large schools of fish, or large flocks of birds feeding at the surface, are observed within the ZOI.

A mission cancellation recommendation could occur if one or more protected species in the zone of influence 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. 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.

If protected marine species are detected during the mission, operations will be immediately halted until the ZOI is clear of all animals, or the mission will be relocated to another target area. If the mission is relocated, the pre-mission survey procedures will be repeated in the new area. If one or more sperm or baleen whales are detected while pre-mission monitoring or during a mission, mission activities will be suspended for the remainder of the day.

3.3.4 Mission Setbacks and Exclusion Area for Rice's Whale

As a mitigation measure to prevent any PTS impacts to the Rice's whale during the 2023–2030 mission period, the USAF will restrict the use of live munitions in the western part of the existing LIA and proposed East LIA based on the setbacks from the 100 m isobath determined by the mission-day categories presented in App A, Table 5. Each user group will use a setback distance corresponding to the category that is appropriate for their actual mission in the existing LIA and proposed East LIA; see Figure 25 and Figure 26 respectively.

To minimize impacts to the Rice's whale from inert munitions both inside and outside the LIAs, the USAF will prohibit the use of inert munitions in Rice's whale habitat during the next mission period. Under this new mitigation measure, inert munitions use will be prohibited between the 100 m and 400 m isobaths throughout the EGTTR.

AFSOC has historically conducted all gunnery missions landward of the 200 m isobath, which is generally considered to be the shelf break in the Gulf of Mexico, as a mitigation measure to prevent impacts to cetacean species known to occur in deeper portions of the Gulf of Mexico, such as the endangered sperm whale. AFSOC gunnery missions during the 2023–2030 period will be conducted at least 500 m landward of the 100 m isobath instead of landward of the 200 m isobath as a new mitigation measure to prevent impacts and minimize disturbance to the Rice's whale.

3.3.5 Gunnery Rounds and Ramp-up

AFSOC AC-130 gunnery training involves the use of 30 mm and 105 mm Full Up (FU) rounds during daytime and 30 mm and 105 mm Training Round (TR) during nighttime. The TR variant (0.35 lb NEW) of the 105 mm HE round has less explosive material than the FU round (4.7 lb NEW). AFSOC uses the 105 mm TRs during nighttime missions as an additional mitigation measure to minimize potential impacts to protected marine species. CV-22 training involves the use of only .50 caliber rounds, which do not contain explosive material and, therefore, do not detonate.

Guns on the AC-130 are first checked for functionality and are calibrated, which requires an abbreviated period of live fire. After the guns are determined to be ready for use, the aircraft deploys a flare onto the water surface as a target, and the mission proceeds under various training scenarios. Gun firing during the initial calibration phase will begin with the smallest round and proceed to increasingly larger rounds. This process is referred to as ramp-up procedures, and its purpose is to expose the environment to steadily increasing noise levels with the intent that marine animals will move away from the area before noise levels increase.

3.3.6 Vessel Strike Avoidance

EAFB will administer protected marine species observer training to vessel operators and instruct them to follow Vessel Strike Avoidance Measures[6], as previously advised by NMFS Southeast Regional Office. Those measures include staying at least 150 ft (45.7 m) away from protected species and 300 ft (91.4 m) away from whales.

Additional action area measures for the Rice's whale will require vessels:

- To stay 500 m from the Rice's whale. If a baleen whale cannot be positively identified to species level then assume it could be a Rice's whale and maintain the 500 m separation distance.
- To avoid transit in the Core Distribution Area[7] (CDA; Rice's whale area of occurrence with an additional buffer) and within the 100 - 400 m isobath zone outside the CDA. If transit in these areas is unavoidable, vessel speed will not exceed 10 knots and no transit will occur at night.

An exception to the speed restriction is instances when speed is required for human safety, such as when members of the public need to be intercepted to secure the human safety zone, or when the safety of a vessel operations crew could be compromised.

3.3.7 Annual Reporting

Eglin Natural Resources submits an annual report to NMFS that summarizes the results of protected species surveys conducted for EGTTR missions each year. Annual reporting of the EGTTR missions conducted for the year with information regarding the mitigation applied and monitoring results will continue during the proposed 2023-2030 mission period.

From 2010 to 2021, Eglin AFB conducted 67 gunnery missions in the EGTTR. There has been no evidence that sea turtles or marine mammals have been impacted from gunnery operations conducted in the EGTTR.

From 2013 to 2020, EAFB conducted 25 live missions collectively under the Maritime Strike Operations and Maritime WSEP Operational Testing programs in the EGTTR. From 2016 to 2021, EAFB conducted 16 live PSW missions in the EGTTR. Maritime WSEP and PSW missions are proposed to continue over the 2023–2030 period (See 53 WEG and 780 TS, in Sections 3.1.1 and 3.1.2 respectively). Protected species monitoring was conducted for these

[6] https://media.fisheries.noaa.gov/2021-06/Vessel_Strike_Avoidance_Measures.pdf?null
[7] https://www.fisheries.noaa.gov/resource/map/rices-whale-core-distribution-area-map-gis-data

missions using a combination of vessel-based surveys and live video monitoring from the CCF. There has been no evidence of mortality, injury, or any other detectable adverse impact to any sea turtle or marine mammal. Dolphins were sighted within the ZOI prior to ordnance delivery during some of these past missions which were postponed until the animals were confirmed to be outside the ZOI.

4 Action Area

Action area is defined as all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02).

The proposed activities will occur in the EGTTR, which is the airspace controlled by Eglin AFB over the Gulf of Mexico, beginning 3 NM (5.6 km) from shore, and the underlying Gulf of Mexico waters. The EGTTR extends southward and westward off the coast of Florida and encompasses approximately 102,000 square nautical miles (NM^2). It is subdivided into blocks of airspace that consist of Warning Areas W-155, W-151, W-470, W-168, and W-174 and Eglin Water Test Areas one through 6 (Figure 2). Most of the blocks are further subdivided into smaller airspace units for scheduling purposes (for example, W-151A, B, C, and D).

Although Eglin AFB may use any portion of the EGTTR, the majority of testing and training operations proposed for the 2023–2030 mission period would occur in Warning Area W-151 which contains the LIA and ELIA (Figure 3). The nearshore boundary of W-151 parallels much of the coastline of the Florida Panhandle and extends horizontally from 3 NM (5.6 km) offshore to approximately 85 to 100 NM (157 to 185 km) offshore, depending on the specific portion of its outer boundary. W-151 encompasses approximately 10,247 NM^2 (35,763 km^2) and includes water depths that range from approximately 5 to 720 m.

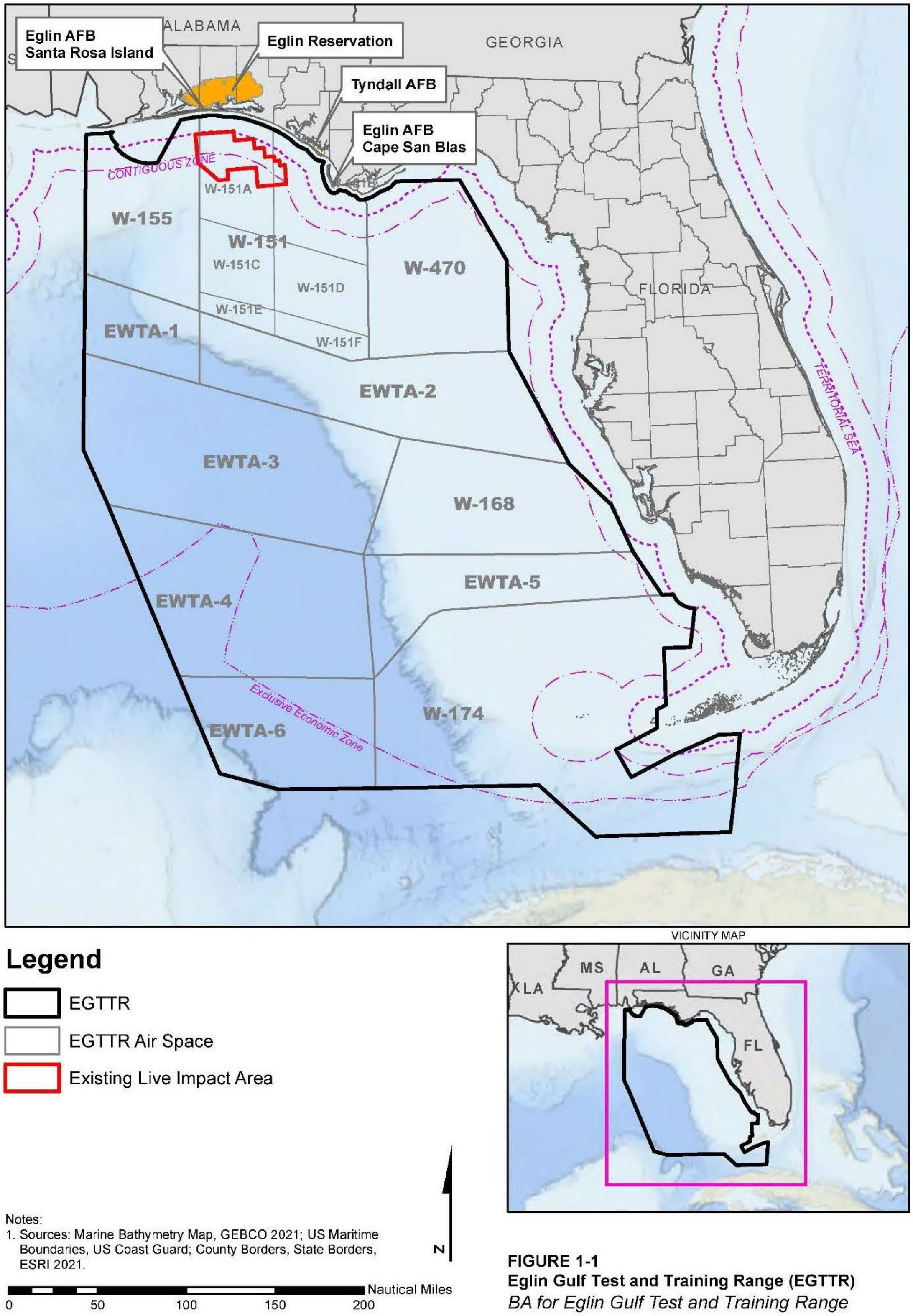

Figure 2. Map of Eglin Test and Training Range.

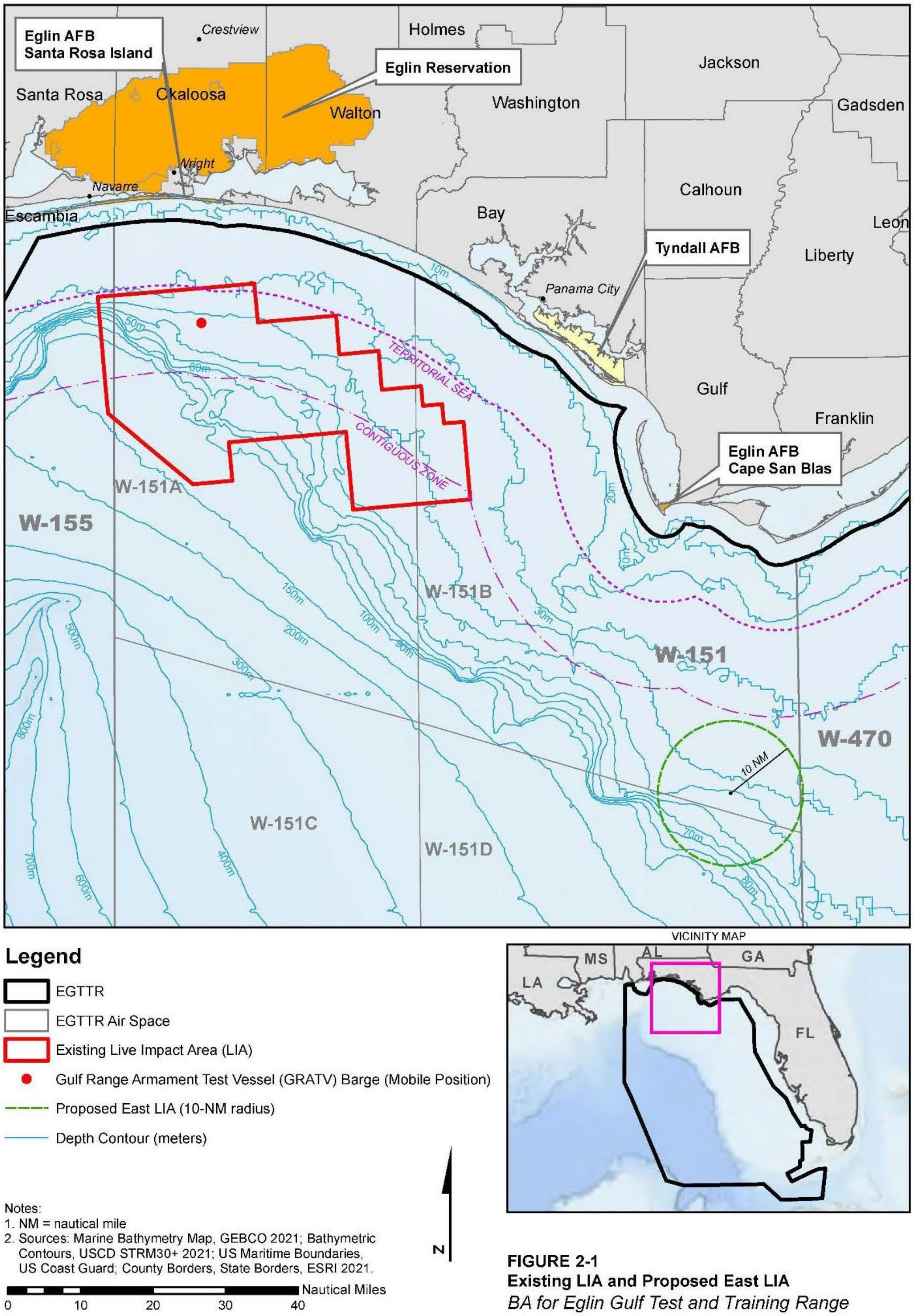

Figure 3. Existing LIA and proposed East LIA.

5 Potential Stressors

Stressors are any physical, chemical, or biological agent, environmental condition, external stimulus or event that may have effects on the physical, chemical, and/or biotic environment. During consultation, we deconstructed the proposed action to identify stressors that could reasonably result from the proposed activities. These potential stressors can be categorized as disturbance from aircraft or vessels, direct strike by munitions or vessels, debris and chemical constituents from munitions or targets, acoustic impacts from detonations.

The potential for these stressors to have adverse consequences to ESA-listed species are evaluated in the effects of the action, Section 10. The proposed action includes conservation measures to minimize effects that may result from these potential stressors. While we expect these measures to reduce the effects of potential stressors, they are not expected to eliminate the stressors.

6 Endangered Species Act Listed and Proposed Species, Designated and Proposed Critical Habitat, Present in the Proposed Action Area

This section identifies the ESA-listed and proposed resources that potentially occur within the action area and may be affected by the proposed action (Table 3).

Table 3. Threatened, endangered, and proposed species, designated and proposed critical habitat under NMFS' jurisdiction that may be affected by the proposed action.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584, 12/2010
Rices Whale (*Balaenoptera physalus)* Name Change (86 FR 47022; August 23, 2021)	E –84 FR 15446, April 15, 2019)	-- --	75 FR 47538 07/2010
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693 Not in action area	10/1991
Green Turtle (*Chelonia mydas*) – South Atlantic DPS	T – 81 FR 20057	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693 Not in action area	57 FR 38818, 08/1992 –
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170 Not in action area	10/1991
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39855	74 FR 2995 10/1991
Fishes			
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916		-- --
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 FR 49653	68 FR 13370	09/1995
Nassau Grouper (*Epinephelus striatus*)	T – 81 FR 42268	87 FR 62930 (Proposed)	8/2018 (Outline)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --	9/2018 (Outline)
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Central and Southwest Atlantic DPS	T – 79 FR 38213	-- --	-- --
Smalltooth Sawfish (*Pristis pectinata*) – U.S. portion of range DPS	E – 68 FR 15674	74 FR 45353 Not in action area	74 FR 3566 01/2009
Marine Invertebrates			
Boulder Star Coral (*Orbicella franksi*)	T – 79 FR 53851	85 FR 76302 (Proposed)	-- --
Elkhorn Coral (*Acropora palmata*)	T – 79 FR 53851	73 FR 72210	80 FR 12146
Lobed Star Coral (*Orbicella annularis*)	T – 79 FR 53851	85 FR 76302 (Proposed)	-- --
Mountainous Star Coral (*Orbicella faveolata*)	T – 79 FR 53851	85 FR 76302 (Proposed)	-- --
Rough Cactus Coral *(Mycetophyllia ferox)*	T – 79 FR 53851	85 FR 76302 (Proposed)	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Pillar Coral (*Dendrogyra cylindrus*)	T – 79 FR 53851	85 FR 76302 (Proposed)	-- --
Staghorn Coral (*Acropora cervicornis*)	T – 79 FR 53851	73 FR 72210	80 FR 12146
Queen Conch (*Aliger gigas*)	T–87 FR 55200 (Proposed)	-- --	-- --

7 Species and Critical Habitat Not Likely to be Adversely Affected

NMFS uses two criteria to identify the ESA-listed species and critical habitats that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are consequences of the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that co-occur with a stressor of the action but are not likely to respond to the stressor are also not likely to be adversely affected by the proposed action. We applied these criteria to the ESA-species and designated critical habitats in Table 3 and we summarize our results below.

The probability of an effect on a species or designated critical habitat is a function of exposure intensity and susceptibility of a species to a stressor's effects (i.e., probability of response). An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly beneficial, insignificant or discountable. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

In the subsections that follow, we evaluate the likelihood of effects from the proposed action's potential stressors (Section 5) to ESA-listed and proposed species or designated and proposed critical habitat that may be affected, but are not likely to be adversely affected by the proposed action.

7.1 Sperm Whale

In the western North Atlantic, sperm whales range from Greenland south into the Gulf of Mexico and the Caribbean, where they are common, especially in deep basins off of the continental shelf (Romero et al. 2001; Wardle et al. 2001). Sperm whales are the most common large whale in the northern Gulf of Mexico, found throughout this area year-round (Fulling et al. 2003; Hansen et al. 1996b; Maze-Foley and Mullin 2006; Mullin and Fulling 2004; Mullin and Hoggard 2000; Mullin et al. 2004; Mullin et al. 1994b), with particularly high concentrations along the continental slope in or near cyclonic cold-core eddies due to enhanced productivity (Davis et al. 2007; O'Hern and Biggs. 2009; Palka and Johnson 2007). Aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Hansen et al. 1996a; Mullin et al. 1994a).

Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997; Watkins 1977), and they are rarely found in waters less than 300 m in depth (Clarke 1956; Rice 1989). When they are found closer to shore, it is usually associated with sharp increases in topography where upwelling occurs and biological production is high, indicating the presence of a good food supply (Clarke 1956). Such areas include oceanic islands and along the outer continental shelf.

In order to prevent impacts to sperm whales, all gunnery missions (daytime and nighttime) will be conducted at least 500 m landward of the 100 m isobath to prevent any PTS impacts to the sperm and Rice’s whales. This setback distance from the 100 m isobath is based on the modeled PTS threshold distance for daytime gunnery missions (mission-day G) of 494 m. Given the low probability of occurrence of sperm whales shallower than 200 m depth, the potential effects from vessel movement and aircraft or weapons noise are so unlikely as to be discountable. Due to the likelihood that the pieces of debris from munitions and targets will be dispersed over a large enough area and sink to an area shallower than 200 m, the potential effects from ingestion of debris from munitions or targets is discountable. Sperm whales are not expected to be exposed to stressors from proposed EGTTR activities and, therefore, are not likely to be adversely affected.

7.2 Hawksbill Sea Turtle

Hawksbills are the rarest of the five species of sea turtle that occur in the Gulf of Mexico, and their current abundance is only a fraction of historical levels because millions were killed for tortoiseshell (jewelry, combs, brushes, buttons, etc.) during the past 100 years. Significant threats to hawksbills include destruction of nesting habitat, their dependence on coral reefs (one of the world’s most endangered ecosystems) for food and shelter, and the continued trade in hawksbill products. Hawksbill sea turtles are rarely observed in the Gulf of Mexico, with Florida and Texas being the only Gulf States with regular sightings (Hildebrand 1983; Keinath et al. 1991; Lee and Palmer 1981; NMFS and USFWS 1993; Parker 1995; Plotkin 1995; Rabalais and Rabalais 1980;

Rester and Condrey 1996; Witzell 1983). The hawksbill sea turtle rarely occurs in the northeastern Gulf of Mexico (Ward 2017). Individuals stranded in Texas are generally young (hatchlings or yearlings) and originate from Mexican nesting beaches (Amos 1989; Collard and Ogren 1990; Hildebrand 1983; Landry and Costa 1999).

Given that this species is not a regular inhabitant in the northern Gulf of Mexico and the effects of the action are focused in the northern Gulf of Mexico, effects to hawksbill sea turtles from EGTTR activities are so unlikely as to be discountable. Therefore, NMFS concurs with the USAF's conclusion that the testing and training activities proposed to be conducted in action area for the reasonably foreseeable future are not likely to adversely affect hawksbill sea turtles.

7.3 Gulf Sturgeon

The Gulf sturgeon is an anadromous fish found in riverine, estuarine, and nearshore marine environments of coastal states along the Gulf of Mexico. Adult Gulf sturgeon occupy freshwater during the warm months, which is when spawning occurs, and migrate into estuarine and marine waters in the fall to forage and overwinter. Historically, Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Their present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi, respectively, east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico and as far east and south as Florida Bay (Reynolds 1993; Wooley and Crateau 1985). When in open waters of the Gulf of Mexico, sturgeon are generally thought to remain near the shoreline, although factors such as water depth or prey distribution may be more important than distance from land. For example, Gulf sturgeon have been observed off the Suwannee River area as far as 9 NM (16.7 km) from shore (USFWS and NMFS 2003).

Eglin AFB has studied Gulf sturgeon presence and distribution near the northern boundary of the EGTTR for several years. The results from these studies indicate that, when Gulf sturgeon are in nearshore waters of the Gulf of Mexico, they occur primarily from shore out to approximately 1.4 NM (2.6 km) offshore (Stephens and Lamont 2020). These finding are consistent with similar studies on Gulf Sturgeon coastal distribution and habitat usage in the Gulf of Mexico (Fox et al. 2002; Ross et al. 2009). Given the commonly cited detection range of 500 m, some individuals could have been at least 1.75 km from shore. The 1.75 km distance does not approach the EGTTR boundary 3 NM miles (5.5 km) offshore from the Florida Gulf coast or the primary air-to-surface test area, the existing LIA located 12 NM (22.2 km) offshore. The nearshore boundary of the proposed East LIA is approximately 25 NM (46.3 km) offshore. Given the extremely low probability of Gulf sturgeon being as far offshore as the LIAs, the effects from munitions and detonations are so unlikely as to be discountable.

The potential for a vessel to strike a Gulf sturgeon is limited to a fish located just beneath the water surface. To date, there have been five documented Gulf Sturgeon mortalities that exhibited tell-tale signs of collision with large vessels. This may be a result of low rates of Gulf Sturgeon ship strikes, or low rates of reporting where ship strikes are occurring. The threat of ship strikes may be greater in areas of the northern Gulf of Mexico where barge and tugboat traffic associated with coastal protection, restoration, and infrastructure activities is expected to increase. Vessel activity associated with EGTTR missions occurs primarily in and near the LIA, which considerably farther offshore than the Gulf sturgeon is expected to occur. EAFB administers protected marine species observer training to vessel operators and instruct them to follow Vessel Strike Avoidance Measures (see Section 3.3.6 Vessel Strike Avoidance). The likelihood of Gulf sturgeon being affected by vessel strike are discountable. Gulf sturgeon are not expected to be exposed to stressors from proposed EGTTR activities and, therefore, are not likely to be adversely affected.

7.3.1 Gulf Sturgeon Critical Habitat

NOAA Fisheries and the U.S. FWS collectively "the Services," designated 14 geographic areas (units) among rivers and coastal portions of the Gulf of Mexico as critical habitat for the threatened Gulf sturgeon. Seven of the units encompass approximately 2,783 river kilometers (rkm) of riverine critical habitat and the other seven units encompass approximately 6,042 square kilometers (km^2) of estuarine and marine critical habitat.

The estuarine and marine critical habitat units in Florida (#9-14) are the closest to the EGTTR: (9) Pensacola Bay, (10) Santa Rosa Sound, (11) Near shore Gulf of Mexico Florida, (12) Choctawhatchee Bay, (13) Apalachicola Bay, and (14) Suwannee Sound. Nearly all of these critical habitat units extend from the mean high water line out to 1 NM (1.85 km) offshore along most of the Florida Panhandle and, therefore, does not include the area encompassed by the EGTTR, which starts at 3 NM (5.6 km) from shore. The Suwannee Sound unit (#14) is the farthest east and extends the farthest into the Gulf of Mexico, 9 NM from shore (16.7 km) out to the State territorial water boundary. The eastern boundary of the EGTTR is farther offshore in this area and starts well after the State territorial water boundary (see Figure 2). The LIA and proposed East LIA, where the majority of EGTTR operations will be focused, are even farther offshore and therefore even more removed from the critical habitat units.

There could be vessels associated with EGTTR operations coming to and from marinas located in the estuarine areas near EAFB and therefore vessel transit could be crossing through some of those estuarine and marine critical habitat units. One of the critical habitat elements considered essential for the conservation of the Gulf sturgeon is safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats. The amount of vessel transit would be very limited compared to traffic related to commercial and recreational vessel use in the area. The size of the vessels is also limited, e.g., 25 ft (7.6 m) center console with outboard motor. These vessels are not expected to create obstructions to migratory pathways. Proposed EGTTR activities are not likely to adversely affect Gulf Sturgeon critical habitat .

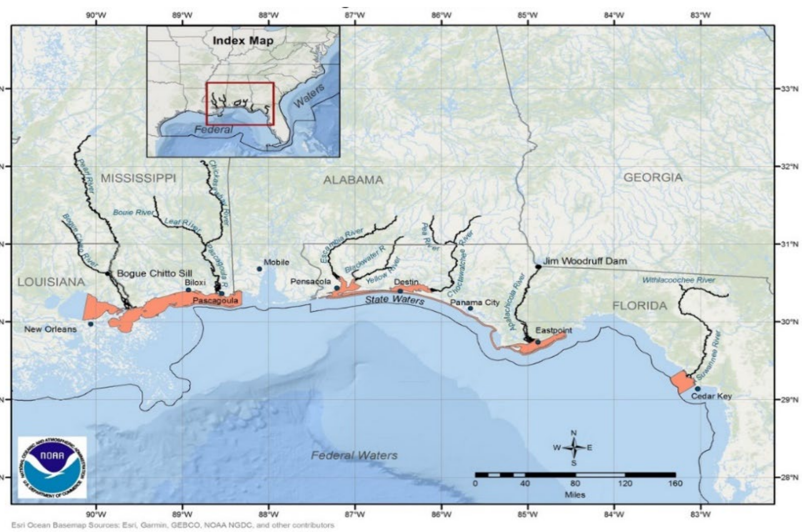

Figure 4. Gulf sturgeon critical habitat.

7.4 Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*) is a tropical marine and estuarine elasmobranch. Although they are rays, sawfish physically resemble sharks, with only the trunk and especially the head ventrally flattened. Smalltooth sawfish are characterized by their "saw," a long, narrow, flattened rostral blade with a series of transverse teeth along either edge (NMFS 2009c). The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003 (68 FR 15674). Although this species is reported to have a circumtropical distribution, NMFS identified smalltooth sawfish from the Southeast United States as a DPS (Figure 5).

Juvenile sawfish spend the first 2-3 years of their lives in the shallow waters provided in the lower reaches of rivers, estuaries, and coastal bays (Simpfendorfer et al. 2008; Simpfendorfer et al. 2011). As smalltooth sawfish approach 250 centimeters (cm) total length they become less sensitive to salinity changes and begin to move out of the protected shallow-water embayments and into the shorelines of barrier islands (Poulakis et al. 2011). Adult sawfish can occur in more open-water, coastal marine habitats (Poulakis and Seitz 2004). Water temperatures (no lower than 16-18°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are the major environmental constraints limiting the distribution of smalltooth sawfish (Bigalow and Schroeder 1953). Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Dry Tortugas, which is also the last U.S. stronghold for the species (Poulakis and Seitz 2004; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004). While the overall abundance appears to be stable, low intrinsic rates of population increase suggest that the species is particularly vulnerable to rapid population declines (NMFS 2010).

Given the association of smalltooth sawfish with shallow estuarine and coastal marine environments, there is a very low probability of smalltooth sawfish being far offshore in the LIAs, and therefore the effects from munitions and detonations are so unlikely also to be discountable. Vessel activity associated with EGTTR missions occurs primarily in and near the LIAs, and therefore vessel interactions with smalltooth sawfish are also unlikely to occur. EAFB administers protected marine species observer training to vessel operators and instruct them to follow Vessel Strike Avoidance Measures (see Section 3.3.6 Vessel Strike Avoidance). The likelihood of smalltooth sawfish being affected by vessel strike is so low that it is discountable. Smalltooth sawfish are not expected to be exposed to stressors from proposed EGTTR activities and, therefore, are not likely to be adversely affected.

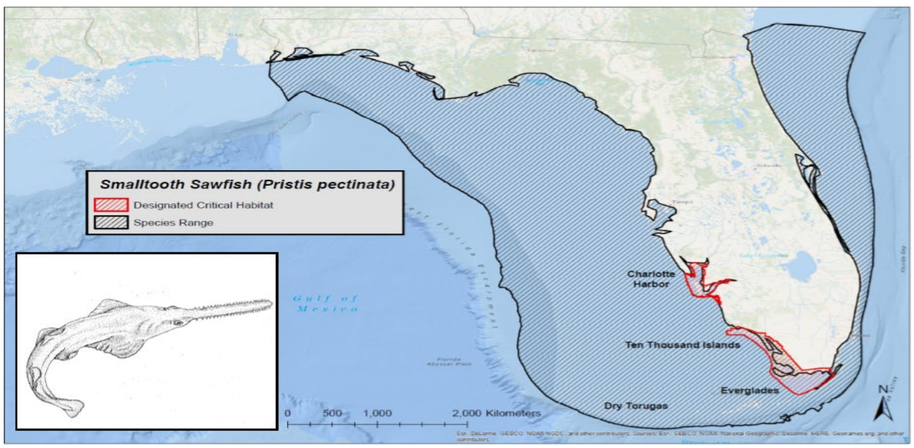

Figure 5. US DPS Smalltooth sawfish range.

7.5 Nassau Grouper

The Nassau grouper primarily occupies nearshore waters throughout the Caribbean Sea, South Florida, Bermuda, and the Bahamas (Figure 6). Current spawning locations are found in Mexico, Bahamas, Belize, Cayman Islands, the Dominican Republic, Cuba, Puerto Rico, and the U.S. Virgin Islands. The Nassau grouper is generally not present in the waters of the Gulf of Mexico, but may occur in the most southern reaches of the EGTTR. Nassau grouper are not expected to occur in the portion of the action area where the LIAs and gunnery exercises will take place. Therefore, overlap of this species with the EGTTR training operations is extremely unlikely to occur and effects of the proposed action are thus discountable. Therefore, Nassau grouper are not likely to be adversely affected by the proposed action.

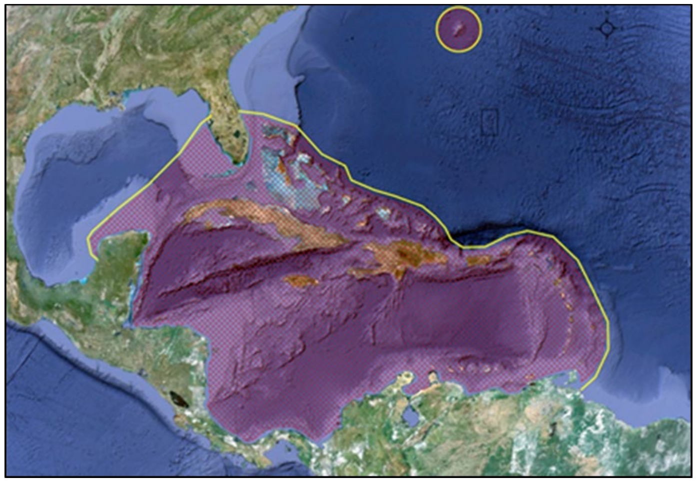

Figure 6. Range of Nassau grouper.

7.5.1 Nassau Grouper Proposed Critical Habitat

Portions of the Nassau grouper's geographic range in Puerto Rico, USVI, and Florida are proposed to be designated as critical habitat. The proposed designation identifies physical and biological habitat features that are essential for the conservation of the species. These include nearshore shallow subtidal marine nursery areas, intermediate hard bottom and seagrass areas in close proximity to the nursery areas, and reefs in close proximity to intermediate hard bottom and seagrass areas. There are some portions of the proposed critical habitat areas in the Florida Keys (see Figure 7) that could overlap the southernmost limit of the EGTTR which could possibly be used by EAFB but are not in any proximity to the LIAs in the north where the majority of mission activities are proposed. Effects to the proposed Nassau grouper critical habitat from EGTTR activities will be extremely unlikely to occur and thus discountable. Therefore, the proposed action may affect, but is not likely to be adversely affect proposed Nassau grouper critical habitat.

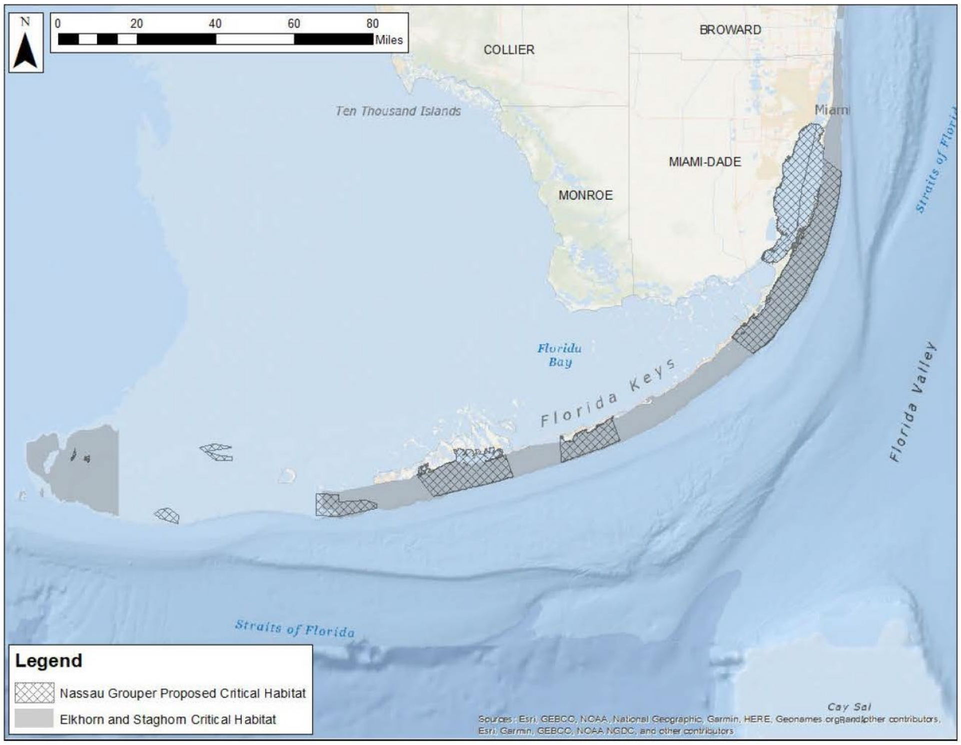

Figure 7. Proposed Nassau grouper critical habitat in the Florida Keys.

7.6 Giant Manta Ray

The giant manta ray occupies tropical, subtropical, and temperate oceanic waters across the globe. They also can be found in some productive coastline areas. The giant manta ray has been reported in the Gulf of Mexico, but is not common. The highest concentrations were predicted near the Mississippi River delta from April to June and again from October to November (Farmer et al. 2022). The Flower Garden Banks National Marine Sanctuary is known to provide habitat for juvenile giant manta rays. The Mississippi River delta and Flower Garden Banks are not in the action area. This species is very rare in the action area, and encounters of this species with the proposed USAF EGTTR training operations unlikely to occur. It is extremely unlikely that giant manta rays will be exposed to stressors from proposed EGTTR activities, therefore, the proposed action may affect, but is not likely to adversely affect the species.

7.7 Oceanic Whitetip Shark

The oceanic whitetip shark is distributed worldwide in tropical and subtropical waters between ten degrees North and 10 degrees South, usually found in open ocean and near the outer continental shelf (Young 2016). They can be found as far as 30 degrees North and 35 degrees South latitude. Oceanic whitetip sharks can be found at the water's surface, but most frequently stay between 25.5 to 50 m (83.7 to 164 ft) (Carlson and Gulak 2012; Young 2016). Oceanic whitetip sharks occur from the water's surface to at least 152 m (498.7 ft) deep, and display a preference for water temperatures above 20 degrees Celsius (68 degrees Fahrenheit. They can be found in waters between 15 and 28 degrees Celsius (59 to 82.4 degrees Fahrenheit and can briefly tolerate waters as cold as 7.75 degrees Celsius (45.9 degrees Fahrenheit) during dives to the mesopelagic zone (Howey-Jordan et al. 2013; Howey et al. 2016). Although oceanic whitetip sharks are highly migratory, they appear to display a high degree of philopatry to certain sites, with females giving birth on one side of a basin or the other, and may not mix with individuals of other regions (Howey-Jordan et al. 2013; Tolotti et al. 2015; Young 2016). Thermal barriers (i.e., water temperatures less than 15 degrees Celsius [59 degrees Fahrenheit]) may prevent inter-ocean basin movements. In the Western Atlantic Ocean, oceanic whitetip sharks occur from Maine to Argentina, including the Caribbean Sea and Gulf of Mexico.

There were 56 records of oceanic whitetip sharks in the Gulf of Mexico from 1975 through 1995 caught by commercial longline vessels as part of the NMFS Southeast Fisheries Science Center Pelagic Longline Observer Program (Kohler et al. 1998). All records are for captures beyond 200 m depth (656.2 ft), the majority of which were mature-sized individuals out near the 2,000 m (6,5681.7 ft) bathymetry line within federal waters of the Gulf of Mexico out to the Exclusive Economic Zone of the U.S..

Information in the status review suggests there was an 88 percent decline in oceanic whitetip sharks in the Gulf of Mexico since the 1950's (Young et al. 2016). One oceanic whitetip shark was tagged in the Gulf of Mexico in the NMFS Cooperative Shark Tagging Program from 1962 through 1993 (Kohler et al. 1998). In 2011 and 2012, no oceanic whitetip sharks were caught in four pelagic longline surveys (B. Hueter, Mote Marine Laboratory, pers. comm. October 5, 2017). We do not have any recent records for this species in the Gulf of Mexico. .

From this overview, the oceanic whitetip shark does occur in the Gulf of Mexico but it is considered rare. The areas where detonations may occur are shoreward of the typical water depth range for this species and overlap with the training exercises proposed for the EGTTR are unlikely to occur. Exposure of oceanic whitetip sharks to stressors from proposed EGTTR activities is extremely unlikely to occur and thus discountable. Therefore, the proposed action may affect, but is not likely to be adversely affect this species.

7.8 Corals

The boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, and staghorn coral are known to occur in portions of Gulf of Mexico, mostly in Flower Garden Banks or to the southeast near the Florida Keys. The southern end of the EGTTR overlaps with portions of the Florida Keys where these ESA-listed corals may occur, however, none of these species are known to occur in the northeastern Gulf of Mexico where target missions are proposed.

Any portion of the EGTTR outside of the Rice's whale exclusion area (see section 3.3.4) could possibly be used by EAFB, but the majority of testing and training operations are proposed to occur in the LIAs which are in the northern portion of the EGTTR. Considering live mission activities could not occur, and the scarce chance of other activities occurring near where the

ESA-listed corals could be, the likelihood of effects is discountable and therefore the proposed action is not likely to adversely affect ESA-listed corals.

Designated critical habitat for elkhorn coral and staghorn coral includes areas of the Florida Keys, portions of which overlaps the southern limit of the EGTTR. Proposed critical habitat for boulder star, lobed star, mountainous star, pillar and rough cactus coral species is also in the Florida Keys, portions of which overlaps the southern limit of the EGTTR. For the same reasoning just described, i.e., the lack of proposed activities in that section of the EGTTR, the proposed action is not likely to adversely affect the designated or proposed critical habitats for ESA-listed coral species.

7.9 Queen Conch

On September 7, 2022, NMFS announced a proposed rule to list the queen conch as a threatened species under the ESA. The queen conch is a large gastropod mollusk that is slow growing and late to mature, reaching up to 12 inches in length and living up to 30 years. They are benthic-grazing herbivores that feed on diatoms, seagrass detritus, and various types of algae and epiphytes. Adult queen conch prefer sandy algal flats, but are also found on gravel, coral rubble, smooth hard coral, and beach rock bottom, while juveniles are primarily associated with seagrass beds.

The queen conch occurs in the Gulf of Mexico, Florida Keys, around Bermuda, and throughout the Caribbean Sea (Figure 8). Queen conch use different habitat types including seagrass beds, sand flats, algal beds, and rubble areas from a few centimeters deep to approximately 30 m. Adult distributions are heavily influenced by food availability and fishing pressure; in unexploited areas, they are most common in shallow marine waters less than 30 m depth.

The southern end of the EGTTR overlaps with portions of the Florida Keys. Although EAFB could use any portion of the EGTTR outside of the Rice’s whale exclusion area (see section 3.3.4), the majority of testing and training operations are proposed to occur in the LIAs which are in the northern portion of the EGTTR. Considering live mission activities could not occur, and the scarce chance of other activities occurring, near where the queen conch could be, the likelihood of effects is discountable and therefore the proposed action is not likely to adversely affect the queen conch. .

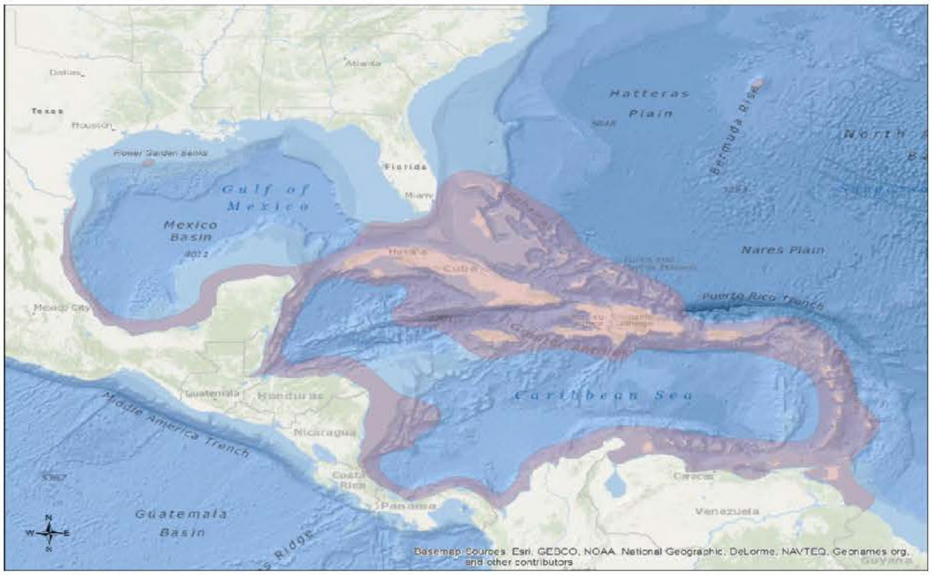

Figure 8. Queen conch geographic range.

7.10 Loggerhead Critical Habitat

Critical habitat for the Northwest Atlantic DPS of the loggerhead sea turtle includes 38 occupied marine areas within the range of the Northwest Atlantic DPS that contain at least one, or a combination of, the following habitat types: nearshore reproductive habitat, winter area, breeding area, constricted migratory corridor, and *Sargassum* habitat. Only nearshore reproductive habitat and *Sargassum* habitat areas were designated in the northern Gulf of Mexico.

Nearshore reproductive habitat describes nearshore waters adjacent to nesting beaches that are used by hatchlings to move into the open-water environment, as well as by nesting females to transit between beach and open water. This includes nearshore waters out to 1.6 km (1 mile) offshore. Thirty six units of nearshore reproductive critical habitat have been identified. This includes waters off three high density/expansion nesting beaches not designated as terrestrial critical habitat by the USFWS because they occur on military lands with an associated Integrated Natural Resources Management Plan in place. Because Eglin's Integrated Natural Resources Management Plan does not address waters off the nesting beaches on Santa Rosa Island, nearshore reproductive habitat has been designated from the shoreline of these beaches out to 1.6 km (1 mile) in the Gulf of Mexico.

The *Sargassum* habitat portion of the marine designation consists of the western Gulf of Mexico from the 10 m (32.8 ft) bathymetry line starting at the mouth of the Mississippi River and proceeding west and south to the outer boundary of the U.S. Economic Exclusion Zone (EEZ). The southern boundary is the U.S. EEZ from the 10 m (32.8 ft) bathymetry line off of Texas to the Gulf of Mexico-Atlantic Ocean border. The eastern edge follows the 10 m bathymetry line from the mouth of the Mississippi River then goes in a straight line to the northernmost boundary of the Loop Current and follows along its eastern edge to the Gulf of Mexico-Atlantic Ocean border.

The northern boundary of the EGTTR begins at 3 NM (5.6 km) offshore and, therefore, does not include nearshore reproductive loggerhead habitat. The *Sargassum* component of loggerhead critical habitat includes the portions of the southern EGTTR but it is far removed from the northern areas that include the existing LIA or proposed East LIA, where the vast majority of military activities are conducted (Figure 9). For this reason, exposure of loggerhead critical habitat to stressors resulting from EGTTR activities is so unlikely to occur as to be discountable. Therefore, the effects of the proposed action may affect, but are not likely to adversely affect loggerhead sea turtle critical habitat (Northwest Atlantic DPS).

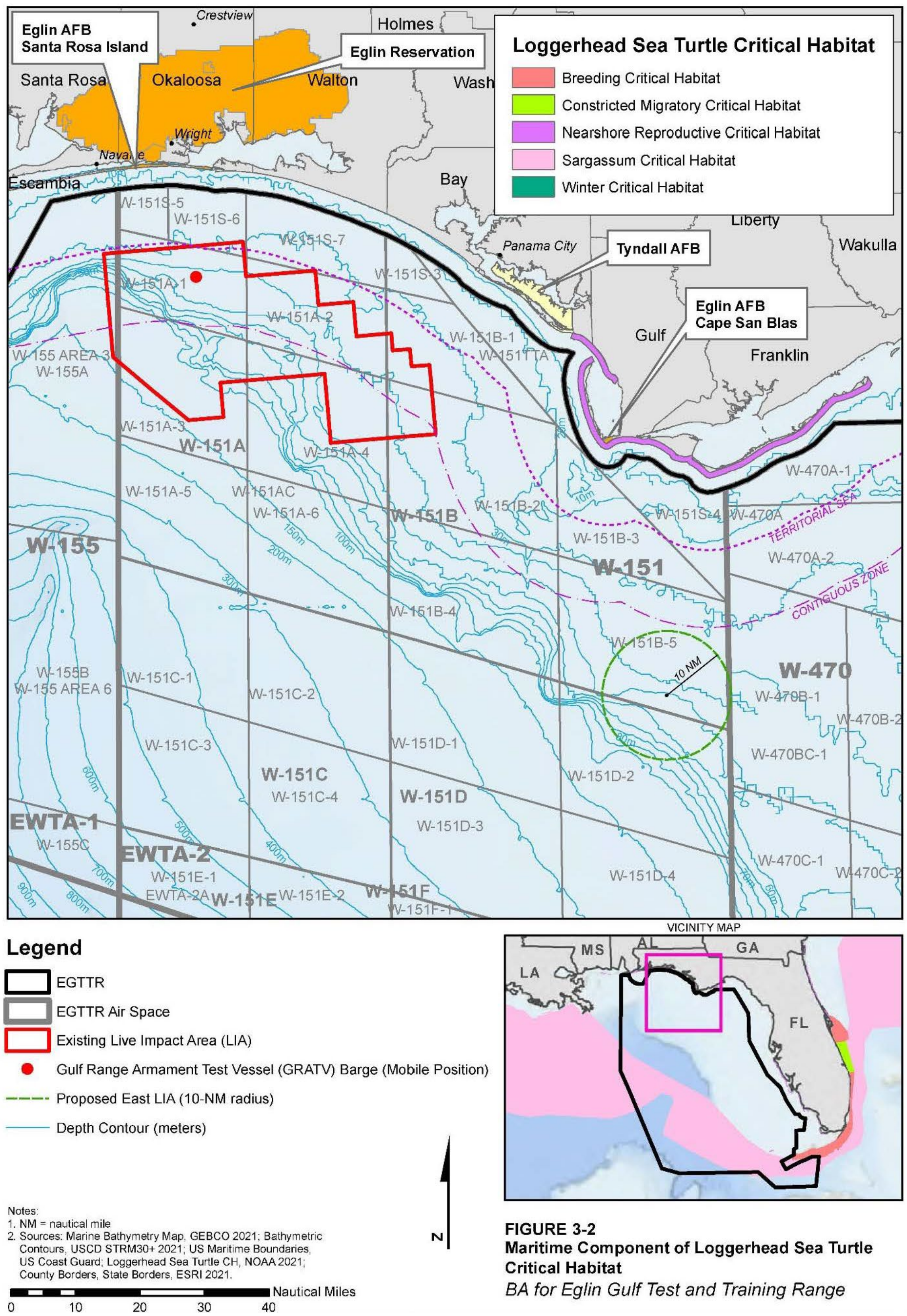

Figure 9. Loggerhead sea turtle critical habitat.

8 STATUS OF THE SPECIES LIKELY TO BE ADVERSELY AFFECTED

This opinion examines the status of the following ESA-listed species that are likely to be adversely affected by live munition exercises within LIAs of the EGTTR: North Atlantic DPS green sea turtle, Northwest Atlantic DPS loggerhead sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and the Rice's whale.

The status of these ESA-listed species is determined by the level of risk they face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the process of determining whether an action is likely to jeopardize the continued existence of listed species (50 C.F.R. §402.02). The evaluation of adverse effects begins by summarizing the biology and ecology of those species that are likely to be adversely affected and what is known about their life histories in the action area. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on these NMFS Web sites: https://www.fisheries.noaa.gov/find-species.

One factor affecting the range wide status of marine mammals, sea turtles, and aquatic habitat at large is climate change. Climate change will be discussed in the *Environmental Baseline* section (Section 9).

8.1 Rice's Whale

The Gulf of Mexico subspecies of Bryde's whale was listed as endangered in 2019 and in 2021 the listing was revised to Rice's whale (86 FR 47022) to reflect the scientifically accepted taxonomy and nomenclature of this species. The scientific name change from *Balaenoptera edeni* to *Balaenoptera ricei* is supported by genetic and morphological evidence (Rosel 2021), which indicate that the Gulf of Mexico subspecies of Bryde's whale was actually a different species.

8.1.1 Life history

The Rice's whale is a medium-sized baleen whale. To date, the largest verified Rice's whale to strand was a lactating female about 1,265 cm long; the largest male was 1,126 cm (Rosel et al. 2021). Rice's whales are uniformly dark gray on top, including the upper and lower jaws, and pale to pinkish on the underside. The flippers are uniformly dark. The fringe of the baleen plates is cream colored with coarse baleen bristles. Rice's whales have a falcate dorsal fin approximately two-thirds of the way back from the snout. Similar to whales in the Bryde's whale complex, the Rice's whale has three longitudinal ridges on the rostrum (Rosel 2021).

The Rice's whale is the only year-round resident baleen whale species in the Gulf of Mexico. Rosel et al. (2021) reported that based on a compilation of sighting and stranding data from 1992 to 2019, the primary habitat of the Rice's whale is the northeastern Gulf of Mexico, particularly the De Soto Canyon area. Rice's whale habitat is considered to be within the depth range of 100 to 400 m in this part of the Gulf of Mexico (NMFS 2016, 2020a,(Rosel 2021). Figure 10 shows visual survey sightings of whales suspected to be the Rice's whale recorded during NMFS vessel and aerial surveys from 1992 to 2019 (Rosel 2021).

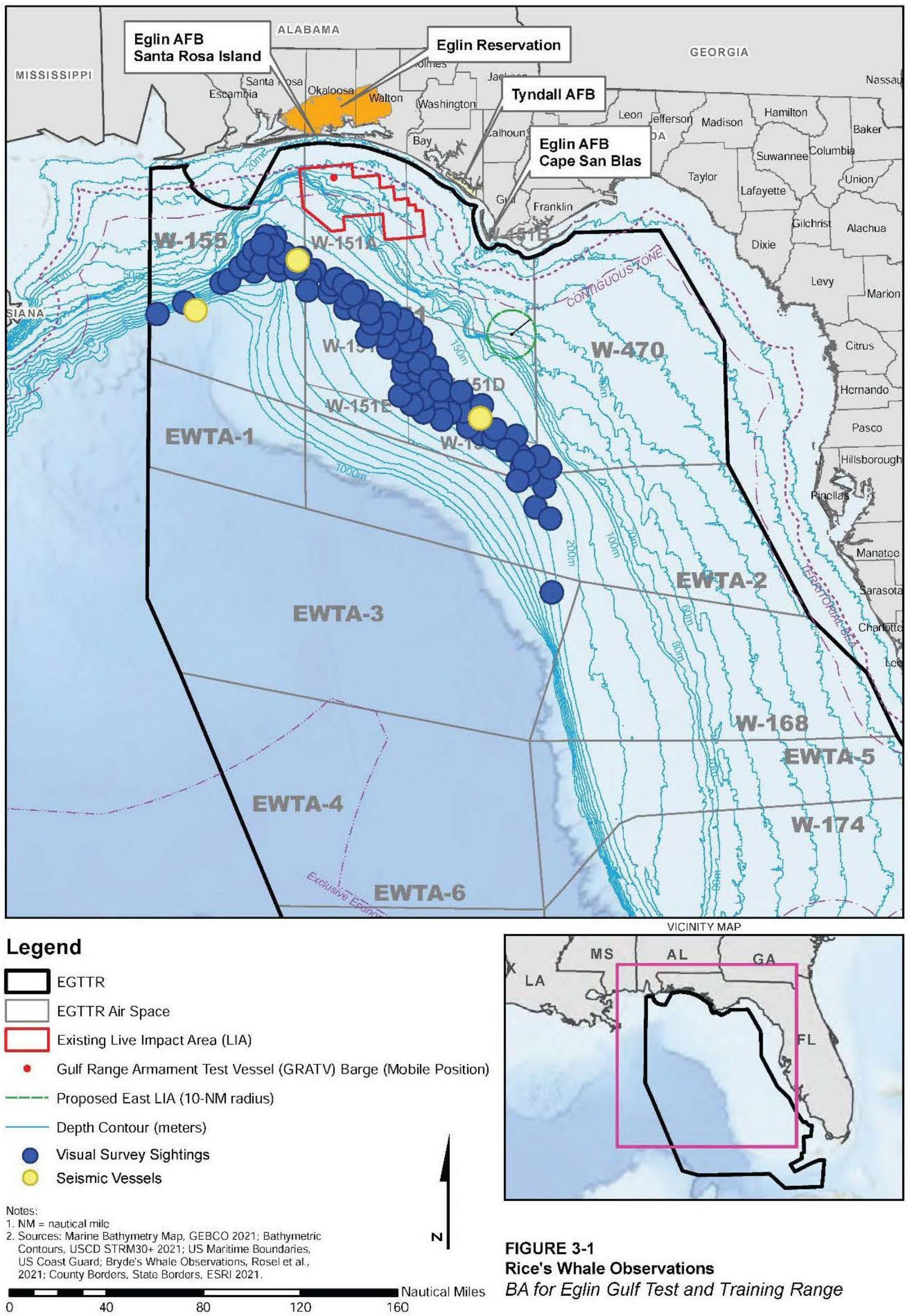

Figure 10. Rice's whale observations.

The Rice's whale population was first discovered in the early 1990s with the beginning of systematic surveys of the shelf break region and oceanic waters (Hansen et al. 1995). Most sightings of Bryde's-like whales in the Gulf of Mexico are from shipboard and aerial line-transect surveys conducted by NMFS (Waring et al. 2013). These surveys were conducted at various times throughout all seasons and covered waters from the 20 m isobath to the seaward extent of the U.S. Exclusive Economic Zone (Fulling et al. 2003); (Mullin and Fulling 2004; Waring 2016)). During these past surveys, sightings of Bryde's like whales were restricted to the northeastern Gulf in waters along and seaward of the 200 m isobath. The deepest location where a Rice's whale was sighted was 408 m (Rosel 2021). The majority of sightings are confined to the northeastern Gulf of Mexico; however, it is possible the species had a broader distribution. Historical whaling records from the 1800s suggest Bryde's-like whales may have been more common in the waters of the north central Gulf, south of the Mississippi River delta and in the southern Gulf on the Campeche Bank (Reeves et al. 2011a). Two Bryde's-like whales were sighted during a NMFS survey in the western Gulf in the early 1990s (Rosel 2021) and more recently, there was a confirmed Rice's whale sighting in the western Gulf of Mexico off the central Texas coast at a 225 m water depth (NMFS 2018c). Data from passive acoustic monitoring revealed long-moan whale calls along the northwestern Gulf of Mexico shelf break that were determined to share distinctive and similar features with Rice's whale calls in the eastern Gulf of Mexico, which provides evidence for the occurrence of Rice's whales over a broader distribution in the Gulf of Mexico than previously understood (Soldevilla et al. 2022).

Little is known about the life history of the Rice's whale. Basic information about the species is incomplete because of inadequate sample sizes. Total length measurements of stranded whales ranged from 470 cm to 1,265 cm (Rosel 2021). Stranding and genetic data indicate that both sexes are present in the Gulf of Mexico (Rosel 2021). Several smaller Rice's whales, including a stranded calf, are reported in stranding records, indicating that the whales are breeding in the isolated region. Two Rice's whales were sighted together in the northeastern Gulf of Mexico during a 2016 NMFS survey (Waring et al. 2016b) and one was half the size of the other and had the physical characteristics of a calf. A dead lactating female was also found in Tampa Bay in 2009.

The diet of the Rice's whale is also poorly understood. Soldevilla et al. (2017) tagged a Rice's whale in the northeastern Gulf of Mexico. The tag remained attached for 3 days and revealed a diel dive pattern that indicates that the whales forage near the seafloor during the day and remain near the surface of the water (within 15 m) during the night. It is unknown what type of prey the whales target during daytime dives. This tagging study provides the first and only data on Rice's whale diving behavior.

Rice's whale is one of the cetaceans with a hearing frequency range of 7 hertz (Hz) to 35 kilohertz (kHz). This range is covered in both the *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing v2.0* (NMFS 2018d), referred to herein as the 2018 NMFS Technical Guidance, and *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis* (Phase III; DoN 2017), referred to herein as the 2018 Navy Phase III Guidance.

8.1.2 Population Dynamics

Estimates of abundance for Rice's whales are under 100 individuals. Data from aerial and vessel-based line-transect surveys conducted in the northern Gulf of Mexico have been used to estimate cetacean abundance. Abundance estimates made between 1991 and 2009 range between 0 and 44 individuals (Rosel et al. 2016a). The best abundance estimate for the Rice's whale (formerly the Gulf of Mexico Bryde's whale) is 51 animals with a minimum population estimate of 34 (NMFS 2021).

The current area where Rice's whales are expected to be found and their density based on best available information is shown in Figure 10 (Rosel 2021).

8.1.3 Recovery planning

The National Marine Fisheries (NMFS) is developing a recovery plan for this species. In the interim, NMFS has developed this recovery outline to provide a preliminary strategy for conservation of the Rice's whale. (https://www.fisheries.noaa.gov/resource/document/rices-whale-recovery-outline)

8.2 Green Sea Turtle – North Atlantic Distinct Population Segment

On April 6, 2016, NMFS published a final rule to list 11 DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20058).

The green turtle is globally distributed and commonly inhabits nearshore and inshore waters, occurring throughout tropical, sub-tropical and, to a lesser extent, temperate waters. The North Atlantic DPS of green turtle is found in the North Atlantic Ocean and Gulf of Mexico. The green turtle is the largest of the hard-shell sea turtles, growing to a weight of 159 kilograms (350 pounds) and a straight carapace length of greater than 1 m (3.3 ft), while hatchlings are just 50 mm (two inches) long. Green turtles have a smooth carapace with four pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux 2001). Adult green turtles are unique among sea turtles in that they are herbivorous, feeding primarily on sea grasses and algae. This diet is thought to give them greenish coloured fat from which they take their name.

8.2.1 Life History

Age at first reproduction for females is 20 to 40 years. Green turtles lay an average of three nests per season with an average of 100 eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation, and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult sea turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges, and other invertebrate prey.

8.2.2 Population Dynamics

The following discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the North Atlantic DPS of green turtle.

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Our knowledge of sea turtle population dynamics, status, and trends is inferred from shifts in the abundance of females returning to their natal beach for nesting. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015a). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites (Figure 11), and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79 percent of nesting females for the DPS (Seminoff et al. 2015a).

The lack of consistent, standardized monitoring at many of the nesting sites around the world makes it difficult to characterize population growth rates for a DPS. For the North Atlantic DPS of green turtle, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008) using data sets for 25 years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent.

The North Atlantic DPS of green turtle has a unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting sub-populations in Florida, Cuba, Mexico, and Costa Rica (Seminoff et al. 2015a). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015a). Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5° North, 77° West) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48° North, 77° West) in the north. The range of the North Atlantic DPS then extends due east along latitudes 48° North and 19° North to the western coasts of

Europe and Africa (Figure 11). Nesting occurs primarily in Costa Rica, Mexico, Florida, and Cuba.

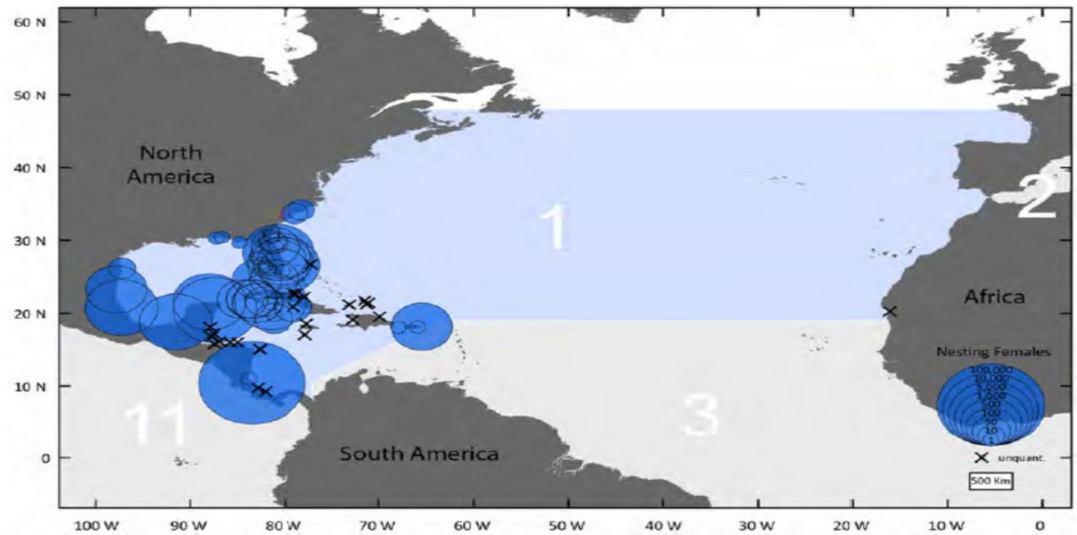

Figure 11. Geographic range of North Atlantic DPS green sea turtle with location and abundance of nesting females from Seminoff et al. (2015).

8.2.3 Status

Once abundant in tropical and sub-tropical waters worldwide, green turtles exist at a fraction of their historical abundance as a result of over-exploitation. Globally, egg harvest, the harvest of females on nesting beaches, and directed hunting of sea turtles in foraging areas remain the three greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, pound-net, and trawl fisheries kill thousands of green turtles annually. Increasing coastal development (including beach erosion and re-nourishment, construction and artificial lighting) threatens nesting success and hatchling survival. On a regional scale, the different DPSs experience these threats as well, to varying degrees. Differing levels of abundance combined with different intensities of threats and effectiveness of regional regulatory mechanisms make each DPS uniquely susceptible to future perturbations.

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population’s decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green turtle generation, up to 50 years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations.

8.2.4 Critical Habitat

On September 2, 1998, NMFS designated critical habitat for green turtles, which is within the action area and include coastal waters surrounding Culebra Island, Puerto Rico, which is outside the action area. No critical habitat is designated within the EGTTR action area for this species.

8.2.5 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover green turtle populations. These threats will be discussed in further detail in the Environmental Baseline section of this consultation. See the 1998 and 1991 recovery plans for the Pacific, East Pacific and Atlantic populations of green turtles for complete down-listing/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

8.3 Loggerhead Sea Turtle – Northwest Atlantic DPS

The loggerhead sea turtle was listed as a threatened species throughout its range on July 28, 1978. NMFS and the U.S. Fish and Wildlife Service (USFWS) have published a final rule designating nine Distinct Population Segments (DPS) for loggerhead sea turtles (76 Federal Register [FR] 58868, September 22, 2011; effective October 24, 2011). The Northwest Atlantic DPS occurs throughout the northwest Atlantic Ocean, Caribbean, and Gulf of Mexico (Figure 12).

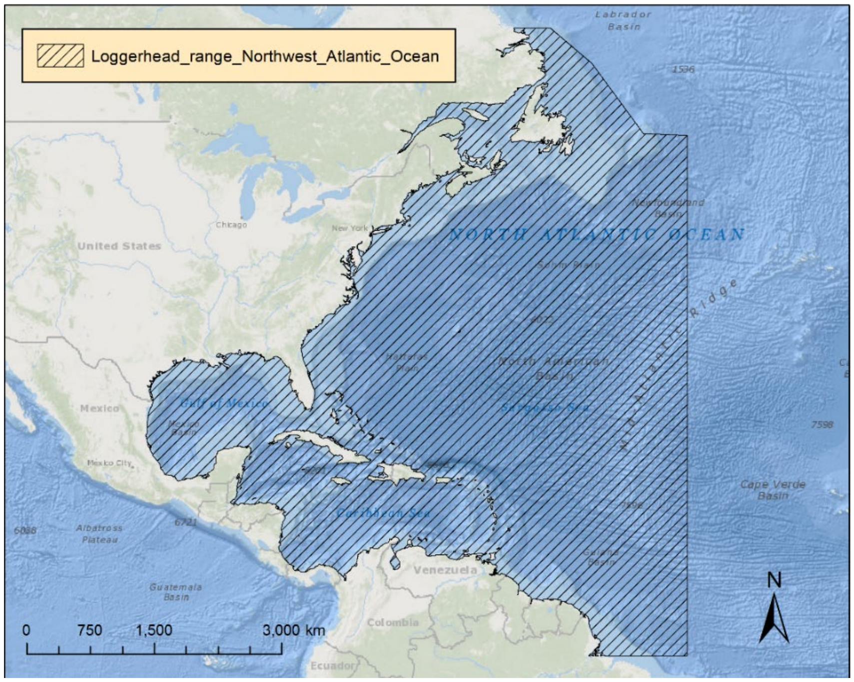

Figure 12. Range of the Northwest Atlantic Ocean DPS loggerhead sea turtles.

8.3.1 Life History

Loggerhead sea turtles reach maturity between 20 and 38 years of age, though the age appears to vary widely among populations(Frazer and Ehrhart 1985; NMFS 2001). The mating season occurs from late March to early June, and eggs are laid throughout the summer months. Female loggerheads deposit an average of 4.1 nests per nesting season (Murphy and Hopkins 1984) and have an average remigration interval of 3.7 years (Tucker 2010). Mean clutch size along the south-eastern U.S. coast varies from 100 to 126 eggs (Dodd 1988). Loggerhead sea turtles are generally thought to circumnavigate the North Atlantic Gyre as pelagic post hatchlings and early juveniles (often occurring in Sargassum drift lines or other convergence zones) and may lead a pelagic existence for as long as 7 to 12 years (Bolten et al. 1998). At some point, individuals shift to a different midwater feeding habitat, which in the eastern North Atlantic Ocean is believed to be the waters surrounding the Azore and Madeira Islands. Other oceanic waters include the Grand Banks (Newfoundland, Canada) and the Mediterranean Sea. Juvenile and adult loggerheads most often occur on the continental shelf and shelf edge of the U.S. Atlantic and Gulf coasts, but are also known to inhabit coastal estuaries and bays along both coasts (CETAP 1982; Shoop and Kenney 1992b). However, the results of recent studies suggest that not all loggerhead turtles follow this model (Laurent et al. 1998) and some turtles may remain in the pelagic habitat in the North Atlantic longer than hypothesized or move back and forth between pelagic and coastal habitats (Witzell 2002). Juveniles are omnivorous and forage on crabs, molluscs, jellyfish and vegetation at or near the surface (Dodd 1988).

8.3.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Northwest Atlantic Ocean DPS of loggerhead turtle.

The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560. Using a stage/age demographic model, the adult female population size of the DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS 2009a). In 2010, there were estimated to be approximately 801,000 loggerhead turtles (greater than 30 cm in size, inter-quartile range of approximately 521,000–1,111,000) in northwestern Atlantic continental shelf region based on aerial surveys (NMFS 2011d). A number of stock assessments and similar reviews (Carlson et al. 2016; Conant et al. 2009; Ehrhart et al. 2014; FFWCC 2018; Foley et al. 2008; NMFS 2004b; NMFS 2005; NMFS 2009b; NMFS/SEFSC 2001; TEWG 2009; Wallace et al. 2008) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Over 90 percent of loggerhead sea turtle nesting in the U.S. occurs in Florida (Ceriani et al. 2021).The majority of loggerhead nesting in Florida occurs along the southeastern coast of the state. In 2020, Brevard and Palm Beach Counties, which are located on the southeastern coast of Florida, had a combined total of 56,456 loggerhead nests, while the three northern Gulf counties where Eglin AFB is located (Santa Rosa, Okaloosa, and Walton) had a combined total of 121 nests (FWC 2021). Since 1989, the Fish and Wildlife Research Institute has coordinated the Index Nesting Beach Survey (INBS), a detailed sea turtle nesting-trend monitoring program. Nest counts from the INBS do not represent total annual nest counts because they are collected from a subset (27 out of 224) of Florida's beaches and only during a 109-day time window (May 15 through August 31). Loggerhead nest counts on the 27 core index beaches have been increasing in recent years. However, long-term nesting data (1989– 2019) reveal a complex pattern with three distinct phases: increasing (1989–1998), decreasing (1998– 2007), and increasing (2007–2019). The observed pattern may be part of a long-term cycle, but many more years of standardized nest counts are needed to assess this hypothesis (FFWCC 2018).Witherington and others (2009) analyzed an 18-year time series (1989–2006) of INBS nest-count data to describe spatial and temporal trends in loggerhead nesting on Florida beaches. Between 1989 and 2006, loggerhead nest counts increased and then declined, with a net decrease over the 18-year period (Witherington et al. 2009). Witherington and others (2009) believe the decline in annual nest counts can best be explained by a decline in the number of adult female loggerheads in the population. Nesting on Florida Panhandle index beaches specifically, which represent the majority of nesting for this recovery unit, generally declined between 1997 and 2011, with a notable exception in 2008. However, since 2012 nesting has trended upward, increasing to levels comparable to the late 1990s, with a record number of nests in 2016 (FFWCC 2018).

A study conducted between 2010 and 2012 used satellite telemetry to tag and track the movements of 39 adult female loggerheads from nesting beaches at three sites in Florida and Alabama (Hart et al. 2012). The results of this study showed that female loggerheads from this subpopulation made longer movements during the inter-nesting period than previously thought and may regularly use nesting beaches from different geographic areas within the same reproductive season, demonstrating a significantly lower nest-site fidelity level than previously reported (Hart et al. 2012). The Peninsular Florida Recovery Unit hosts more than 10,000 females nesting annually, which constitutes 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS of loggerhead turtles (Ehrhart et al. 2003). The Northern Gulf of Mexico Recovery Unit has between 100 to 999 nesting females annually, and a mean of 910 nests per year.

8.3.3 Status

Due to declines in nest counts at index beaches in the U.S. and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS of loggerhead turtle is at risk and likely to decline in the foreseeable future (Conant et al. 2009).

8.3.4 Critical Habitat

Critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtles was designated in 2014 and was discussed in Section 7.10.

8.3.5 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover loggerhead turtle populations (NMFS and USFWS 2008). These threats will be discussed in further detail in the environmental baseline section of this opinion.

8.4 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Internationally, the Kemp's ridley is considered the most endangered sea turtle (Groombridge 1982a; TEWG 2000b; Zwinenberg 1977a).

The Kemp's ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982b; Zwinenberg 1977b). Its range extends from the Gulf of Mexico the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas (Figure 13).

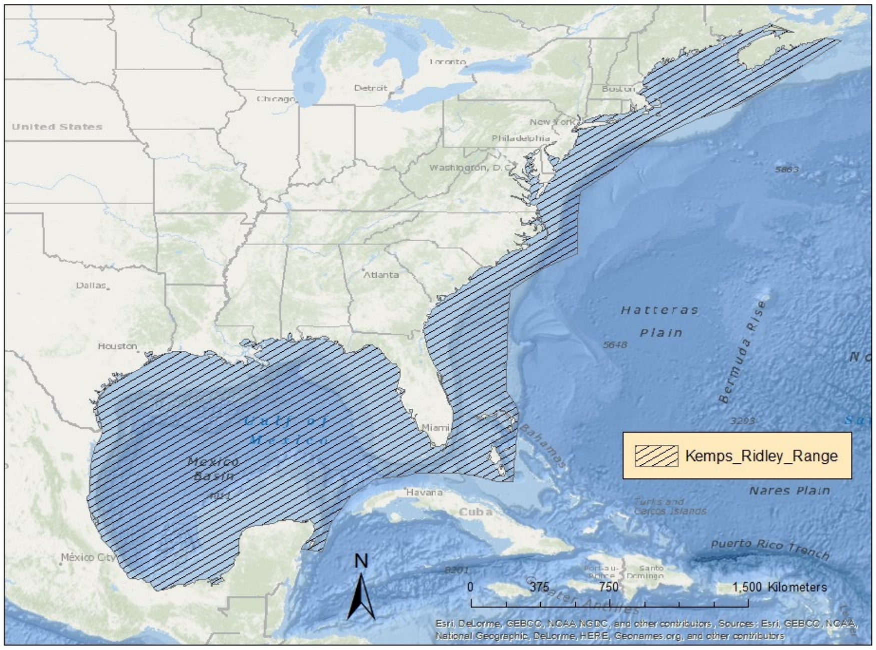

Figure 13. Kemp's ridley sea turtle geographic range.

We used information available in the revised recovery plan (NMFS et al. 2011c), the five-year review (NMFS and USFWS 2015b), and the scientific literature to summarize the life history, population dynamics, and status of the species, as follows.

8.4.1 Life History

Females mature at 12 years of age. The average remigration is two years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is 97 to 100 eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately two years before returning to nearshore coastal habitats. Juvenile Kemp's ridley turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 37 m deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridley turtles forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS et al. 2011c).

8.4.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distributions as it relates to the Kemp's ridley turtle.

Of the seven sea turtle species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS and USFWS 2015b). The number of nests in Padre Island, Texas has increased over the past two decades, with one nest observed in 1985, four in 1995, 50 in 2005, 197 in 2014 (NMFS and USFWS 2015b).

The Kemp's ridley turtle occurs from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000a). Kemp's ridley turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico. During spring and summer, juvenile Kemp's ridley turtles occur in the shallow coastal waters along the Atlantic continental shelf from New England to Florida, and from the northern Gulf of Mexico from Texas to north Florida. In the fall, most Kemp's ridley turtles migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many sea turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2011c).

8.4.3 Status

The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May to August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program has resulted in re-establishment of nesting at Texan beaches. Heppell et al. (2005) predicted in a population model that the population is expected to increase at least 12 to 16 percent per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011b) produced an updated model that predicted the population to increase 19 percent per year and attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. While counts did not reach 25,000 nests by 2012, it is clear that the population is steadily increasing. The recent increases in Kemp's ridley sea turtle nesting seen in the last two decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of turtle exclusion devices, reduced trawling effort in Mexico and the United States, and possibly other changes in vital rates (TEWG 1998b; TEWG 2000b). The species limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty.

Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS 2011a). Additional analysis of the mitochondrial DNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006).

While fisheries bycatch remains a threat, the use of sea turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. It is clear that the species is steadily increasing; however, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

8.4.4 Critical Habitat

No critical habitat has been designated for Kemp's ridley turtles.

8.4.5 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover Kemp's ridley turtle populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles for complete down listing/delisting criteria for each of their respective recovery goals (NMFS et al. 2011a).

8.5 Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970, under the Endangered Species Conservation Act of 1969. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973.

The leatherback turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. Leatherback turtles are the largest living sea turtle, reaching lengths of 1.8 m long, and weighing up to 907.2 kilograms. Leatherback turtles have a distinct black leathery skin covering their carapace with pinkish white skin on their belly. It ranges from tropical to sub-polar latitudes, worldwide (Figure 14).

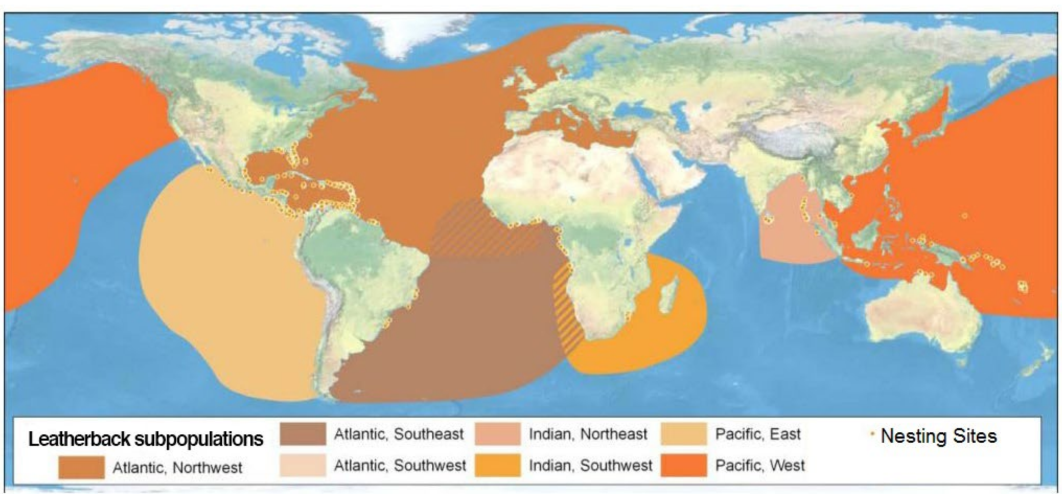

Figure 14. Range of endangered leatherback turtle; adapted from Wallace et al. 2013.

8.5.1 Life History

Leatherbacks are a long-lived species that delay age of maturity, have low and variable survival in the egg and juvenile stages, and have relatively high and constant annual survival in the subadult and adult life stages (Chaloupka 2002; Crouse 1999; Heppell et al. 1999; Heppell et al. 2003; Spotila et al. 1996; Spotila et al. 2000). While a robust estimate of the leatherback sea turtle's life span does not exist, the current best estimate for the maximum age is 43 (Avens et al. 2009a). It is still unclear when leatherbacks first become sexually mature, with estimates ranging from five to 29 years (Avens et al. 2009b; Spotila et al. 1996).

Females lay up to seven clutches per season, with more than 65 eggs per clutch and eggs weighing greater than 80 grams (Reina et al. 2002; Wallace et al. 2007). The number of leatherback turtle hatchings that make it out of the nest on the beach (i.e., emergent success) is approximately 50 percent worldwide (Eckert et al. 2012). Eggs hatch after 60 to 65 days, and the hatchlings have white striping along the ridges of their backs and on the edges of the flippers. Leatherback hatchlings weigh approximately 1.5 to 2 ounces (40 to 50 grams), and are approximately two to three inches (51 to 76 mm) in length, with fore flippers as long as their bodies. Hatchlings grow rapidly with reported growth rates for leatherbacks from 2.5 to 27.6 inches (six to 70 cm) in length, estimated at 12.6 inches (32 cm) per year (Jones et al. 2011). Females nest every one to seven years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean.

Leatherback turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherback turtles must consume large quantities to support their body weight. Leatherback turtles weigh about 33 percent more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (Aguirre et al. 2006; James et al. 2005). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000; Price et al. 2004).

8.5.2 Population Dynamics

The status of the Atlantic leatherback population has been less clear than the Pacific population, which has shown dramatic declines at many nesting sites (Santidrián-Tomillo et al. 2007; Sarti Martínez et al. 2007; Spotila et al. 2000). This uncertainty has been a result of inconsistent beach and aerial surveys, cycles of erosion, and reformation of nesting beaches in the Guianas (representing the largest nesting area). Leatherbacks also show a lesser degree of nest-site fidelity than occurs with the hard-shell sea turtle species. Coordinated efforts of data collection and analyses by the leatherback TEWG have helped to clarify the understanding of the Atlantic population status (TEWG 2007b).

Population growth rates for leatherback turtles vary by ocean basin. Counts of leatherback turtles at nesting beaches in the western Pacific indicate that the sub-population has been declining at a rate of almost six percent per year since 1984 (Tapilatu et al. 2013). Leatherback turtle sub-populations in the Atlantic Ocean, however, are showing signs of improvement. Nesting females in South Africa are increasing at an annual rate of four to 5.6 percent, and from nine to 13 percent in Florida and the U.S. Virgin Islands (TEWG 2007a), believed to be a result of conservation efforts.

Analyses of mitochondrial DNA from leatherback turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian Oceans suggest that each of the rookeries represent demographically independent populations (NMFS and USFWS 2013b).

Leatherback turtles are distributed in oceans throughout the world (Figure 14) from nearshore habitats to oceanic environments (Shoop and Kenney 1992a). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011). The Florida nesting stock nests primarily along the east coast of Florida. This stock is of growing importance, with total nests between 600 and 700 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (Florida Fish and Wildlife Conservation Commission data available at http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). Using data from the index nesting beach surveys, the TEWG (TEWG 2007b) estimated a significant annual nesting growth rate of 1.17 percent between 1989 and 2005. A similar pattern was also observed statewide (Table 4). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting. Overall, the trend shows growth on Florida's east coast beaches.

Table 4. Number of leatherback sea turtle nests in Florida.

Nests Recorded	2010	2011	2012	2013	2016
Index Nesting Beaches	552	625	515	322	319
Statewide	1,334	1,653	1,712	896	1,054

Data from ***http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/***

Because the available nesting information is inconsistent, it is difficult to estimate the total population size for Atlantic leatherbacks. Spotila et al. (1996) characterized the entire Western Atlantic population as stable at best and estimated a population of 18,800 nesting females. Spotila et al. (1996) further estimated that the adult female leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, was about 27,600 (considering both nesting and interesting females), with an estimated range of 20,082 to 35,133. This is consistent with the estimate of 34,000 to 95,000 total adults (20,000 to 56,000 adult females; 10,000 to 21,000 nesting females) determined by the TEWG (2007b). The latest review by NMFS and USFWS (2013d) suggests the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean.

8.5.3 Critical Habitat

There is no designated critical habitat for leatherback sea turtles in the EGTTR action area. On March 23, 1979, leatherback designated critical habitat was identified adjacent to Sandy Point, St. Croix, U.S.Virgin Islands, which is outside the action area.

8.5.4 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover leatherback turtle populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 1998 and 1991 Recovery Plans for the U.S. Pacific and U.S. Caribbean, Gulf of Mexico, and Atlantic leatherback turtles for complete down listing/delisting criteria for each of their respective recovery goals (NMFS and USFWS 1992; NMFS and USFWS 1998).

9 ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02).

9.1 Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to impact ESA resources. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://climate.gov).

In order to evaluate the implications of different climate outcomes and associated impacts throughout the 21st century, many factors have to be considered. The amount of future greenhouse gas emissions is a key variable. Developments in technology, changes in energy generation and land use, global and regional economic circumstances, and population growth must also be considered.

A set of four scenarios was developed by the Intergovernmental Panel on Climate Change (IPCC) to ensure that starting conditions, historical data, and projections are employed consistently across the various branches of climate science. The scenarios are referred to as representative concentration pathways (RCPs), which capture a range of potential greenhouse gas emissions pathways and associated atmospheric concentration levels through 2100 (IPCC 2014). The RCP scenarios drive climate model projections for temperature, precipitation, sea level, and other variables: RCP2.6 is a stringent mitigation scenario; RCP2.5 and RCP6.0 are intermediate scenarios; and RCP8.5 is a scenario with no mitigation or reduction in the use of fossil fuels. The IPCC future global climate predictions (2014 through 2022) and national and regional climate predictions included in the Fourth National Climate Assessment for U.S. states and territories (2018) use the RCP scenarios.

The increase of global mean surface temperature change by 2100 is projected to be 0.3 to 1.7°C under RCP 2.6, 1.1 to 2.6°C under RCP 4.5, 1.4 to 3.1°C under RCP 6.0, and 2.6 to 4.8°C under RCP8.5 with the Arctic region warming more rapidly than the global mean under all scenarios (IPCC 2014). The Paris Agreement aims to limit the future rise in global average temperature to 2°C, but the observed acceleration in carbon emissions over the last 15 to 20 years, even with a lower trend in 2016, has been consistent with higher future scenarios such as RCP8.5 (Hayhoe et al. 2018).

The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately one degrees Celsius from 1901 through 2016 (Hayhoe et al. 2018). The *IPCC Special Report on the Impacts of Global Warming* (IPCC 2018) noted that human-induced warming reached temperatures between 0.8 and 1.2 degrees Celsius above pre-industrial levels in 2017, likely increasing between 0.1 and 0.3 degrees Celsius per decade. Warming greater than the global average has already been experienced in many regions and seasons, with most land regions experiencing greater warming than over the ocean (Allen et al. 2018).

In ocean and coastal ecosystems, risk of biodiversity loss ranges between moderate and very high by 1.5°C global warming level and is moderate to very high by 2°C but with more ecosystems at high and very high risk , and increases to high to very high across most ocean and coastal ecosystems by 3°C (depending on ecosystem). Very high extinction risk for endemic species in biodiversity hotspots is projected to at least double from 2% between 1.5°C and 2°C global warming levels and to increase at least tenfold if warming rises from 1.5°C to 3°C .(IPCC 2022)

Changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish), ultimately affecting primary foraging areas of ESA-listed species including marine mammals, sea turtles, and fish. Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012).

Ocean acidification may cause a variety of species- and ecosystem-level effects in high latitude ecosystems. Species-level effects may include reductions in the calcification rates of numerous planktonic and benthic species, alteration of physiological processes such as pH buffering, hypercapnia, ion transport, acid-base regulation, mortality, metabolic suppression, inhibited blood-oxygen binding, and reduced fitness and growth (Fabry et al. 2008). Ecosystem effects could include altered species compositions and distributions, trophic dynamics, rates of primary productivity, and carbon and nutrient cycling (Fabry et al. 2008). Additionally, as the ocean becomes more acidic, low frequency sounds (1 to 3 kiloHertz and below) travel farther because the concentrations of certain ions that absorb acoustic waves decrease with decreasing pH (Brewer and Hester 2009).

Climate change has the potential to impact species abundance, geographic distribution, migration patterns, and susceptibility to disease and contaminants, as well as the timing of seasonal activities and community composition and structure (Evans and Bjørge 2013; IPCC 2014; Kintisch 2006; Learmonth et al. 2006; MacLeod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005). Though predicting the precise consequences of climate change on highly mobile marine species is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring. For example, in sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25 to 35 degrees Celsius (Ackerman 1997a). Increases in global temperature could skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007aa; NMFS and USFWS 2007bb; NMFS and USFWS 2013aa; NMFS and USFWS 2013cb; NMFS and USFWS 2015a). These impacts will be exacerbated by sea level rise. This loss of habitat because of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Similarly, climate-related changes in important prey species populations are likely to affect predator populations. For example, blue whales, as predators that specialize in eating krill, are likely to change their distribution in response to changes in the distribution of krill (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990). Pecl and Jackson (2008) predicted climate change will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter life-spans, and mature younger at a smaller size. This could have negative consequences for species such as sperm whales, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperatures, regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

The 2022 Sixth Assessment Report reviews key developments since the Fifth Assessment Report (IPCC 2022). The following are the overarching conclusions from the whole of the assessment:

1. The magnitude of observed impacts and projected climate risks indicate the scale of decision-making, funding and investment needed over the next decade if climate resilient development is to be achieved.
2. Climate risks are appearing faster and will get more severe sooner (high confidence). Impacts cascade through natural and human systems, often compounding with the impacts from other human activities. Feasible, integrated mitigation and adaptation solutions can be tailored to specific locations and monitored for their effectiveness while avoiding conflict with sustainable development objectives and managing risks and tradeoffs (high confidence).
3. Available evidence on projected climate risks indicates that opportunities for adaptation to many climate risks will likely become constrained and have reduced effectiveness should 1.5 degree Celsius global warming be exceeded and that, for many locations on Earth, capacity for adaptation is already significantly limited. The maintenance and recovery of natural and human systems will require the achievement of mitigation targets.

Global sea level rise has already affected the United States; the incidence of daily tidal flooding is accelerating in more than 25 Atlantic and Gulf Coast cities. Global average sea levels are expected to continue to rise by at least several inches in the next 15 years and by one to four ft (0.3 to 1.2 m) by 2100. Sea level rise will be higher than the global average on the East and Gulf Coasts of the United States (Wuebbles et al. 2017). Climate change has been linked to changing ocean currents as well. The Atlantic Ocean appears to be warming faster than all other ocean basins except perhaps the southern oceans.

9.2 Department of Defense Activities

The air space over the Gulf of Mexico is used extensively by the DoD for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf of Mexico. The western Gulf of Mexico has four warning areas that are used for military operations. The areas total approximately 21 million acres or 58 percent of the area. In addition, six blocks in the western Gulf of Mexico are used by the Navy for mine warfare testing and training. The central Gulf of Mexico has five designated military warning areas that are used for military operations. These areas total approximately 11.3 million acres Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million acres in the Central Planning Area (CPA). The total 11.8 million acres is about 25 percent of the area of the CPA.

Formal consultations on overall U.S. Navy (USN) activities in the Atlantic (including the Gulf of Mexico) have been completed, including the USN Activities in East Coast Training Ranges (June 1, 2011); USN Atlantic Fleet Sonar Training Activities (AFAST; January 20, 2011); USN AFAST LOA 2012 to 2014: USN active sonar training along the Atlantic Coast and Gulf of

Mexico (December 19, 2011); activities in GOMEX Range Complex from November 2010 to November 2015 (March 17 2011); the USN East Coast Training Ranges (Virginia Capes, Cherry Point, and Jacksonville; June 2010); and U.S. Navy's Atlantic Fleet Training and Testing (AFTT) Activities (October 22, 2018).

On October 22, 2018, NMFS issued a conference and biological opinion on the effects of the Navy's Atlantic Fleet Training and Testing (AFTT) Phase III activities on ESA-listed resources (NMFS 2018c). The AFTT action area includes the Gulf of Mexico Range Complex which encompasses approximately 17,000 NM^2 (22513 km^2) of sea and undersea space and includes 285 NM (528 km) of coastline. The four operating areas (OPAREAs) within this range complex are: Panama City OPAREA off the coast of the Florida panhandle, approximately 3,000 NM^2 (3973 km^2); Pensacola OPAREA off the coast of Florida west of the Panama City OPAREA , approximately 4,900 NM^2 (6489 km^2); New Orleans OPAREA off the coast of Louisiana, approximately 2,600 NM^2 (3443 km^2); and Corpus Christi OPAREA off the coast of Texas , approximately 6,900 NM^2 (9137 km^2). The AFTT Phase III opinion includes an ITS with exempted take for the following ESA-listed species found in the Gulf of Mexico: sperm whales, Bryde's whales (now Rice's whale), sea turtles, and Gulf sturgeon.

These opinions concluded that although there is a potential for some USN activities to affect ESA-listed species, those effects were not expected to impact any species on a population level. Therefore, the activities were determined not likely to jeopardize the continued existence of any ESA-listed species. However, NMFS did calculate take in the form of harassment from TTS and behavioral harassment. This shows these animals are under regular stress and pressure from military activities in the Gulf of Mexico which is their sole range and primary habitat.

NMFS previously completed consultations on EAFB testing and training activities in the Gulf of Mexico. These consultations determined the training operations would adversely affect sea turtles but would not jeopardize their continued existence. They further determined that because the activities were to be completed over shallow shelf waters (less than 100 m), that they were not likely to adversely affect sperm whales or Bryde's whales. These consultations concluded that the incidental take of sea turtles is likely to occur. These opinions included ITSs for these actions: Eglin Gulf Test and Training Range (NMFS 2004b), the Precision Strike Weapons Tests (NMFS 2005b), the Santa Rosa Island Mission Utilization Plan (NMFS 2005c), Naval Explosive Ordnance Disposal School (NMFS 2004a), Eglin Maritime Strike Operations Tactics Development and Evaluation (NMFS 2013a), and Ongoing Eglin Gulf Testing and Training Activities (NMFS 2017e).

9.2.1 US Navy

The majority of the training and testing activities the Navy conducts in the action area and plans to continue are similar, if not identical, to activities that have been occurring in the same locations for decades. The US Navy activities can produce sound and visual disturbances to the Rice's whale (formerly Gulf of Mexico Bryde's whale) and sea turtles which have previously undergone section 7 consultations Anticipated impacts from Navy activities include harassment due to changes in foraging, resting, milling, and other behavioral states that require lower energy expenditures; to traveling, avoidance, and behavioral states that require higher energy expenditures. Sound produced during Navy training and testing activities can also result in instances of TTS and PTS to the Rice's whale and sea turtles. NMFS calculated a total ITS for Rice's whale at 28 takes in the form of harassment from TTS and 24 for behavioral harassment for a total of 52 takes, which then indicated 1.58 takes per animal based on an abundance estimate of 33 animals for the U.S. Navy's AFTT activities. The Navy implements monitoring and mitigation measures to reduce the potential effects of underwater sound from military training and testing activities on ESA-listed resources in the Gulf of Mexico action area. Conservation measures include employing visual observers and implementing mitigation zones when training and testing using active sonar or explosives (NMFS 2018b).

The action area for these activities encompassed the coastal waters at the U.S. Naval Surface Warfare Center, Panama City, Florida, including waters within and adjacent to the Pensacola and Panama City Operating Areas, warning areas W-155, W-151- and W-470 (Figure 15).

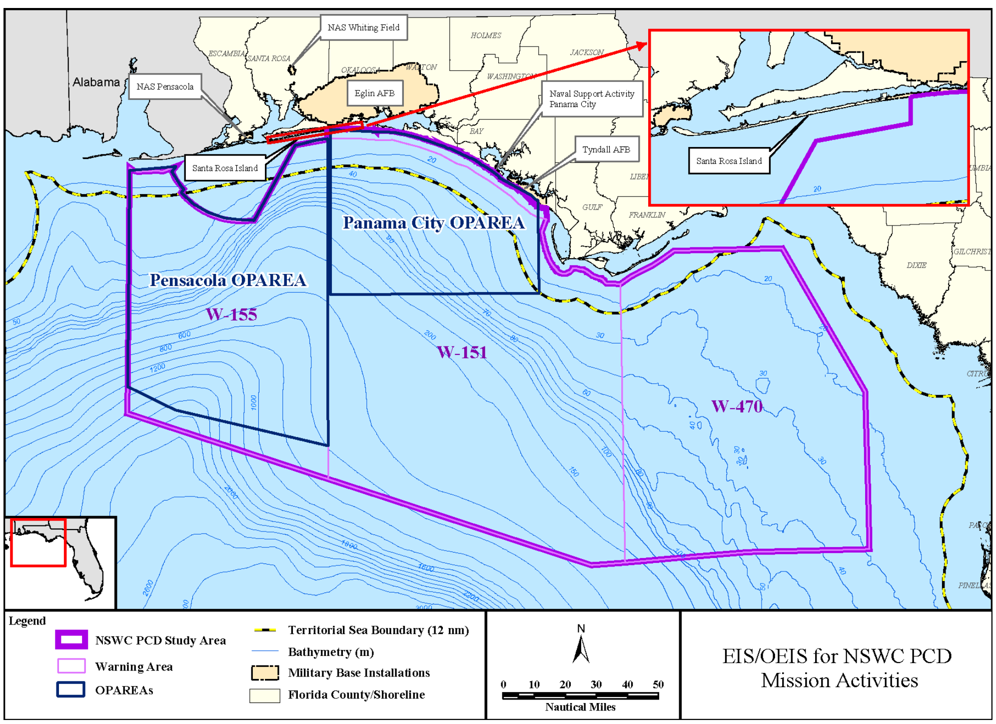

Figure 15. U.S. Navy Research, Development, Test, and Evaluation (RDT&E) Area; Panama City, FL.

In particular, U.S. Navy Research, Development, Test, and Evaluation (RDT&E) activities at the U.S. Navy's NSWC PCD action area primarily consisted of eight operations between 2012 and 2014: (1) air operations, (2) surface operations, (3) subsurface operations, (4) sonar operations, (5) electromagnetic operations, (6) laser operations, (7) ordnance operations, and (8) projectile firing.

NMFS concluded that exposure to these RDT&E activities could disrupt one or more behavioral patterns that are essential to an individual animal's life history or to the animal's contribution to a population. However, because of the short duration and low repetition rate of any changes in behavior, NMFS expected those individuals to be able to compensate for those behavioral changes (as they do when in response to other short-term changes in their behavior), thereby not likely to jeopardize the continued existence of ESA-listed species in the action area.

9.3 Fisheries

Commercial and recreational fisheries managed by NMFS under the Magnuson-Stevens Act in the Gulf of Mexico have interacted with sea turtles, and Rice's whale throughout the past. While interactions between federal fisheries and Rice's whale are rare, threatened and endangered sea turtles are more susceptible to interactions with several types of fishing gear in the action area including gillnet, hook-and-line (i.e., vertical line), and trawl gear. For all fisheries for which there is a fishery management plan (FMP) or for which any federal action is taken to manage that fishery, the impacts have been evaluated via section 7 consultation. Past consultations have addressed the effects of federally permitted fisheries on ESA-listed species, sought to minimize the adverse impacts of the action on ESA-listed species, and, when appropriate, have authorized the incidental taking of these species. Formal section 7 consultations have been conducted on the following federal fisheries that operate in the action area: Coastal Migratory Pelagics, Highly Migratory Species (HMS) Atlantic Shark and Smoothhound, Gulf of Mexico Reef Fish, and Southeastern Shrimp Trawl Fisheries. A summary of each consultation is provided below, but more detailed information can be found in the respective biological opinions (NMFS 2011b; NMFS 2011c; NMFS 2012; NMFS 2015).

Fisheries can have a profound influence on fish populations. In a study of retrospective data, Jackson et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Marine mammals are known to feed on several species of fish that are harvested by humans (Waring et al., 2008). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations of marine mammals and sea turtles.

Marine mammals are also known to ingest fishing gear, likely mistaking it for prey, which can lead to fitness consequences and mortality. Necropsies of stranded whales have found that ingestion of net pieces, ropes, and other fishing debris has resulted in gastric impaction and ultimately death (Jacobsen et al., 2010). As with vessel strikes, entanglement or entrapment in fishing gear likely has the greatest impact on populations of ESA-listed species with the lowest abundance (e.g., Kraus et al., 2016). Nevertheless, all species of marine mammals may face threats from derelict fishing gear.

9.3.1 Rice's Whale Fisheries Interactions

Rice's whale habitat spatially overlaps with several state and federal fisheries that may pose a threat to marine mammals (Figure 16). The gillnet and Florida West Coast sardine purse seine fisheries are less likely to overlap; and the large pelagics longline, snapper-grouper and other reef fish bottom longline/hook-and-line, shark bottom longline/hook-and-line, pelagic hook-and-line/harpoon, shrimp trawl and butterfish trawl fisheries may overlap. Direct interactions with gillnets, purse-seines, shrimp trawls, and trap pots may be unlikely, but indirect interactions, such as entanglement in derelict "ghost fishing" gear may be of concern for Rice's whales. Indirect effects such as ecosystem wide trophic impacts may also be of concern (Rosel 2016).

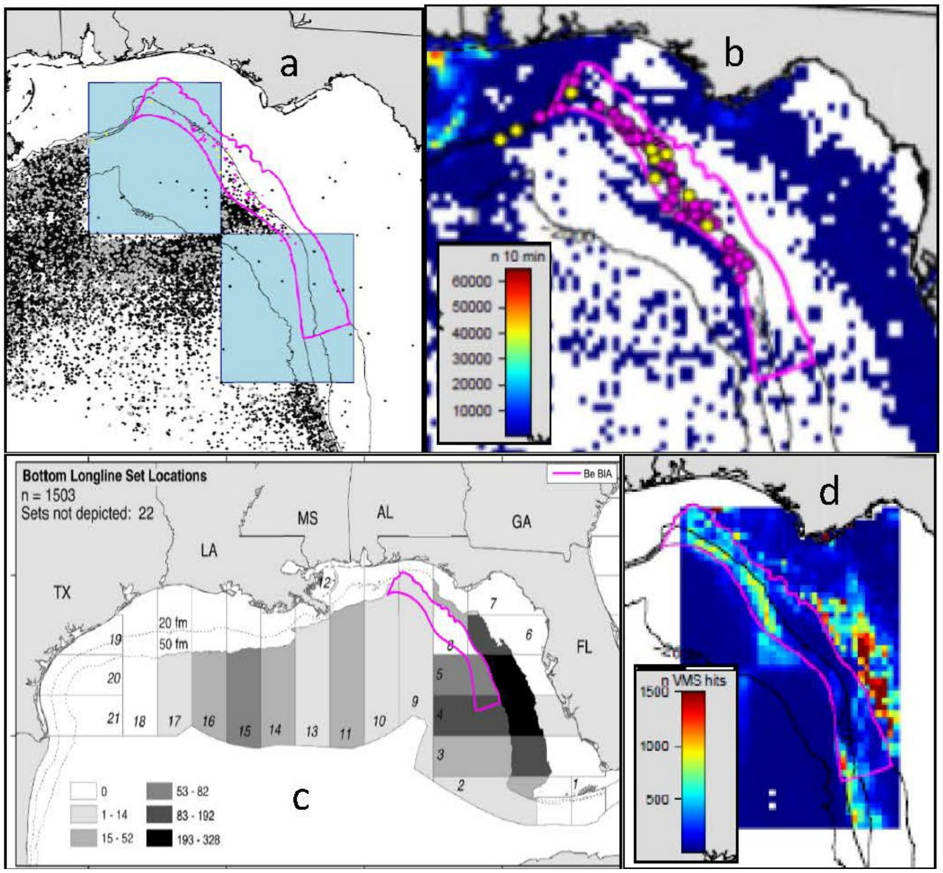

Figure 16. a.) Pelagic longline set locations - blue boxes represent the De Soto Canyon MPA, which is closed to pelagic longline fishing year-round and covers approximately 2/3 of the Rice's whale (RW) habitat. b.) Shrimp trawl active fishing effort near the RW habitat from 2002-2014. c.) Bottom longline sets from 2006-2009. d.) Vessel Monitoring System ping locations from vessels carrying reef fish permit and shark directed permit, and may represent both transiting and active fishing. Figures from Rosel et al. (2016b).

9.3.2 Sea Turtle Fisheries Interactions

Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack thereof. Wallace et al. (2010) estimated that worldwide 447,000 sea turtles are killed each year from bycatch in commercial fisheries. Although sea turtle excluder devices and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in U.S. waters, mortality still occurs. Sea turtles in the region are also caught to a lesser extent on longlines that target groupers and snappers, typically in water depths of 12 to 40 m (39.4 to 131.2 ft) where there is rocky habitat (Cuevas et al., 2008).

For all fisheries for which there is a fishery management plan (FMP) or for which any federal action is taken to manage that fishery, the impacts have been evaluated via section 7 consultation. Past consultations have addressed the effects of federally permitted fisheries on ESA-listed species, sought to minimize the adverse impacts of the action on ESA-listed species, and, when appropriate, have authorized the incidental taking of these species. Formal section 7 consultations have been conducted on the following federal fisheries that operate in the action area: Coastal Migratory Pelagics (CMP), Highly Migratory Species (HMS) Atlantic Shark and Smoothhound, Gulf of Mexico Reef Fish, and Southeastern Shrimp Trawl Fisheries.

9.3.3 Coastal Migratory Pelagics Fishery

A June 18, 2015 Opinion, as amended via a November 18, 2017 memorandum and attachment, comprises the most recent completed Section 7 consultation on the operation of the CMP fishery in the Gulf of Mexico and South Atlantic. (NMFS 2015). In the Gulf of Mexico, hook-and-line, gillnet, and cast net gears are used commercially, while the recreational sector uses hook-and-line gear. The hook-and-line effort is primarily trolling. The 2015 Opinion, as amended, concluded that the proposed action is likely to adversely affect but is not likely to jeopardize the continued existence of all of the listed sea turtle species in the Gulf of Mexico (i.e., green North Atlantic and South Atlantic DPS, hawksbill, Kemp's ridley, leatherback, and loggerhead NWA DPS).

Sea turtle captures and mortalities during 3-year management periods of the federal CMP fisheries were estimated to be 31 captures with 9 mortalities for green sea turtles, 27 captures with 7 mortalities for loggerhead sea turtles, 8 captures with 2 mortalities for Kemp’s ridley sea turtles, and one lethal capture for both hawksbill and leatherback sea turtles. (NMFS 2015)

9.3.4 Highly Migratory Species Atlantic Shark and Smoothhound Fisheries

These fisheries include commercial shark bottom longline and gillnet fisheries and recreational shark fisheries under the Fishery Management Plan (FMP) for Atlantic Tunas, Swordfish, and Sharks (HMS FMP). NMFS has formally consulted several times on the effects of HMS shark fisheries on sea turtles (NMFS 2003; NMFS 2008; NMFS 2012a). NMFS has also authorized a federal smoothhound fishery that will be managed as part of the HMS shark fisheries. NMFS (2012b) analyzed the potential adverse effects from the smoothhound fishery on sea turtles for the first time. Both bottom longline and gillnet are known to adversely affect sea turtles. From 2007-2011, the sandbar shark research fishery had 100 percent observer coverage, with 4-6 percent observer coverage in the remaining shark fisheries. During that period, ten sea turtle takes (all loggerheads) were observed on bottom longline gear in the sandbar shark research fishery and five were taken outside the research fishery. The five non-research fishery takes were extrapolated to the entire fishery, providing an estimate of 45.6 sea turtle takes (all loggerheads) for non-sandbar shark research fishery from 2007-2010 (Carlson and Gulak 2012; Carlson et al. 2016). No sea turtle takes were observed in the non-research fishery in 2011 (NMFS 2012a). Since the research fishery has a 100 percent observer coverage requirement, those observed takes were not extrapolated (Carlson and Gulak 2012; Carlson et al. 2016). Because few smoothhound trips were observed, no sea turtle captures were documented in the smoothhound fishery.

The most recent ESA section 7 consultation was completed on December 12, 2012, on the continued operation of Atlantic shark and smoothhound fisheries and Amendments 3 and 4 to the Consolidated HMS FMP (NMFS 2012b). The consultation concluded the proposed action was not likely to jeopardize the continued existence of sea turtles. An ITS was provided authorizing 18 takes (nine of which could be lethal) of each species for hawksbill and leatherback sea turtles every three years. Loggerhead, green and Kemp's ridley turtle takes were 126, 57, and 36, respectively.

9.3.5 Gulf of Mexico Reef Fish Fishery

The Gulf of Mexico reef fish fishery uses two basic types of gear: spear or powerhead, and hook-and-line gear. Hook-and-line gear used in the fishery includes both commercial bottom longline and commercial and recreational vertical line (e.g., handline, bandit gear, rod-and-reel).

Prior to 2008, the reef fish fishery was believed to have relatively moderate levels of sea turtle bycatch attributed to the hook-and-line component of the fishery (i.e., approximately 107 captures and 41 mortalities annually, all species combined, for the entire fishery; NMFS 2005a). In 2008, SEFSC observer programs and subsequent analyses indicated that the overall amount and extent of incidental take for sea turtles specified in the ITS of the 2005 opinion on the reef fish fishery had been severely exceeded by the bottom longline component of the fishery: approximately 974 captures and at least 325 mortalities estimated for the period July 2006-2007.

In response, NMFS published an Emergency Rule prohibiting the use of bottom longline gear in the reef fish fishery shoreward of a line approximating the 50-fathom depth contour in the eastern Gulf of Mexico, essentially closing the bottom longline sector of the reef fish fishery in the eastern Gulf of Mexico for six months pending the implementation of a long-term management strategy. The Gulf of Mexico Fishery Management Council (GMFMC) developed a long-term management strategy via a new amendment (Amendment 31 to the Reef Fish FMP). The amendment included: (1) a prohibition on the use of bottom longline gear in the Gulf of Mexico reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida, from June through August and ; (2) a reduction in the number of bottom longline vessels operating in the fishery via an endorsement program and a restriction on the total number of hooks that may be possessed onboard each Gulf of Mexico reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing.

On October 13, 2009, SERO completed an opinion that analyzed the expected effects of the continued operation of the Gulf of Mexico reef fish fishery under the changes proposed in Amendment 31 (NMFS-SEFSC 2009b). The opinion concluded that sea turtle takes would be substantially reduced compared to the fishery as it was previously prosecuted, and that operation of the fishery would not jeopardize the continued existence of any sea turtle species. Amendment 31 was implemented on May 26, 2010. In August 2011, consultation was reinitiated to address the DWH oil release event and potential changes to the environmental baseline. Reinitiation of consultation was not related to any material change in the fishery itself, violations of any terms and conditions of the 2009 opinion, or an exceedance of the ITS. The resulting September 30, 2011, opinion concluded the continued operation of the Gulf of Mexico reef fish fishery is not likely to jeopardize the continued existence of any listed sea turtles (NMFS 2011b).

9.3.6 Southeastern Shrimp Trawl Fisheries

NMFS has prepared opinions on the Gulf of Mexico shrimp trawling numerous times over the years (most recently 2014). The consultation history is closely tied to the lengthy regulatory history governing the use of TEDs and a series of regulations aimed at reducing potential for incidental mortality of ESA-listed sea turtles in commercial shrimp trawl fisheries. The level of annual mortality described by the National Research Council (NRC 1990) is believed to have continued until 1992-1994, when U.S. law required all shrimp trawlers in the Atlantic and Gulf of Mexico to use TEDs, allowing at least some sea turtles to escape nets before drowning ((NMFS 2002)). TEDs were mandatory on all shrimping vessels. However, certain shrimpers (e.g., fishers using skimmer trawls or targeting bait shrimp) could operate without TEDs if they agreed to follow specific tow-time restrictions.

Despite the apparent success of TEDs for some species of sea turtles (e.g., Kemp's ridleys), it was later discovered that TEDs were not adequately protecting all species and size classes of sea turtles. Analyses by Epperly and Teas (2002) indicated that the minimum requirements for the escape opening dimension in TEDs in use at that time were too small for some sea turtles and that as many as 47% of the loggerheads stranding annually along the Atlantic and Gulf of Mexico were too large to fit the existing openings(Epperly et al. 2002). On December 2, 2002, NMFS completed a consultation on shrimp trawling in the southeastern United States ((NMFS 2002)) regarding proposed revisions to the TED regulations requiring larger escape openings (68 FR 8456 2003), February 21, 2003). This Opinion determined that the shrimp trawl fishery under the revised TED regulations would not jeopardize the continued existence of green, hawksbill, loggerhead, Kemp's ridley, or leatherback sea turtles. The determination was based in part on the Opinion's analysis that shows the revised TED regulations were expected to reduce shrimp trawl related mortality by 94% for loggerheads and 97% for leatherbacks. In February 2003, NMFS implemented the revisions to the TED regulations. Although mitigation measures have greatly reduced the impact on sea turtle populations, the shrimp trawl fishery is still responsible for large numbers of turtle mortalities each year. The Gulf of Mexico fleet accounts for a large percentage of the sea turtle bycatch in this fishery. In 2010, the Gulf of Mexico shrimp trawl fishery had an estimated bycatch mortality of 5,166 turtles (18 leatherback, 778 loggerhead, 486 green and 3,884 Kemp's ridley). By comparison, the southeast Atlantic fishery had an estimated bycatch mortality of 1,033 turtles (8 leatherback, 673 loggerhead, 28 green and 324 Kemp's ridley) in 2010 ((NMFS 2004a)).

On May 9, 2012, NMFS completed a Biological Opinion that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act (NMFS 2012e). The Opinion also considered a proposed amendment to the sea turtle conservation regulations to withdraw the alternative tow-time restriction at 50 CFR 223.206(d)(2)(ii)(A)(3) for skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) and instead require all of those vessels to use TEDs. The Opinion concluded that the proposed action was not likely to jeopardize the continued existence of any ESA-listed sea turtle species. An ITS was provided that used anticipated trawl effort and fleet TED compliance (i.e., compliance resulting in overall average sea turtle catch rates in the shrimp otter trawl fleet at or below 12%) as surrogates for sea turtle takes. On November 21, 2012, NMFS determined that a Final Rule requiring TEDs in skimmer trawls, pusher-head trawls, and wing nets was not warranted and withdrew the proposal. The decision to not implement the Final Rule created a change to the proposed action analyzed in the 2012 Opinion and triggered the need to reinitiate consultation. Consequently, NMFS reinitiated consultation on November 26, 2012. Consultation was completed in April 2014; it determined the continued implementation of the sea turtle conservation regulations and the operation of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act was not likely jeopardize the continued existence of any ESA-listed sea turtle species. The ITS maintained the use of anticipated trawl effort and fleet TED compliance as surrogates for numerical sea turtle takes.

In 2016, ESA Section 7 consultation was reinitiated for this fishery to address new/updated listings for green sea turtles (listing 8 new green sea turtle DPSs as threatened and 3 new green sea turtle DPSs as endangered; the North Atlantic and South Atlantic DPS' were the only two affected by this fishery) and Nassau grouper. Subsequently, on December 20, 2019, NMFS published a final rule requiring all skimmer trawl vessels 40 ft (12 m) and greater in length to use TEDs with 3-inch bar spacing or less, beginning on April 1, 2021 (84 FR 70048; correction at 85 FR 59198, September 21, 2020). A challenge to that rule resulted in a remand of the 2014 biological opinion without vacatur of the rule. A new consultation on the shrimp fishery including the new TED requirement is currently underway.

9.3.7 State Fisheries

Several coastal state fisheries are known to incidentally take ESA-listed sea turtles, but information on these fisheries is sparse (NMFS 2001). Various fishing methods used in these commercial and recreational fisheries, including trawling, pot fisheries, gillnets, and vertical line are known to incidentally take sea turtles ((NMFS 2001). The past and current effects of state fisheries on listed species are currently unknown, as most state data are based on extremely low observer coverage or sea turtles were not part of data collection.

In addition to commercial state fisheries, ESA-listed sea turtles can also be incidentally captured by hook and line recreational fishers. Observations of state recreational fisheries have shown that loggerhead, leatherback, Kemp's ridley, and green sea turtles are known to bite baited hooks. Further, observations show that loggerheads and Kemp's ridleys frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, beaches, banks, and jetties. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead sea turtles can be found in the TEWG reports ((TEWG 1998a; TEWG 2000b)).

9.4 Coastal Environment

Several estuarine and riverine areas are located on or adjacent to Eglin AFB, including Choctawhatchee Bay, Santa Rosa Sound, Yellow River, East Bay, and East Bay River. Emergent vegetation coverage in Choctawhatchee Bay is estimated at about 2,500 acres of (presumably) salt marsh and 3,700 acres of fresh marsh habitat (FDEP 2012). Eglin AFB includes property on Santa Rosa Island (SRI) and Cape San Blas (CSB). Eglin AFB controls 4,760 acres of SRI that includes a four-mile strip of limited-access beach eastward of Fort Walton Beach, and a restricted access 13-mile section extending to the west to Navarre Beach. Eglin AFB owns approximately 962 acres on CSB, which is located on St. Joseph Peninsula in Gulf County, Florida, approximately 90 miles southeast of the Eglin Reservation. A number of rare and protected species and habitats occur on both SRI and CSB, such as nesting sea turtles, shorebirds, and piping plover critical habitat.

There are no Coastal Barrier Resources concerns for Eglin AFB, and the Coastal America program is not applicable. For marine animal protection, Eglin AFB conducts MMPA and ESA consultations with the NMFS and USFWS and follows all applicable requirements from those consultations. Eglin NRS participates in Florida's sea turtle and marine mammal stranding and salvage network program. Artificial reefs are distributed across portions of the EGTTR; these are avoided as much as possible during Gulf missions.

Sea turtles are also affected by non-fishery impacts in marine and terrestrial environments. Construction and maintenance of federal navigation channels in nearshore U.S. waters can result in turtle mortality due to entrainment in dredges. Turtles may also be entrained in the cooling systems of electrical plants. Other nearshore threats include vessel operations, military exercises (including detonations), oil and gas activities, and scientific research activities. Coastal development may affect sea turtles through habitat alteration and nesting interference. The placement of buildings, pilings, and beach armoring materials, as well as sand removal or beach nourishment, may remove nesting beach habitat, change thermal profiles, and increase erosion (Ackerman 1997b; Bouchard et al. 1998; Lutcavage et al. 1997; Witherington et al. 2012; Witherington 1994). Artificial lighting associated with coastal development may also interfere with nesting behavior of adults (Witherington 1992) and may result in hatchling disorientation (Witherington and Bjorndal 1991). Additional terrestrial threats include predation by land animals, direct harvest of egg and adult which occurs mostly in foreign countries (NMFS and

USFWS 2010), and the introduction of pollutants such as pesticides, hydrocarbons, and organochlorides into marine waters (Grant and Ross 2002a; Hartwell 2004).

9.5 Oil and Gas

Oil and gas operations on the Outer Continental Shelf that have been ongoing for more than 50 years involve a variety of activities that may adversely affect ESA-listed species in the action area. These activities and resulting impacts include vessels making supply deliveries, drilling operations, seismic surveys, fluid spills, oil spills and response, and oil platform removals.

9.5.1 Lease Sales and Drilling

The sale of Outer Continental Shelf leases in the Gulf of Mexico and the resulting exploration and development of these leases for oil and natural gas resources has affected the status of ESA-listed species in the action area. BOEM administers the Outer Continental Shelf leases and authorizes the exploration and development of wells in Gulf leases. As technology has advanced over the past several decades, oil exploration and development has moved and will continue to move further offshore into deeper waters of the Gulf (Murawski et al. 2020). The development of wells often involves additional activities such as the installation of platforms, pipelines, and other infrastructure. Once operational, a platform will generate a variety of wastes including a variety of effluents and emissions. Each of these wastes can contribute to the baseline. Additionally, although the release of oil is prohibited, accidental oil spills can occur from loss of well control and thus adversely affect sea turtles, sperm whales, and Gulf sturgeon in the Gulf of Mexico. Previous biological opinions considered the effects resulting from the variety of actions associated with lease sales and development. These opinions determined that oil and gas leasing may adversely affect protected sea turtles, sperm whales, and Gulf sturgeon, but was found not likely to jeopardize their continued existences. However, that opinion did not contemplate the effects of a disastrous blowout and resulting extremely large oil spill event. The DWH incident resulted in exceedance of take limits in the ITS of the 2007 opinion, and alteration of the environmental baseline.

9.6 Vessel Interactions

Within the action area, vessel interactions pose a threat to ESA-listed Rice's whales and sea turtles. Vessel interactions can come in the form of vessel strike and whale watching and tourism.

9.6.1 Vessel Strike

Vessels have the potential to affect animals through strikes, sound, and disturbance associated with their physical presence. Responses to vessel interactions include interruption of vital behaviors and social groups, separation of mothers and young, and abandonment of resting areas (Boren et al. 2001; Constantine 2001; Mann et al. 2000; Nowacek 2001; Samuels et al. 2000).

Vessel strikes are considered a serious and widespread threat to ESA-listed marine mammals (especially large whales) and sea turtles and are the most well-documented "marine road" interaction with large whales (Pirotta et al. 2019). This threat is increasing as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle et al. 1993; Wiley et al. 1995).

As vessels become faster and more widespread, an increase in vessel interactions with cetaceans is to be expected. All sizes and types of vessels can hit whales, but most lethal and severe injuries are caused by vessels 80 m (262.5 ft) or longer (Laist et al. 2001). For whales, studies show that the probability of fatal injuries from vessel strikes increases as vessels operate at speeds above14 knots (26 km per hour) () (Laist et al. 2001). Evidence suggests that not all whales killed as a result of vessel strike are detected, particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass et al. 2010). The vast majority of commercial vessel strike mortalities of cetaceans are likely undetected and unreported, as most are likely never reported. Most animals killed by vessel strike likely end up sinking rather than washing up on shore (Cassoff 2011). Kraus et al. (2005) estimated that 17 percent of vessel strikes are actually detected. Therefore, it is likely that the number of documented cetacean mortalities related to vessel strikes is much lower than the actual number of moralities associated with vessel strikes, especially for less buoyant species such as blue, humpback, and fin whales (Rockwood et al. 2017). Rockwood et al. (2017) modeled vessel strike mortalities of blue, humpback, and fin whales off California using carcass recovery rates of five and 17 percent and conservatively estimated that vessel strike mortality may be as high as 7.8, 2.0, and 2.7 times the recommended limit for blue, humpback, and fin whale stocks in this area, respectively.

Several important commercial shipping lanes travel through primary Rice's whale habitat in the northeastern Gulf of Mexico, while in the north-central and western Gulf of Mexico the sheer number of support and supply vessels for the energy industry creates a high likelihood of interactions with any large whales. Furthermore, there is one documented case of a Rice's whale ship strike mortality in the Gulf of Mexico when a commercial vessel brought a dead lactating female Rice's whale into the Tampa Bay harbor on its bow in 2009. Blunt impact trauma, shredded muscle, blood clots and vertebral separations noted during necropsy confirmed ship strike as the likely cause of death. In the fall of 2015, an Acousonde acoustic and kinematic data-logging, suction-cup tag was placed on a Rice's whale by the NMFS SEFSC and it revealed that, while the whale spent ~50% of daytime hours deeper than 15 m, at night the whale spent nearly 90% of its time at the surface or within 15 m of the surface (NMFS, unpublished data). Given the location of commercial shipping lanes in the Gulf of Mexico, the difficulty of sighting a whale at the surface at night, and the low ability of large ships to change course quickly enough to avoid a whale, ship strikes may pose a significant threat to this population, particularly given their very small population size (Rosel et al. 2016a).

Potential sources of adverse effects from federal vessel operations in the action area include operations of the U.S. DoD, BOEM/BSEE, Federal Energy Regulatory Commission (FERC), USCG, NOAA, and USACE. The Gulf of Mexico is known for a high level of commercial shipping activity and many large ports, especially those with transiting bulk carriers (Wiggins et al. 2016). Vessels are the greatest contributors to increases in low-frequency ambient sound in the sea (Andrew et al. 2011). It is predicted that ambient ocean sound will continue to increase at a rate of ½ dB per year (Ross 2005). Sound levels and tones produced are generally related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels, and vessels underway with a full load, or those pushing or towing a load, are noisier than unladen vessels.

9.6.2 Vessel Impacts to Sea Turtles in the EGGTR

Most live missions in the EGTTR involve the use of boats for various support functions, including monitoring for protected species before and after the mission, monitoring the established safety zone during the mission, serving as targets, towing targets, participating in swarm exercises, and participating in post-mission cleanup activities. The perimeter of a typical human safety zone established for a live mission may be monitored by more than 25 support boats to ensure it is free of any non-participating vessels before and during the mission. Mission-support boats may be stationary or one moving at various speeds at any given time.

Boat activity and noise have the potential to physically disturb sea turtles that occur in the mission area. Disturbance from boats may interrupt important biological functions such as feeding and cause sea turtles to expend energy to dive or swim away from the disturbance. The extent to which boats may disturb sea turtles would depend on several factors such as the distance between the boat and sea turtle, the position of the sea turtle in the water column, and the speed, direction, and other factors related to the movement of the boat. In addition to disturbance, there is also potential for mission-support boats to strike sea turtles that are at or just below the water surface. A boat strike could potentially result in severe impacts ranging from injury to death. The potential for boat strikes may be greatest during swarm exercises, which typically involve 25 to 30 manned boats operating in a small area at relatively high speeds, up to 30 knots (55.6 km per hour). The number of swarm exercises that would be conducted on an annual basis under the Proposed Action would vary but is expected to be generally comparable to past activity. One to three swarm exercises per year have been typically conducted in the past, with each exercise lasting up to 4 days, with 3 to 4 hours of boat operation per day (USAF 2015a).

Disturbance of sea turtles from boat activity and noise can be expected to occur during certain missions, however, any impacts would be temporary and the associated energy expended by the sea turtle to dive or swim away from the disturbance is expected to be within the normal range experienced by sea turtles.

Vessel strikes are a poorly-studied threat to sea turtles, but have the potential to be highly significant given that they can result in serious injury and mortality (Work et al. 2010). All sea turtles must surface to breathe and several species are known to bask at the sea surface for long periods. However, sea turtles in general spend the majority of their time submerged where they cannot be struck by boats; Renaud and Carpenter (1994) estimated that loggerhead sea turtles in the Gulf of Mexico spend approximately 90 percent of their time underwater. Although sea turtles can move somewhat rapidly, they apparently are not adept at avoiding vessels that are moving at more than 2.6 knots (4 km per hour); most vessels move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). Both live and dead sea turtles are often found with deep cuts and fractures indicative of a collision with a vessel hull or propeller (Hazel et al. 2007). Hazel et al. (2007) suggests that green turtles may use auditory clues to react to approaching vessels rather than visual cues, making them more susceptible to vessel strike or vessel speed increases.

9.7 Pollution

Within the action area, pollution poses a threat to ESA-listed marine mammals and sea turtles. Pollution can come in the form of marine debris, pesticides, contaminants, and hydrocarbons.

9.7.1 Marine Debris

Marine debris is an ecological threat that is introduced into the marine environment through ocean dumping, littering, or hydrologic transport of these materials from land-based sources (Gallo et al. 2018). Even natural phenomena, such as tsunamis and continental flooding, can cause large amounts of debris to enter the ocean environment (Watters et al. 2010). Marine debris has been discovered to be accumulating in gyres throughout the oceans. Marine mammals often become entangled in marine debris, including fishing gear (Baird et al. 2015). Despite debris removal and outreach to heighten public awareness, marine debris in the environment has not been reduced (NRC 2008) and continues to accumulate in the ocean and along shorelines within the action area.

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it (Gall and Thompson 2015). Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species including marine mammals and sea turtles. The ingestion of marine debris has been documented to result in blockage or obstruction of the digestive tract, mouth, and stomach lining of various species and can lead to serious internal injury or mortality (Derraik 2002). In addition to interference with alimentary processes, plastics lodged in the alimentary tract could facilitate the transfer of pollutants into the bodies of whales and dolphins (Derraik 2002). Law et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 through 2008. More than 60 percent of 6,136 surface plankton net tows collected small, buoyant plastic pieces. Data on marine debris in some locations of the action area is largely lacking; therefore, it is difficult to draw conclusions as to the extent of the problem and its impacts on populations of ESA-listed species in the Atlantic Ocean, but we assume similar effects from marine debris documented within other ocean basins could also occur to species from marine debris.

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as polychlorinated biphenyl and dichlorodiphenyltrichloroethane. Marine mammals and sea turtles can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. It is expected that marine mammals and sea turtles may be exposed to marine debris over the course of the action although the risk of ingestion or entanglement and the resulting impacts are uncertain at the time of this consultation.

Marine Mammal Impacts

Cetaceans are also impacted by marine debris, which includes: plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear (Baulch and Perry 2014a; Li et al. 2016). Over half of cetacean species (including sperm whales) are known to ingest marine debris (mostly plastic), with up to 31 percent of individuals in some populations containing marine debris in their guts and being the cause of death for up to 22 percent of individuals found stranded on shorelines (Baulch and Perry 2014b).

In 2019 a Rice's whale that stranded in the Everglades (FMMSN1908, USNM 594665) was found to have a sharp piece of intragastric plastic approximately 6.6 l × 6.2 w × 0.2 d cm in dimension. The plastic caused hemorrhaging and acute gastric necrosis in the second stomach chamber. The whale was thin and because the necropsy identified no other infections or pathologies that could be attributed to the animal's death, it was concluded that the ingestion of the plastic led to the stranding and subsequent mortality of this whale.

Given the limited knowledge about the impacts of marine debris on marine mammals, it is difficult to determine the extent of the threats that marine debris poses to marine mammals. However, marine debris is consistently present and has been found in marine mammals in and near the action area.

Sea Turtles Impacts

Ingestion of marine debris can be a serious threat to sea turtles. Floating material have been shown to concentrate in ocean gyres and convergence zones where *Sargassum* and consequently juvenile sea turtles are known to occur (Carr 1987). When feeding, sea turtles (e.g., leatherback turtles) can mistake debris (e.g., tar and plastic) for natural food items, especially jellyfish, which are a primary prey. Some types of marine debris may be directly or indirectly toxic, such as oil. One study found plastic in 37 percent of dead leatherback turtles and determined that nine percent of those deaths were direct result of plastic ingestion (Mrosovsky et al. 2009). Plastic ingestion is very common in leatherback turtles and can block gastrointestinal tracts leading to death (Mrosovsky et al. 2009). Other types of marine debris, such as discarded or derelict fishing gear and cargo nets, may entangle and drown sea turtles of all life stages.

In a study on marine debris ingestion in 115 green and hawksbill turtles stranded in Queensland, Schuyler et al. (2012) found that the probability of debris ingestion was inversely correlated with size (curved carapace length), and when broken down into size classes, smaller pelagic sea turtles were significantly more likely to ingest debris than larger benthic feeding sea turtles. Parker et al. (2005) conducted a diet analysis of 52 loggerhead turtles collected as bycatch from 1990 through 1992 in the high seas drift gillnet fishery in the central North Pacific Ocean. The authors found that 34.6 percent of the individuals sampled had anthropogenic debris in their stomachs (e.g., plastic, Styrofoam, paper, rubber, etc.). Similarly, a study of green turtles found that 61 percent of those observed stranded that ingested some form of marine debris, including rope or string, which may have originated from fishing gear (Bugoni et al. 2001). In a study looking at oceanic-stage juvenile loggerhead turtles on a feeding ground near the Azores, 83 percent (20 loggerhead turtles) had ingested plastic marine debris (Pham et al. 2017). Green turtles in their oceanic life stage are also vulnerable to pollutants like tar balls because they tend to accumulate in *Sargassum* mats at convergence zones, where young green turtles associate (Seminoff 2015).

9.7.2 Pesticides and Contaminants

Exposure to pollution and contaminants have the potential to cause adverse health effects in marine species. Marine ecosystems receive pollutants from a variety of local, regional, and international sources, and their levels and sources are therefore difficult to identify and monitor (Grant and Ross 2002b). Marine pollutants come from multiple municipal, industrial, and household as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002b; Hartwell 2004; Iwata 1993). Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation (Garrett 2004; Grant and Ross 2002b; Hartwell 2004).

The accumulation of persistent organic pollutants, including polychlorinated-biphenyls, dibenzo-p-dioxins, dibenzofurans and related compounds, through trophic transfer may cause mortality and sub-lethal effects in long-lived higher trophic level animals (Waring et al. 2016a), including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn et al. 2007). Persistent organic pollutants may also facilitate disease emergence and lead to the creation of susceptible “reservoirs” for new pathogens in contaminated marine mammal populations (Ross 2002).

9.7.3 Pollutants - Marine Mammals

Numerous factors can affect concentrations of persistent pollutants in marine mammals, such as age, sex and birth order, diet, and habitat use (Mongillo et al. 2012). In marine mammals, pollutant contaminant load for males increases with age, whereas females pass on contaminants to offspring during pregnancy and lactation (Addison and Brodie 1987; Borrell et al. 1995). Pollutants can be transferred from mothers to juveniles at a time when their bodies are undergoing rapid development, putting juveniles at risk of immune and endocrine system dysfunction later in life (Krahn et al. 2009). Polychlorinated-biphenyls have been found in muscle tissue samples taken from stranded sperm whales in the North Atlantic Ocean (Megson et al. 2022). While exposure to pesticides and other contaminants is likely to continue and occur for marine mammals in the action area through the duration of the project, the level of risk and degree of impact is unknown.

9.7.4 Pollutants-Sea Turtles

In sea turtles, a variety of heavy metals (e.g., arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc) have been found in tissues in levels that increase with sea turtle size (Anan et al. 2001; Barbieri 2009; Fujihara et al. 2003; Garcia-Fernandez et al. 2009; Gardner et al. 2006; Godley et al. 1999; Saeki et al. 2000; Storelli et al. 2008). Cadmium has been found in leatherback turtles at the highest concentration compared to any other marine vertebrate (Caurant et al. 1999; Gordon et al. 1998). Newly emerged hatchlings have higher concentrations than are present when laid, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo et al. 1996).

Sea turtle tissues have been found to contain organochlorines and many other persistent organic pollutants. Polychlorinated biphenyl (better known as PCB, found in engine coolants) concentrations in sea turtles are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500-530 ng/g wet weight; Davenport 1990; Oros 2009). PCBs have been found in leatherback turtles at concentrations lower than expected to cause acute toxic effects, but might cause sub-lethal effects on hatchlings (Stewart 2011).

The contaminants (organochlorines) can cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007) and are known to depress immune function in loggerhead turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation. Exposure to sewage effluent may also result in green turtle eggs harboring antibiotic resistant strains of bacteria (Al-Bahry et al. 2009).

There are studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Aguirre et al. 1994; Corsolini et al. 2000). Mckenzie et al. McKenzie et al. (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in sea turtles tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles (Storelli et al. 2008). It is thought that dietary preferences were likely to be the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age.

Sakai et al (1995) found the presence of metal residues occurring in loggerhead turtle organs and eggs. Storelli et al. (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law et al. 1991). No information on detrimental threshold concentrations are available, and little is known about the consequences of exposure of organochlorine compounds to sea turtles. Research is needed on the short- and long-term health and fecundity effects of chlorobiphenyl, organochlorine, and heavy metal accumulation in sea turtles.

9.7.5 Hydrocarbons

Hydrocarbons that may pose a threat to ESA-listed marine mammals and sea turtles consist of natural seeps as well as oil spills. Hydrocarbons also have the potential to impact prey populations, and therefore may affect ESA-listed species indirectly by reducing food availability.

9.7.6 Natural Seeps

Natural seeps provide the largest petroleum input to the offshore Gulf of Mexico, about 95 percent of the total. Mitchell et al. (1999) estimated a range of 280,000 to 700,000 barrels per year (40,000 to 100,000 tonnes per year), with an average of 490,000 barrels (70,000 tonnes) for the northern Gulf of Mexico, excluding the Bay of Campeche. Using this estimate and assuming seep scales are proportional to surface area the NRC (2003b) estimated annual seepage for the entire Gulf of Mexico at about 980,000 barrels (140,000 tonnes) per year, or about three times the estimated amount of oil spilled by the 1989 *Exxon Valdez* event (about 270,000 barrels) (SteynSteyn 2010) or a quarter of the amount released by the *Deepwater Horizon* even (4.9 million barrels of oil) (Lubchenco and Sutley 2010). As seepage is a natural occurrence, the rate of approximately 980,000 barrels (140,000 tonnes) per year is expected to remain unchanged into the foreseeable future.

9.7.7 Oil Spills

Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from oil and gas activities in the Gulf of Mexico, as well as from the use of vessels. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Most instances of oil spill are generally small (less than 1,000 barrels), but larger spills occur as well. Large scale and numerous small scale (vessel) oil spills have occurred in the Gulf of Mexico.

A nationwide study examining vessel oil spills from 2002 through 2006 found that over 1.8 million gallons of oil were spilled from vessels in all U.S. waters (Dalton and Jin 2010). In this study, “vessel” included numerous types of vessels, including barges, tankers, tugboats, and recreational and commercial vessels, demonstrating that the threat of an oil spill can come from a variety of vessel types. Below we review the effects of oil spills on marine mammals and sea turtles more generally. Much of what is known comes from studies of large oil spills such as the *Deepwater Horizon* (DWH) oil spill since no information exists on the effects of small-scale oil spills within the action area.

Exposure to hydrocarbons released into the environment via oil spills and other discharges pose risks to marine species. Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Grant and Ross 2002b). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990).

On April 20, 2010, while working on an exploratory well approximately 80.5 km offshore of Louisiana, the semi-submersible drilling rig DWH experienced an explosion and fire. The rig subsequently sank and oil and natural gas began leaking into the Gulf of Mexico. Oil flowed for 86 days, until the well was capped on July 15, 2010. Millions of barrels of oil were released. Additionally, approximately 1.84 million gallons of chemical dispersant was applied both subsurface and on the surface to attempt to break down the oil. Berenshtein et al. (2020b) used in situ observations and oil spill transport modeling to examine the full extent of the DWH spill, beyond the satellite footprint, that was at toxic concentrations to marine organisms. Figure 17 below displays visible and toxic (brown); invisible and toxic (yellow), and non-toxic (blue) oil concentrations.

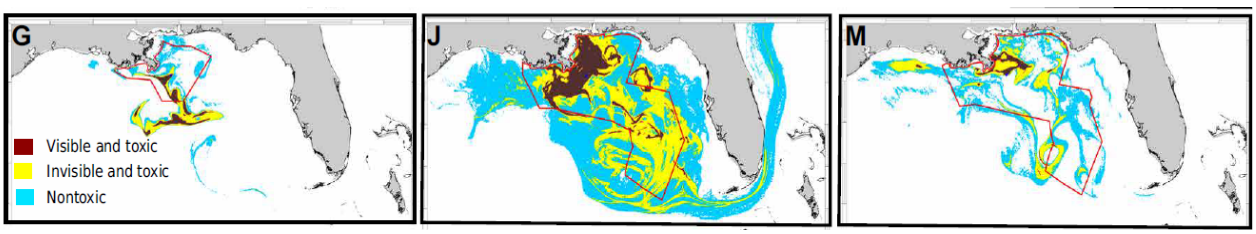

Figure 17. Spatiotemporal dynamics of cumulative oil spill concentrations in the Gulf of Mexico. Figure: G. May 15, 2010, J. June 18, 2010, M. July 2, 2010; from Berenshtein et al. (2020a).

The investigation conducted under the National Resource Damage Assessment regulations under the Oil Pollution Act (33 USC §2701 et seq.) assessed natural resource damages stemming from the DWH oil spill. The findings of this assessment provide details regarding impacts to the environmental baseline of listed species and critical habitats in the Gulf of Mexico and is summarized below and can be found at http://www.gulfspillrestoration.noaa.gov/restorationplanning/gulf-plan.

The unprecedented DWH spill and associated response activities (e.g., skimming, burning, and application of dispersants) resulted in adverse effects on listed sea turtles, sperm whales, Rice's whales, and Gulf sturgeon. Despite natural weathering processes over the years since the DWH, oil persists in some habitats where it continues to expose and impact resources in the northern Gulf of Mexico resulting in new baseline conditions (BOEM 2016). The true impacts to offshore megafauna populations and their habitats may never be fully quantified, though it was necessary to characterize these impacts for response, damage assessment and restoration activities ((Frasier 2020). While post-spill restoration has happened and continues, the effects of the restoration efforts and potential benefits raise uncertainty regarding overall effectiveness of restoration efforts (Wallace et al. 2019). It is unclear how these restoration efforts have changed the baseline relative to what it would be if those efforts had not happened.

The DWH oil spill in the Gulf of Mexico in 2010 led to the exposure of tens of thousands of marine mammals to oil, causing reproductive failure, adrenal disease, lung disease, and poor body condition. Sea turtles were also impacted, being mired and killed by oil at the water's surface. Exposure also occurred via ingestion, inhalation, and maternal transfer of oil compounds to embryos; these effects are more difficult to assess, but likely resulted in sub-lethal effects and injury (Deepwater Horizon Trustees 2016).

Cetaceans have a thickened epidermis that greatly reduces the likelihood of petroleum toxicity from skin contact with oils (Geraci 1990), but they may inhale these compounds at the water's surface and ingest them while feeding (Matkin and Saulitis 1997). For example, as a result of the DWH oil spill, sperm whales could have been exposed to toxic oil components through inhalation, aspiration, ingestion, and dermal exposure. There were 19 observations of 33 sperm whales swimming in *Deepwater Horizon* surface oil or that had oil on their bodies (Diaz 2015 as cited in Deepwater Horizon NRDA Trustees 2016). The effects of oil exposure likely included physical and toxicological damage to organ systems and tissues, reproductive failure, and death. Sperm whales may have experienced multiple routes of exposure at the same time, over intermittent timeframes and at varying rates, doses, and chemical compositions of oil. This estimation of effects to sperm whales is largely based on observed impacts to bottlenose dolphins resulting from exposure to oil from the DWH event. The oil spill from the DWH event occurred in deep water, which is sperm whale habitat. The same routes of internal oil exposure (ingestion, inhalation, and aspiration) would have occurred in sperm whales that have been shown to adversely affect bottlenose dolphins in coastal habitat.

Sperm whales were likely exposed to harmful toxins during the DWH event. Corexit 9500 and 9527 were both chemical dispersants used during the DWH response. These dispersant compounds were found to be cytotoxic (kills cells) and Corexit 9427 was found to genotoxic (damages DNA) to sperm whale skin cells (Wise et al. 2014). A three-year study focusing on DWH-relevant metals found sperm whale skin samples with genotoxic metals (aluminum, arsenic, chromium, nickel, and lead) at concentrations higher than global averages, and patterns for DWH-relevant metals decreased with time from the oil spill (Wise et al. 2018).

Rice's Whales

Similar to sperm whales, the Rice's whale population was adversely affected by the DWH spill and response. Nearly half of the population was impacted by DWH oil (Figure 18), resulting in an estimated 22 percent maximum decline in population size that will require 69 years to recover to the pre-spill population size (Trustees 2016). Small populations like the Rice's whales are highly susceptible to stochastic, or unpredictable, processes and genetic effects that can reduce productivity and resiliency to perturbations. The population models used by the Trustees (2016) did not account for these effects, and, therefore, the capability of the Rice's whale population to recover from this injury is unknown.

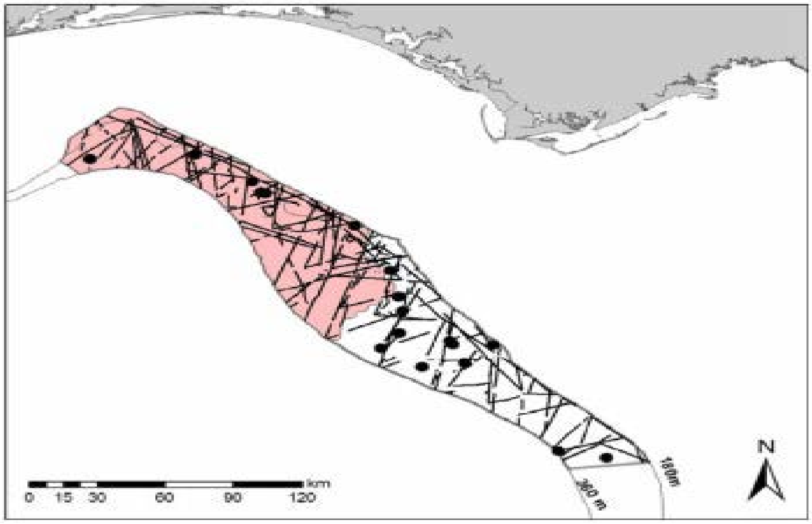

Figure 18. Line transects and sightings of Bryde's whales with the red area representing the overlap of DWH oil exposure and the area where Bryde's whales are typically found. Figure from MMIQT (2015).

Sea Turtles

The DWH oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of Mexico. *Sargassum* habitats, benthic foraging habitats, surface and water column waters, and sea turtle nesting beaches were all affected by DWH. Sea turtles were exposed to DWH oil in contaminated habitats; breathing oil droplets, oil vapors, and smoke; ingesting oil-contaminated water and prey; and by maternal transfer of oil compounds to developing embryos. Translocation of eggs from the Gulf of Mexico to the Atlantic coast of Florida resulted in the loss of sea turtle hatchlings. Other response activities, including vessel strikes and dredging also resulted in turtle deaths. Oil can also be hazardous to sea turtles, with fresh oil causing significant mortality and morphological changes in hatchlings, but aged oil having no detectable effects (Fritts and McGehee 1981).

Stacy et al. (2017) reported 319 live oiled sea turtles were rescued and showed disrupted metabolic and osmoregulatory functions, likely attributable to oil exposure, physical fouling and exhaustion, dehydration, capture and transport. Accounting for sea turtles that are unobservable during the response efforts, high numbers of small oceanic and large sea turtles are estimated to have been exposed to oil resulting from the DWH event due to the duration and large footprint of the oil spill. It was estimated that as many as 7,590 large juvenile and adult sea turtles (Kemp’s ridley, loggerhead, and unidentified hard-shelled sea turtles) and up to 158,900 small juvenile sea turtles (hawksbill, Kemp’s ridley, loggerhead, and hard-shelled sea turtles not identified to species) were killed by the DWH event. Small juveniles were affected in the greatest numbers and suffered a higher mortality rate than large sea turtles. Leatherback turtle foraging and migratory habitat was also affected and through impacts to leatherback turtles were unquantified, it is likely some died as a result of the DWH oil spill and spill response (Deepwater Horizon NRDA Trustees 2016; NMFS and USFWS 2013b).

Table 5. Estimated oceanic juvenile sea turtles exposed and killed by the *Deepwater Horizon* event.

Species	Total Exposed	Heavily Oiled/Dead	Non-Heavily Oiled/Dead	Total Dead
Green Turtle	148,000	15,300	39,800	55,100
Hawksbill Turtle	8,650	595	2,390	2,990
Kemp's Ridley Turtle	206,000	35,500	51,000	86,500
Loggerhead Turtle	29,800	2,070	8,310	10,400
Unidentified Turtle	9960	1,310	2,600	3,910
Total Sea Turtles	402,320	54,775	104,100	158,900

Source: (Trustees 2016; Wallace et al. 2015)

Table 6. Estimated large juvenile and adult sea turtles exposed and killed by the *Deepwater Horizon* event.

Species	Total Exposed	Heavily Oiled/Dead	Non-Heavily Oiled/Dead	Total Dead
Kemp's Ridley Turtle (Age 4+)	21,000	1,700	950	2,700
Kemp's Ridley Turtle (Age 3)	990	380	30	410
Kemp's Ridley Turtle (All)	22,000	2,100	980	3,100
Loggerhead Turtle	30,000	2,200	1,400	3,600
Unidentified Turtle	5,900	630	260	890

Total Sea Turtles	57,900	4,930	2,640	7,590

Source: (Trustees 2016; Wallace et al. 2015)

Subsequent to the Programmatic Damage Assessment and Restoration Plan release and as part of the DWH natural resource damage assessment, McDonald et al. (2017) estimated approximately 402,000 surface pelagic sea turtles were exposed with 54,800 likely heavily oiled. Additionally, approximately 30 percent of all oceanic sea turtle affected by the DWH event and not heavily oiled were estimated to have died from ingestion of oil (Mitchelmore et al. 2017).

The DWH event and associated response activities (e.g., nest relocation) saved animals that may have been lost to oiling, but resulted in some future fitness consequences for those individuals. Nests from green, Kemp's ridley, and loggerhead turtles were excavated prior to emergence and eggs were translocated from Florida and Alabama beaches in the northern Gulf of Mexico between June 6 and August 19, 2010 to a protected hatchery on the Atlantic Coast of Florida. More than 28,000 eggs from 274 nests were translocated and nearly 15,000 hatchling sea turtles emerged and were released into the Atlantic Ocean (Table 7).

Table 7. Summary of egg translocation and hatchling release during the response to the *Deepwater Horizon* event.

Species	Clutches	Number of Eggs	Hatchling Released
Green Turtle	4	580	455
Kemp's Ridley Turtle	5	483	125
Loggerhead Turtle	265	27,618	14,216
Total Sea Turtles	274	28,681	14,796

Hatchlings from nesting beaches in the Gulf of Mexico were released in the Atlantic Ocean and not the Gulf of Mexico. Therefore, the hatchlings imprinted on the area of their release beach. It is thought that sea turtles use this imprinting information to return to the location of nesting beaches as adults. It is unknown whether these sea turtles will return to the Gulf of Mexico to nest; therefore, the damage assessment determined that the 14,796 hatchlings will be lost to the Gulf of Mexico breeding populations as a result of the DWH event. It is estimated that nearly 35,000 hatchling sea turtles (green, Kemp's ridley, and loggerhead turtles) were injured by response activities, and thousands more Kemp's ridley and loggerhead turtle hatchlings were lost due to unrealized reproduction of adult sea turtles that were killed by the DWH event.

Green turtles made up 32.2 percent (154,000 animals) of all sea turtles exposed to oil from the DWH event with 57,300 juvenile mortalities out of the total exposed animals, which removed a large number of small juvenile green turtles from the population. A total of four nests (580 eggs) were relocated during response efforts. While green turtles regularly use the northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean Sea, and Atlantic Ocean. Nesting is relatively rare on the northern Gulf of Mexico beaches. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of Mexico were reduced as a result of the DWH event, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, and thus a population-level impact to green turtles, is not likely.

Kemp's ridley turtles accounted for 49 percent (239,000 animals) of all exposed sea turtles (478,900 animals) during the DWH event, and were the most impacted at a population level. The DWH damage assessment calculated the number of unrealized nests and hatchlings of Kemp's ridley turtles because all Kemp ridley's turtles nest in the Gulf of Mexico and belong to the same population (NMFS et al. 2011a). The total population abundance of Kemp's ridley turtles could be calculated based on numbers of hatchlings because all individuals are reasonably expected to inhabit the northern Gulf of Mexico throughout their lives. The loss of these reproductive-stage females will have contributed to some extent to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley turtle nests is between 1,300 and 2,000, which translates to approximately 65,000 and 95,000 unrealized hatchlings. However, this is a minimum estimate because of the overall potential effect of the DWH event because the sub-lethal effects of oil on sea turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years may have contributed substantially to additional nesting deficits observed following the DWH event. These sub-lethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season). The nature of the effect of the DWH event on reduced Kemp's ridley turtle nesting abundance and associated hatchling production after 2010 requires further evaluation.

Loggerhead turtles made up 12.7 percent (60,800 animals) of the total sea turtle exposures to oil from the DWH event. (478,900 animals) and a total of 14,300 loggerhead turtles died as a result of those exposures Unlike Kemp ridley's turtles, the majority of nesting for the Northwest Atlantic Ocean DPS of loggerhead turtles occurs on the Atlantic coast, and thus nesting was impacted to a lesser degree in this species. It is likely that impacts to the Northern Gulf of Mexico Recovery Unit of the Northwest Atlantic Ocean DPS of loggerhead turtles would be proportionally much greater than the impacts occurring to the other recovery units, and likely included impacts to mating and nesting adults. Although the long-term effects remain unknown, the impacts from the DWH event to the Northern Gulf of Mexico Recovery Unit may include some nesting declines in the future due to a large reduction of oceanic age classes. However, the overall impact on the population recovery of the entire Northwest Atlantic Ocean DPS of loggerhead turtles is likely small.

Available information indicates hawksbill and leatherback turtles were least affected by the oil spill. Hawksbill turtles made up 1.8 percent (8,850 animals) of all sea turtle exposures. Although leatherback turtles were documented in the area of the oil spill, the number of affected leatherback turtles was not estimated due to a lack of information for leatherback turtles compared to other species of sea turtles. Potential DWH-related impacts to leatherback turtles include direct oiling or contact with dispersants, inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred. Although adverse impacts likely occurred to hawksbill and leatherback turtles, the relative proportion of the populations of these species that are expected to have been exposed to and directly impacted by the DWH event is relatively low, and thus a population-level impact is not believed to have occurred due to the widespread distribution and nesting locations outside of the Gulf of Mexico for both of these species of sea turtles.

The unprecedented DWH oil spill and associated response activities (e.g., skimming, burning, and application of dispersants) resulted in adverse effects on ESA-listed marine mammals and sea turtles. Despite natural weathering processes over the years since the DWH event, oil persists in some habitats where it continues to expose and impact resources in the northern Gulf of Mexico resulting in new environmental baseline conditions (BOEM 2016; Trustees 2016). The true impacts of offshore megafauna populations and their habitats may never be fully quantified, though it was necessary to characterize these impacts for response, damage assessment, and restoration activities (Frasier 2020).

9.8 Anthropogenic Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of anthropogenic sounds. These include, but are not limited to maritime activities, vessel sounds, seismic surveys (exploration and research), and marine construction (dredging and pile-driving as well as the construction, operation, and decommissioning of offshore structures). These activities occur to varying degrees throughout the year. Many researchers have described behavioral responses of marine mammals to sounds produced by boats and vessels, as well as other sound sources such as dredging and construction (reviewed in Gomez et al. 2016; and Nowacek et al. 2007). Most observations have been limited to short-term behavioral responses, which included avoidance behavior and temporary cessation of feeding, resting, or social interactions; however, in terrestrial species habitat abandonment can lead to more long-term effects, which may have implications at the population level (Barber et al. 2010). Cetaceans generate and rely on sound to navigate, hunt, and communicate with other individuals and anthropogenic sound can interfere with these important activities (Nowacek et al. 2007). Noise generated by human activity has the potential to affect sea turtles as well, although effects to sea turtles are not well understood. The ESA-listed species have the potential to be impacted by either increased levels of anthropogenic-induced background sound or high intensity, short-term anthropogenic sounds.

Despite the potential for these impacts to affect individual ESA-listed marine mammals and sea turtles, information is not currently available to determine the potential population level effects of anthropogenic sound levels in the marine environment (MMC 2007). For example, we currently lack empirical data on how sound impacts growth, survival, reproduction, and vital rates, nor do we understand the relative influence of such effects on the population being considered. As a result, the consequences of anthropogenic sound on ESA-listed marine mammals and sea turtles at the population or species scale remain uncertain, although recent efforts have made progress establishing frameworks to consider such effects (NAS 2017).

9.8.1 Anthropogenic Sound in the Gulf of Mexico

NOAA is working cooperatively with the ship-building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels. Through ESA consultation with NMFS, BOEM and BSEE have implemented and periodically revised Gulf of Mexico-wide measures, such as BOEM Notice to Lessees and Operators (NTL) 2016-G02, to reduce the risk of harassment to whales from sound produced by geological and geophysical surveying activities and explosive removal of offshore structures.

NOAA has implemented to CetSound Ocean Sound Strategy (https://cetsound.noaa.gov/) that provides a better understanding of manmade sound impacts on cetacean species. CetSound produced modeled ambient sound maps for several sound source types in the Gulf of Mexico. Annual average ambient sound sums of the modeled source types including seismic airgun surveys at different frequencies and depths is displayed in Figure 19. Other modeled events that can be viewed on the CetSound website for the Gulf of Mexico include annual average ambient sound for only seismic airgun surveys, summed sound sources without airguns, and explosive severance of an oil platform during decommissioning.

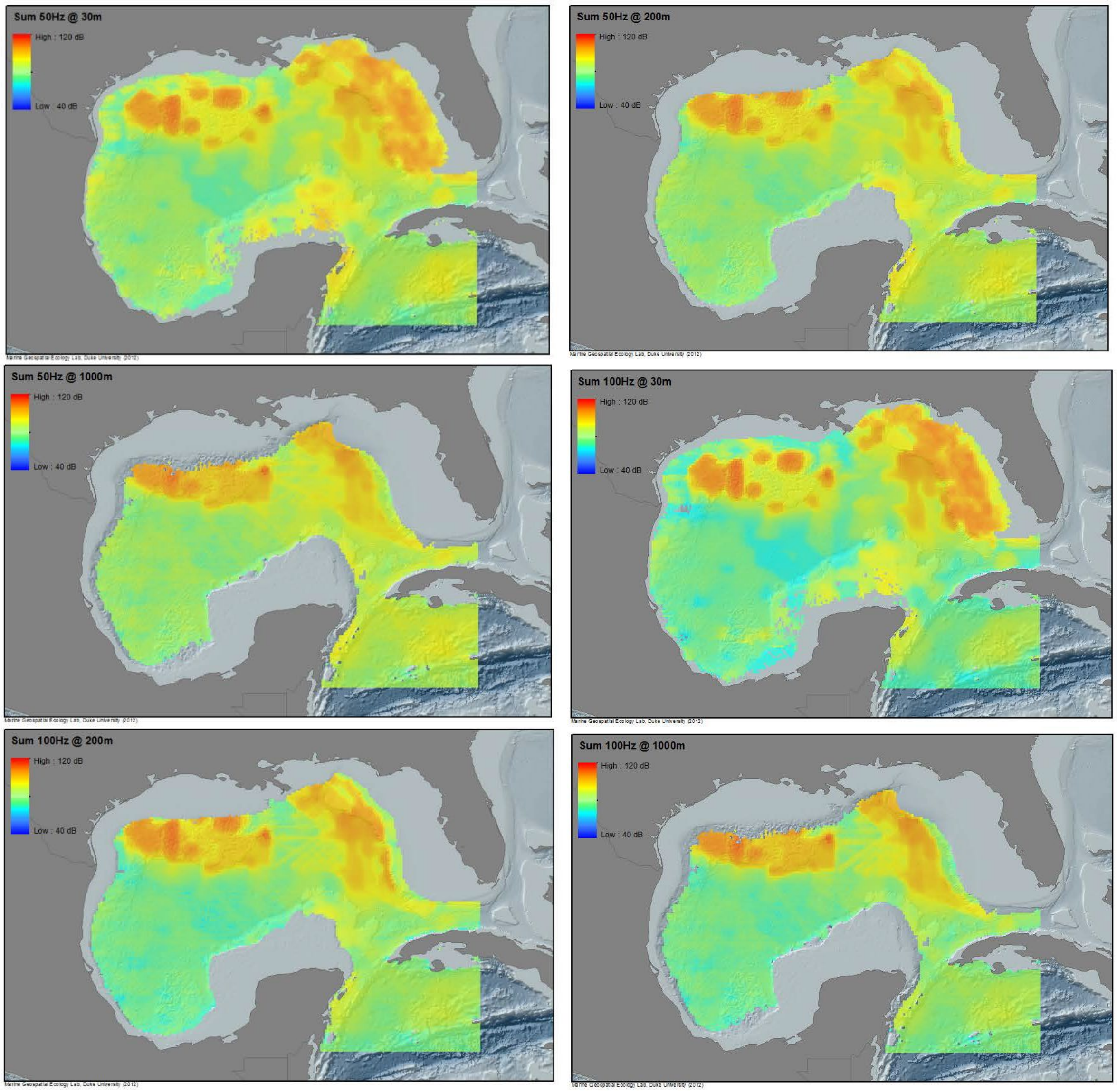

Figure 19. Maps of predicted average contribution to ambient sound from modeled sound sources including seismic airgun surveys at different depths for 50 Hertz and 100 Hertz (Marine Geospatial Ecology Laboratory, Duke University [2012] as published on CetSound website).

The Gulf of Mexico soundscape is being studied over the long-term by NOAA's Sound Reference Station Network (https://www.pmel.noaa.gov/acoustics/noaanps-ocean-noise-reference-station-network). This network uses static passive acoustic monitoring hydrophone (sound recorder) units to monitor trends and changes in the ambient sound field in U.S. federal waters. In addition to this network, there have been several other hydrophone units in the northern Gulf of Mexico (Figure 20). A study by Wiggins et al. (2016) placed two high-frequency acoustic recording packages (HARPs) in 100 to 250 m (328.1 to 820.2 ft) water depths and three HARPs in approximately 1,000 meter (3,280.8 ft) water depth to compare low-frequency sound pressure spectrum levels over three years.

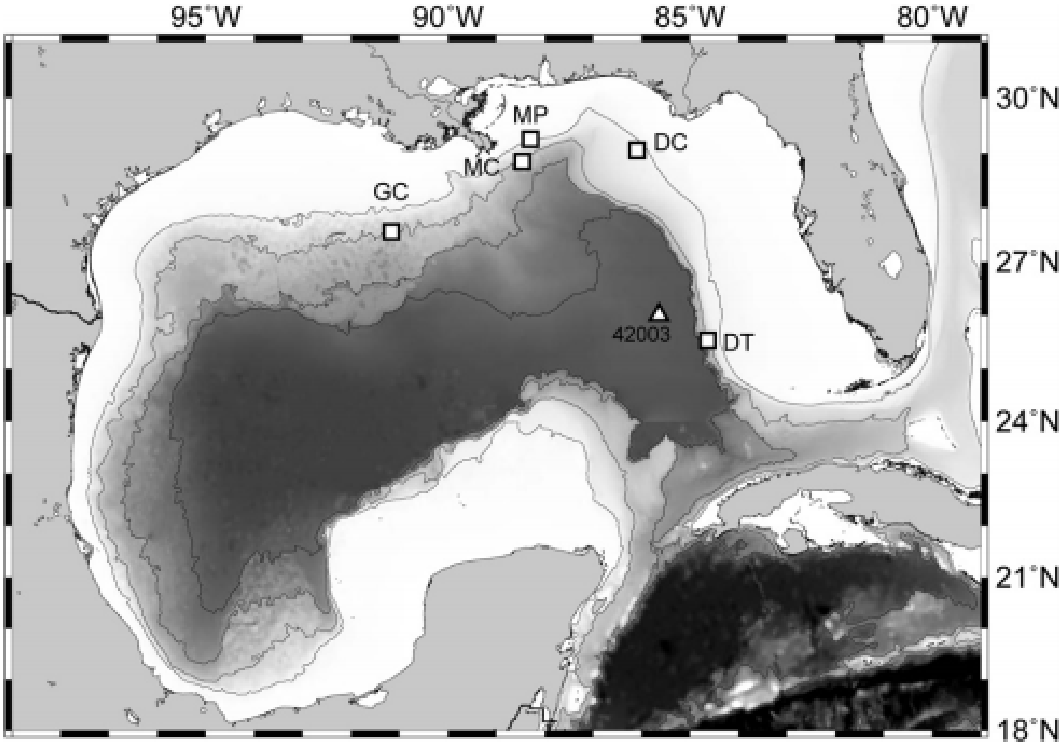

Figure 20. Map of five high-frequency acoustic recording packages locations, which collected data over several months during 2010 through 2013, are displayed as squares notated with site codes (GC=Green Canyon; MC=Mississippi Canyon; MP=Main Pass; DC=DeSoto Canyon; and DT=Dry Tortugas). The triangle is a National Oceanic and Atmospheric Administration weather buoy station used to measure wind speeds. Figure from (Wiggins et al. 2016).

Sound is a stressor that is produced by many activities discussed in the remaining sections of the Environmental Baseline.

9.8.2 Vessel Sound and Commercial Shipping

Much of the increase in sound in the ocean environment is due to increased shipping, as vessels become more numerous and of larger tonnage (Hildebrand 2009b; McKenna et al. 2012; NRC 2003c). Commercial shipping continues to be a major source of low-frequency sound in the ocean, particularly in the Northern Hemisphere where the majority of vessel traffic occurs. Figure 21 shows commercial vessel activity in the eastern Gulf of Mexico.

Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kiloHertz. The low frequency sounds from large vessels overlap with many mysticetes predicted hearing ranges (7 Hertz to 35 kiloHertz) (NOAA 2018) and may mask their vocalizations and cause stress (Rolland et al. 2012). The broadband sounds from large vessels may interfere with important biological functions of odontocetes, including foraging (Blair et al. 2016; Holt 2008). At frequencies below 300 Hertz, ambient sound levels are elevated by 15 to 20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013). Analysis of sound from vessels revealed that their propulsion systems are a dominant source of radiated underwater sound at frequencies less than 200 Hertz (Ross 1976). Additional sources of vessel sound include rotational and reciprocating machinery that produces tones and pulses at a constant rate. Other commercial and recreational vessels also operate within the action area and may produce similar sounds, although to a lesser extent given their much smaller size.

Vessels produce unique acoustic signatures, although these signatures may change with vessel speed, vessel load, and activities that may be taking place on the vessel. Peak spectral levels for individual commercial vessels are in the frequency band of 10 to 50 Hertz and range from 195 dB re: μPa^2-s at 1 m for fast-moving (greater than 37 km per hour [20 knots]) supertankers to 140 dB re: μPa^2-s at 1 m for small fishing vessels (NRC 2003c). Small boats with outboard or inboard engines produce sound that is generally highest in the mid-frequency (1 to 5 kiloHertz) range and at moderate (150 to 180 dB re: one µPa at 1 m) source levels (Erbe 2002; Gabriele et al. 2003; Kipple and Gabriele 2004). On average, sound levels are higher for the larger vessels, and increased vessel speeds result in higher sound levels. Measurements made over the period 1950 through 1970 indicated low frequency (50 Hertz) vessel traffic sound in the eastern North Pacific Ocean and western North Atlantic Ocean was increasing by 0.55 dB per year (Ross 1976; Ross 1993; Ross 2005). Whether or not such trends continue today is unclear. Most data indicate vessel sound is likely still increasing (Hildebrand 2009a). However, the rate of increase appears to have slowed in some areas (Chapman and Price 2011), and in some places, ambient sound including that produced by vessels appears to be decreasing (Miksis-Olds and Nichols 2016). Efforts are underway to better document changes in ambient sound (Haver et al. 2018), which will help provide a better understanding of current and future impacts of vessel sound on ESA-listed species. NOAA is working cooperatively with the ship building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels.

Sonar systems are used on commercial, recreational, and military vessels and may also affect cetaceans (NRC 2003a). Although little information is available on potential effects of multiple commercial and recreational sonars to cetaceans, the distribution of these sounds would be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Nowacek et al. 2007). However, military sonar, particularly low frequency active sonar, often produces intense sounds at high source levels, and these may impact cetacean behavior (Southall et al. 2016).

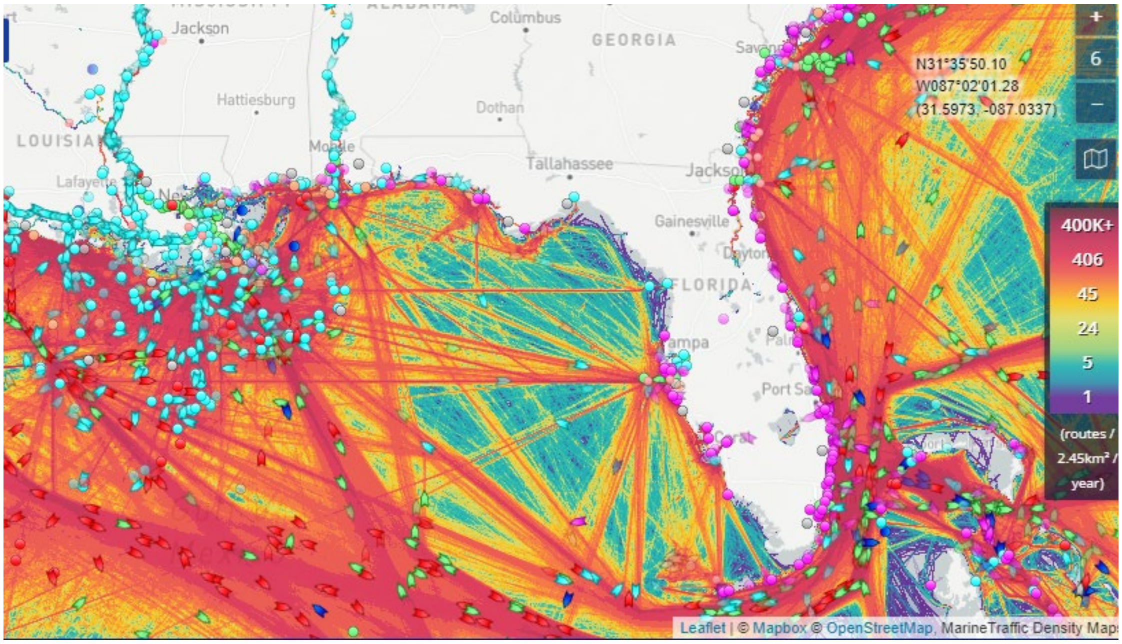

Figure 21. Map of commercial vessel traffic density in the eastern Gulf of Mexico in 2021. Image retrieved from Marine Traffic (2022).

9.8.3 Military Vessels

U.S. Navy vessel operations can be widely dispersed in the offshore waters, but typically more concentrated in portions of the action area in close proximity to ports, military installations, range complexes, and testing ranges. In an attempt to determine traffic patterns for Navy and non-Navy vessels, the Center for Naval Analysis (Mintz and Parker 2006) conducted a review of historic data for commercial vessels, coastal shipping patterns, and Navy vessels. Commercial and non-Navy traffic, which included cargo vessels, bulk carriers, passenger vessels, and oil tankers (all over 20 m in length), was heaviest near the major shipping ports from the Gulf of Maine to southern Florida, as well as in specific international shipping lanes. Navy traffic was heaviest just offshore of Norfolk, Virginia, and Jacksonville, Florida, as well as along the coastal waters between the two ports. The consultation for the Navy's current AFTT activities (NMFS 2018a) found that only a small portion of the training exercises occur an annual basis in the Gulf of Mexico Range Complex (<10%) as compared to the Jacksonville Range Complex (~65%). It was determined that potential disturbance and strike from vessels were not likely to adversely affect the Gulf of Mexico Bryde's whale (now Rice's whale) but were likely to adversely affect sea turtles. A few sea turtles could suffer injuries or mortalities from vessel interactions annually, up to 15 for loggerheads was the highest estimate, but will not jeopardize the continued existence of any sea turtle species.

9.8.4 Explosions in Water

The potential impacts to the Rice's whale and sea turtles from detonations of explosives underwater or at the water's surface are discussed for EAFB missions in the Effects of the Action, Section 10. The US Navy also conducts Testing and Training Operations in the Gulf of Mexico and some are in close proximity to EGTTR operations. The ESA Section 7 consultation for those operations (NMFS 2018a) determined that impacts to the Rice's whale from mine warfare exercises and ship shock trials could result in some behavioral and TTS annually, and possibly up to one PTS per 5 years; no mortalities or serious injuries expected. Estimated impacts per year from explosives to sea turtles include harassment, TTS and PTS. The highest annual PTS estimate, 41, was for loggerheads. These estimates include other areas not in the Gulf of Mexico, so only a few of these would be expected to occur near the EGTTR. There were some injuries for all sea turtles except for the greens, and up to one mortality, only for loggerheads, that could result from ship shock trials. The Navy AFTT activities are not expected to cause jeopardy to the continued existence of the Rice's whale or sea turtles.

9.8.5 Seismic Surveys

There are seismic survey activities involving towed airgun arrays that may occur within the action area. They are the primary exploration techniques to locate oil and gas deposits, fault structure, and other geological hazards. Airguns contribute a massive amount of anthropogenic energy to the world's oceans (3.9×10^{13} Joules cumulatively), second only to nuclear explosions (Moore and Angliss 2006). Although most energy is in the low-frequency range, airguns emit a substantial amount of energy up to 150 kiloHertz (Goold and Coates 2006). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). These activities may produce noise that could impact Rice's whale and sea turtles within the action area.

These airgun arrays generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of ten to 20 seconds for extended periods (NRC 2003c). Most of the energy from the airguns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns usually reach 235 to 240 dB at dominant frequencies of five to 300 Hertz (NRC 2003a). Most of the sound energy is at frequencies below 500 Hertz, which is within the hearing range of baleen whales and sperm whales (Nowacek et al. 2007). In the U.S., seismic surveys involving the use of airguns with the potential to take marine mammals are generally covered by incidental take authorizations under the MMPA, and if they involve ESA-listed species, undergo formal ESA section 7 consultation. In addition, the Bureau of Ocean Energy Management authorizes oil and gas activities in domestic waters as well as the NSF and U.S. Geological Survey funds and/or conducts these seismic survey activities in domestic, international, and foreign waters, and in doing so, consults with NMFS to ensure their actions do not jeopardize the continued existence of ESA-listed species or adversely modify or destroy designated critical habitat. More information on the effects of these activities on ESA-listed species, including authorized takes, can be found in recent biological opinions. For seismic surveys for oil and gas discovery, development and production in the Gulf of Mexico, required mitigation measures can be found in Bureau of Ocean Energy Management Notice to Lessees and Operators 2016-G02 “Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program” (https://www.boem.gov/sites/default/files/documents/oil-gas-energy/BOEM-NTL-No-2016-G02.pdf).

Scientific seismic research is conducted by the NSF-funded and L-DEO (Lamont-Doherty Earth Observatory) in the northern Gulf of Mexico on the R/V *Maurice Ewing* for purposes of calibration of the airgun arrays in 2003 and on the R/V *Marcus G. Langseth* in 2007 and 2008. The U.S. Geological Survey funded and conducted a low-energy seismic survey on the R/V *Pelican* in the Gulf of Mexico in 2013. Each of these seismic surveys include a MMPA IHA and each were subject to ESA section 7 consultations. The finalized consultations all resulted in a “no jeopardy” opinion.

9.9 Scientific Research Activities

Regulations for section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research. Prior to the issuance of such a permit, the proposal must be reviewed for compliance with section 7 of the ESA. Scientific research permits issued by NMFS currently authorize studies of ESA-listed species in the Gulf of Mexico, some of which extend into portions of the action area for the proposed actions. Marine mammals and sea turtles have been the subject of field studies for decades. The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits on an annual basis for various forms of “take” of marine mammals and sea turtles in the action area from a variety of research activities.

Authorized research on ESA-listed marine mammals includes aerial and vessel surveys, close approaches, photography, videography, behavioral observations, active acoustics (playbacks and prey mapping), remote ultrasound, passive acoustic monitoring, biological sampling (i.e., biopsy, breath, fecal, prey, sloughed skin, and environmental DNA), and tagging. Research activities generally involve non-lethal “takes” of these marine mammals.

Sea turtles are the focus of research activities authorized by section 10 permits under the ESA. Authorized research on ESA-listed sea turtles includes aerial and vessel surveys, close approaches, active acoustics, capture, handling, holding, restraint, and transportation, tagging, shell and chemical marking, biological sampling (i.e., biopsy, blood and tissue collection, tear, fecal and urine, and lavage), drilling, pills, imaging, ultrasound, antibiotic (tetracycline) injections, captive experiments, laparoscopy, and mortality. Most research activities involve authorized sub-lethal “takes,” with some resulting mortality. The number of authorized takes by research permits varies widely depending on the research and species involved but may involve the taking of hundreds of sea turtles annually. Most takes authorized under these permits are expected to be nonlethal. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, section 7 analysis is also required to ensure the issuance of the permit is not likely to result in jeopardy to the species.

There have been numerous research permits issued since 2009 under the provisions of both the MMPA and ESA authorizing scientific research on marine mammals and sea turtles all over the world, including for research activities in the action area. The consultations which took place on the issuance of these ESA scientific research permits each found that the authorized research activities will have no more than short-term effects on individuals or populations and were not determined to result in jeopardy to the species or adverse modification of designated critical habitat.

9.10 Hypoxia and Nutrient Loads

Nutrient loading from land-based sources, such as coastal communities and agricultural operations stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. Rabalais et al. (2010) provide an example of the large area of the Louisiana continental shelf with seasonally depleted oxygen levels (< 2 mg/liter) that is caused by eutrophication from both point and non-point sources. The oxygen depletion, referred to as hypoxia, begins in late spring, reaches a maximum in mid-summer, and disappears in the fall. Since 1993, the average extent of mid-summer, bottom-water hypoxia in the northern Gulf of Mexico has been approximately 16,000 km2, approximately twice the average size measured between 1985 and 1992. The hypoxic zone attained a maximum measured extent in 2002, when it was about 22,000 km^2 which is larger than the state of Massachusetts. This zone was predicted to reach its largest area in 2011 (Rabalais et al., 2010), between 22,253 and 26,515 km^2 (average 24,400 km^2) of the bottom of the continental shelf off Louisiana and Texas.

9.11 Disease

There are no diseases known to be impacting the Rice's whale population. Fibropapilloma has been documented in all seven sea turtle species; however, green turtles are most commonly and severely affected.[8] Fibropapilloma is characterized by tumorous growths, which can range in size from very small to extremely large, and are found both internally and externally. Large tumors can interfere with feeding and essential behaviors, and tumors on the eyes can cause permanent blindness (Foley et al. 2005).

Fibropapilloma was first described in green turtles in the Florida Keys in the 1930s. Since then it has been recorded in many green turtle populations around the world, most notably present in green turtles of Hawaii, Florida, and the Caribbean. In Florida, up to 50 percent of the immature green turtles captured in the Indian River Lagoon are infected, and there are similar reports from other sites in Florida, including Florida Bay, as well as from Puerto Rico and the U.S. Virgin Islands. In addition, scientists have documented fibropapilloma in populations of loggerhead, olive ridley, and flatback turtles (Loureiro and Matos 2009). The effects of fibropapilloma at the

[8] https://www.fisheries.noaa.gov/national/marine-life-distress/fibropapillomatosis-and-sea-turtles-frequently-asked-questions

population level are not well understood and could be a serious threat to their recovery. Fibropapillomatosis is associated with infection by a herpesvirus called Chelonid FP-Associated Herpesvirus or Chelonid Herpesvirus 5. However, the development of tumors is likely caused by multiple factors that we do not yet fully understand.

An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs and an increased presence of native species (e.g. raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Non-native vegetation has invaded many coastal areas and often outcompetes native species. Non-native vegetation is usually less-stabilizing and can lead to increased erosion and degradation of suitable nesting habitat. Non-native vegetation may also form impenetrable root mats that can prevent proper nest cavity excavation, invade and desiccate eggs, or trap hatchlings. In light of these issues, conservation and long-term protection of sea turtle nesting and foraging habitats is an urgent and high priority need. The actions conducted by USAF at EGTTR should have no impacts on increased disease to sea turtles.

9.12 Impact of the Baseline on Endangered Species Act-Listed Species

Collectively, the baseline described above has had, and likely continues to have, impacts on the status of ESA-listed species considered in this opinion. Both the Rice's whale and sea turtles have suffered from the DWH spill. Ongoing major threats include vessel strike and underwater sound (e.g., seismic surveys and explosives) for both Rice's whale and sea turtles, and additional pressure is placed on sea turtles from commercial fisheries bycatch in the Gulf of Mexico. We consider the best indicator of the aggregate impact of the environmental baseline on ESA-listed resources to be the status and trends of those species.

There is limited information on the Rice's whale population, as far as we know there are not many individuals (could be less than 50), which indicates the potential vulnerability of this population. We do not have enough information to determine population stability or trends and that deters our ability difficult to infer what effects the collective stressors may be having on the Rice's whale.

The status of the Northwest Atlantic DPS loggerhead, North Atlantic DPS green, Kemp's ridley, and leatherback sea turtle populations relevant to the action area has generally been stable and some shows signs of increasing populations, indicating the potential for resilience to the ongoing major threats occurring from the various sources in the action area.

10 Effects of the Action

Regulations for ESA Section 7 define "effects of the action" as all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 C.F.R. §402.02).

This section follows the exposure and response analysis framework described in Section 2. The effects analyses describe the potential stressors associated with the proposed action and then identifies stressors that are not likely to adversely affect ESA-listed resources (species or critical habitat). The effects analyses then identifies stressors considered likely to adversely affect ESA-listed resources and the probability of exposure to these stressors based on the best scientific and commercial evidence available, and the probable responses of those resources (given probable exposures) based on the available evidence.

For any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), we then consider the risk posed to the viability of the population(s) those individuals comprise and to the ESA-listed species those populations represent in the Integrated Risk Assessment, Section 12. The purpose of this assessment and, ultimately, of this consultation is to determine if it is reasonable to expect the proposed action to have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

10.1 Stressors Not Likely to Adversely Affect

We evaluated the potential stressors and determined those discussed in the following subsections may affect, but are not likely to adversely affect ESA-listed resources. Stressors anticipated to have adverse consequences are identified in the next section (Section 10.2).

The applicable standard to find that a proposed action is not likely to adversely affect ESA-listed species or designated critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or wholly beneficial, as discussed in Section 7. .

10.1.1 Disturbance

Aircraft

Missions in the EGTTR involve aircraft, bombers and fighter jets to helicopters. Low-flying aircraft produce sounds that marine mammals and sea turtles can hear when they occur at or near the ocean's surface. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Sounds from aircraft would not have physical effects on marine mammals or sea turtles, but represent acoustic stimuli (primarily low-frequency sounds from engines and rotors) that could potentially affect the behavior of marine mammals and sea turtles.

Reviews on the behavioral reactions of marine mammals to aircraft and missile overflight are presented in Richardson et al. (1995a), Efroymson et al. (2000), Luksenburg and Parsons (2009b), and Holst et al. (2011). The most common responses of cetaceans to aircraft overflights were short surfacing durations, abrupt dives, and percussive behavior (breaching and tail slapping) (Nowacek et al. 2007). Other behavioral responses such as flushing and fleeing the area of the source of the noise have also been observed (Holst et al. 2011; Manci et al. 1988). Luksenburg and Parsons (2009a) determined that the sensitivity of whales and dolphins to aircraft noise may depend on the animals' behavioral state at the time of exposure (e.g. resting, socializing, foraging or travelling) as well as the altitude and lateral distance of the aircraft to the animals. While resting animals seemed to be disturbed the most, low flying aircraft with close lateral distances over shallow water elicited stronger disturbance responses than higher flying aircraft with greater lateral distances over deeper water (Patenaude et al. 2002; Smultea et al. 2008) in Luksenburg and Parsons (2009a).

Richardson et al. (1995b) reported that while data on the reactions of mysticetes is meager and largely anecdotal, there is no evidence that single or occasional aircraft flying above mysticetes causes long-term displacement of these mammals. Mysticetes have either ignored or occasionally dive in response to aircraft overflights (Efroymson et al. 2000; Koski et al. 1998). In general, overflights above 305 m (1,000 ft) do not seem to cause reactions.

Based on sea turtle sensory biology (Bartol et al. 1999; Ketten and Bartol 2005; Ketten and Bartol 2006; Lenhardt et al. 1994; Ridgway et al. 1969), sound from low flying aircraft could be heard by a sea turtle that is at or near the surface. Turtles might also detect low flying aircraft via visual cues such as the aircraft's shadow. Hazel et al. (2007) suggested that green turtles rely more on visual cues than auditory cues when reacting to approaching water vessels. This suggests that sea turtles might not respond to aircraft overflights based on noise alone.

Acoustic energy in the air does not effectively cross the air-water interface and noise can be reflected off the water surface (Richardson et al. 1995a). Research conducted by the USAF reported significant reductions in noise underwater related to in air sonic booms[9], indicating a lack of harassment risk for protected marine species under water (USAF 2000). Sound waves in air can be reduced by a factor of more than a thousand when they cross the air-sea interface (Hildebrand 2005), constituting a substantial sound barrier.

If whales or sea turtles are at or very near the surface and aircraft are directly overhead, there could be potential for some sort of behavioral reaction. USAF aircraft do not fly at very low altitudes, hover over, or follow protected species, therefore limiting the possibility to evoke behavioral responses. The lowest flying aircraft, helicopter and tilt rotor are not capable creating sonic booms. The tilt-rotor CV-22 gunnery 1000’ above sea level operation altitudes are the lowest proposed under this action. Jet aircraft capable of creating sonic booms travel at much higher altitudes. Fixed-wing non-gunnery aircraft operate at altitudes above sea level on the order of tens of thousands of ft. Launch and landing occurs at EAFB and not near Rice’s whale habitat. Inert missions are restricted from occurring in the Rice’s whale area. Live missions will apply setback distances from the 100 m isobath to mitigate potential acoustic impacts to Rice’s whale from detonations, further removing mission activities from Rice’s whale habitat and therefore reducing the potential for disturbance from aircraft.

[9] When the aircraft exceeds the speed of sound, pressure waves around the aircraft form shock waves, the sound heard on the ground as a "sonic boom" is an impulsive noise, similar to thunder, resulting from the sudden onset and release of pressure after the buildup by the shock wave. https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104540/sonic-boom/

If exposure to aircraft noise were to occur, the most likely occasion would be transient passing of aircraft at altitude, which could result in a temporary behavioral response. These behavioral responses are not expected to increase the likelihood of injury from significantly disrupting breeding, feeding, or sheltering and will not rise to the level of take. Therefore, the effects of aircraft noise on ESA-listed species are unlikely to be measurable or have any meaningful consequence, which would be insignificant and therefore not likely to adversely affect these species.

Vessels

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Amaral and Carlson 2005; Au and Green 2000; Bain et al. 2006; Bauer 1986; Bejder et al. 1999; Bejder and Lusseau. 2008; Bejder et al. 2009; Bryant et al. 1984; Corkeron 1995; Erbe 2002; Félix 2001; Goodwin and Cotton 2004; Lemon et al. 2006; Lusseau 2003; Lusseau 2006; Magalhaes et al. 2002; Nowacek et al. 2001; Richter et al. 2003; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002; Wursig et al. 1998). However, several authors suggest that the noise generated during motion is probably an important factor (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994). Although most of these studies focused on small cetaceans (for example, bottlenose dolphins, spinner dolphins, spotted dolphins, harbor porpoises, beluga whales, and killer whales), studies with large whales have reported similar results (David 2002). Baker et al. (1983) reported that humpbacks in Hawaii responded to vessels at distances of 2 to 4 km. Richardson et al. (1985) reported that bowhead whales (*Balaena mysticetus*) swam in the opposite direction of approaching seismic vessels at distances between 1 and 4 km and engage in evasive behavior at distances under 1 km. Fin whales also responded to vessels at a distance of about one km (Edds and Macfarlane 1987). The majority of vessels used during EGTTR activities are relatively small boats, ranging in size from 25 to 40 ft (7.6 to 12.2 m), as opposed to large vessels, such as those used for cargo shipping, which are louder and contribute low-frequency noise (< 1 kHz) that can chronically interfere with the life history of marine animals that vocalize within the same range (e.g., Rice's whale) (Erbe et al. 2019).

For behavioral responses to result in energetic costs that result in long-term harm, such disturbances would likely need to be sustained for a significant duration or extent and exposed individuals are not be able to access alternate habitat to recover and feed. EGTTR mission activities would not likely result in such prolonged exposures or preclusion of individuals from feeding, breeding, or sheltering habitat. Most of the vessel activity associated with the proposed action will occur in portions of the LIA and ELIA, where Rice's whale is not expected to occur. If an operations vessel were to be in the vicinity of the Rice's whale, available evidence leads us to expect the whale to have an avoidance response consisting of slow movements away from vessels the animals perceive are on an approaching course, perhaps accompanied by a dive that could be slightly longer. This change in behavior would need more energy than just resting at that the surface but would be temporary and within behaviors conducted daily (e.g. swimming and diving). Sea turtles can occur in across a broader extent of the EGTTR and are therefore more likely to be in the vicinity of an operations vessel. Sea turtles may have a brief startle response, but also may ignore operation vessels entirely and continue behaving as if the vessels, and any risks associated with those vessels did not exist (Hazel et al. 2007).

Vessel activity associated with the EGTTR missions will primarily occur in and adjacent the LIAs. In the past five years there was an average of 4 days per year for live targeting and 5 days a year for gunnery missions (see Section 12). The occasions for potential exposure to vessel noise areinfrequent. There has been no evidence of any adverse impact to any sea turtles or marine mammals found during monitoring of past EGTTR operations. If a cetacean or sea turtle were to be exposed to noise from mission related vessels, they may not respond or may have a temporary behavioral response (e.g., a startle, brief avoidance) and we do not expect that type of reaction to have any measurable effect on any individual's fitness. Therefore, the effects of noise from operations vessels on ESA-listed species are insignificant and are not likely to adversely affect these species.

10.1.2 Direct strike

Munitions

The proposed activities have potential to directly strike an ESA-listed species with munitions (e.g., gunnery rounds, bombs, and missiles). Water is substantially denser than air, causing munition velocity to decrease rapidly after impact with the water, thereby decreasing the risk of direct physical strike to ESA-listed species underwater. The potential for being struck by a munition is limited to an ESA-listed species at or near the surface of the water. An animal would have to be at the exact location where the munition impacts the surface of the water at exactly the same time as impact. The very low densities of sea turtles in the action area indicate the chance of co-occurrence with a munition impact is highly unlikely. Mission activity is concentrated in the LIAs, which employ pre-mission surveys for protected species (see Section 3.3, Conservation Measures) further reducing the likelihood of a direct strike because the mission would be delayed or cancelled if a protected species was observed in proximity to the target area. Live missions have setbacks to avoid impacts to the Rice's whale and inert munitions will not be used in the 100-400 m isobath area recognized as habitat for the Rice's whale. For these reasons, the likelihood of munitions items from EGTTR activities physically striking a sea turtle or the Rice's whale is so unlikely as to be considered discountable and, therefore, the effects are not likely to adversely affect ESA-listed species.

Vessels

Vessels will be used in the EGTTR to prepare target areas, conduct range clearance for human safety, and conduct protected species surveys. The vessel operations required for the proposed activities have the potential risk of strike of a protected species. Vessels used in operations are typical of what is used by public recreational boaters (e.g., center console with outboard motor, 25-40 ft [7.6 to 12 m] in length). These vessels have open deck space often intended for recreational fishing and this allows for visual access around the craft for surveys and range clearance.

Risk of vessel strike will be greatest for protected species at or near the surface of the water. Sea turtles spend a significant portion of their time below the surface (Renaud and Carpenter 1994) reducing their risk of exposure to strike. As mentioned previously, the density of sea turtles in the action area is very low, which further reduces the potential for vessel strike risk.

The majority of vessel strikes of large whales occur when vessels are traveling at speeds greater than approximately 10 knots (18.5 km per hour), with faster travel, especially of large vessels (262.5 ft [80 m] or greater), being more likely to cause serious injury or death (Conn and Silber 2013; Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007). The EGTTR operations vessels are significantly smaller, allowing them to be more responsive and maneuverable to avoid collisions. There are restrictions on vessel activity to avoid Rice's whale habitat and if transit is unavoidable, there is a 10 knot speed restriction for that area.

Vessel operators undergo protected marine species observer training and are instructed to follow Vessel Strike Avoidance Measures (see Section 3.3, Conservation Measures). Most of the vessel activities involve observing the range for public and protected species safety. Adherence to observation and avoidance measures is expected to diminish the potential risk of marine mammal and sea turtle vessel strike. Despite EGTTR activities occurring in the action area for many years, monitoring reports document no marine mammals or sea turtles having been struck. All factors considered, we have concluded vessel strike of ESA-listed species by EGTTR vessel operations is extremely unlikely to occur and thus the effects of this stressor are discountable. Therefore, vessel strike may affect, but is not likely to adversely affect ESA-listed species.

10.1.3 Debris and Chemical Constituents

Gunnery rounds and pieces of expended munitions are expected to sink quickly and settle on the seafloor. Heavier pieces of damaged targets (e.g., metal) are expected to sink to the seafloor, other materials (e.g., plastic or plywood) could float or be temporarily suspended and then sink to the bottom. After missions involving targets are completed, vessel crews clean up the area by removing debris at the surface of the water. Post-mission cleanup crews recover as much target-related debris as possible from the water surface involve the use of several boats for up to two to 3 hours.

Larger debris is likely picked up efficiently but very small pieces may be more difficult and, even though the clean-up crews use hand-held dip nets, they may not be able to collect all the small debris. Remaining bits of debris can be dispersed by currents and the wind. Given the likely dispersion and the low density of sea turtles in the action area, the probability of a sea turtle encountering and trying to ingest the debris at the sea surface is low. The seafloor in the W-151 action area is sandy with little relief and few bottom features, which is expected to have patchy and low density of food items (e.g., benthic invertebrates) for sea turtle species, meaning it is not a valuable foraging area, limiting the chance of sea turtles foraging in the area and encountering the debris that sinks near the target site. In conclusion, it is extremely unlikely that sea turtles will encounter and ingest expended material and thus discountable. Therefore, the effects of this stressor may affect, but are not likely to adversely affect sea turtles.

The Rice's whale is not expected to encounter munition fragments and target debris because the live munition target areas are well outside of the Rice's whale habitat zone between the 100 m and 400 m isobaths (see Rice's whale habitat in Section 8.1.1), and inert munitions are prohibited from use in that zone throughout the EGTTR. The likelihood of co-occurrence of this species with mission target activities is extremely unlikely to occur and thus discountable. Therefore, munition fragments and target debris may affect, but are not likely to adversely affect Rice's whale.

Up to eight CBU-105D munitions could be used in a year during Combat Hammer missions, each using 10 small parachutes for their submunitions, for a total of up to 80 small (8 inch diameter) parachutes annually. After the parachutes detach from the submunitions, they land on the water surface, temporarily get carried by currents as they slowly sink, and eventually settle on the seafloor. Larger parachutes that could be used for mission-related supplies and equipment (one to two a year, or none in a given year) are weighted and would sink much more rapidly. Parachutes on the seafloor are expected to be covered by sediment, as well as colonized by attaching and encrusting organisms over time, which would weigh them down. The size of the small parachutes limits the risk of entanglement to sea turtles, and the weighting of the larger parachutes significantly reduces the time spent in the water column, which also reduces entanglement risk. The low density of sea turtles limits the possibility of encountering the parachutes. Parachutes are used in vicinity of the GRATV in the LIA, which is a considerable distance (~13 km) from the Rice's whale exclusion area making encounters extremely unlikely to occur. Entanglement in fishing gear has occurred for the Rice's whale, but there are no reports of entanglement in parachutes (Rosel et al. 2016b). For these reasons, the potential for entanglement from parachutes is discountable and this stressor may affect, but is not likely to adversely affect sea turtles and the Rice's whale.

Metals and Explosives

Metals used to construct the munitions used in the EGTTR include aluminum, steel, and lead. These metals could settle to the seafloor after munitions are expended. Metal ions would slowly leach into the substrate and the water column, causing elevated concentrations in a small localized area around munition fragments. Some metals bioaccumulate and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals. Evidence from a number of studies (Briggs et al. 2016a; Edwards et al. 2016; Kelley et al. 2016; Koide et al. 2016a; Navy 2013a) indicate metal contamination is highly localized and that bioaccumulation resulting from munitions cannot be demonstrated. Specifically, in sampled marine life living on or around munitions on the seafloor, metal concentrations could not be definitively linked to the munitions because comparison of metals in sediment next to munitions show relatively little difference in comparison to other baseline marine sediments used as a control (Koide et al. 2016a). It is expected that any metal ions leached into the water column would quickly become diluted through the mixing action of currents, tides, and other sources of turbulent water flow.

Munitions used for EGTTR testing and training operations contain a wide variety of high explosives including TNT, RDX, HMX, Composition B, Tritonal, AFX-757, PBXN, and others. Explosive byproducts could be introduced into the water column through detonation of live munitions. Thermal degradation of high explosives creates intermediate products during the time that a detonation is in progress. These may include carbon ions, nitrogen ions, oxygen ions, water, hydrogen cyanide, carbon monoxide, nitrogen gas, nitrous oxide, cyanic acid, and carbon dioxide (Becker 1995). Reactions occur very quickly between the intermediates, and the final products consist mainly of water, carbon monoxide, carbon dioxide, and nitrogen gas. Chemicals introduced to the water column due to detonation would be quickly dispersed by waves, currents, and tidal action and become distributed in the surrounding open ocean waters. Some of the nitrogen and carbon compounds would be metabolized or assimilated during protein synthesis 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 ESA-listed species or the marine environment.

High-order detonations occur when the munition functions as intended and typically less than one percent residual amount of the explosive material would be unconsumed and potentially released into the environment (Walsh et al. 2011). Low-order detonations occur when the munition partially functions and only a portion of the explosives are consumed with some remaining unconsumed portion of the explosive fill that could enter the marine environment. If the munition fails to detonate and it does not explode, it becomes a UXO. All the explosive material would remain within the munition casing. Explosives in UXOs may be released into the marine environment if the casing corrodes or ruptures.

Most of the live munitions used during EGTTR operations are successfully detonated as intended. High-order detonations consume the vast majority of explosive material in the munition and are considered to potentially release minuscule amounts of explosives into the marine environment. Failure rates for munitions vary by munition type and the manner in which the munition is used during the mission. Failure rates are not available for all munitions that would be used under the proposed activities; however, EAFB considers a failure rate of 5 percent as a reasonable general estimate. Low-order detonations are much less common than munition failures and, therefore, contribute a very minor amount of explosives into the marine environment.

Various factors influence how explosives behave in the marine environment, including their solubility in seawater, their capacity for adsorbing onto other materials in the water, and the extent to which they degrade and lose their energetic properties. Explosive material that is not consumed in a detonation could sink to the substrate and bind to sediments. Several studies have shown that high explosives, like those used in EGTTR (e.g., TNT and RDX), can undergo degradation in the marine environment aided by microbes in the water column and sediments (Walker et al. 2006,(Juhasz and Naidu 2007). Studies conducted at World War II munitions disposal sites in Hawaii reported that there were no confirmed detections of explosives in any sediment samples collected from the sites (Briggs et al. 2016b) and that there was no bioaccumulation of munitions-related chemicals in organisms that colonized intact munitions (either UXO or inert) at the sites (Koide et al. 2016b). A study conducted at the Potomac River Test Range, where a wide variety of munitions (e.g., bombs, rockets, mortars, mines, torpedoes, gun ammunition, etc.) have been used for almost 100 years, reported that the concentrations of explosives and explosives by-products in sediments at the range were lower than in other portions of the Potomac River that receive inputs from non-military sources (Navy 2013b). Lastly, Pait et al. (2010) reported that explosives were not detected in sediment samples collected off the coast of Vieques, Puerto Rico, following the cessation of Navy training activities on the island, which were conducted for more than 45 years. Collectively, these studies indicate that explosives and explosives by-products released into the marine environment can be removed via biodegradation and that expended or disposed military munitions on the seafloor do not result in excessive accumulation of explosives in sediments or significant degradation of sediment quality by explosives. Lotufo et al. (2010) studied the potential toxicity of RDX byproducts to marine organisms. The authors concluded that degradation products of these explosives are not toxic at realistic exposure levels. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately six to 12 inches away from degrading munitions, the concentrations of these compounds were not statistically distinguishable from baseline levels beyond three to six feet from the degrading munitions.

Given the information above, the effect of exposure of sea turtles to explosives byproducts will be at such a low level as to be insignificant. The Rice's whale is not expected to encounter metals from munitions or their explosive products because the live target areas are well outside of the Rice's whale habitat area and the likelihood of co-occurrence of this species with mission targeting is so low as to be extremely unlikely to occur and thus discountable. Therefore, munition metals and explosive material or their byproducts from EGTTR activities are not likely to adversely affect ESA-listed species.

Flares and Chaff

The 53 WEG proposes to use a total of 1,800 flares and 7,500 bundles of chaff annually for Combat Archer missions in the EGTTR during the 2023–2030 period (App A, Table 1). These quantities of flares and chaff are substantially lower than the quantities proposed for use in the EGTTR annually during the previous mission period, which were 202,747 flares and 434,275 bundles of chaff. There are also plastic end caps of the flares and chaff that are expended and expected to float for a period of time before eventually sinking and settling on the seafloor (Navy 2018).

Combat Archer missions would use the MJU-7A/B decoy flare, which is widely used throughout the DoD. This flare consists of a rectangular case that measures 1 by 2 by eight inches and contains magnesium pellets. The pellets and case are designed to burn completely but the plastic end caps and pistons do not burn. Flare ash is a by-product of the combustion process that can be dispersed by winds. Magnesium deposition into the marine environment would occur only when expended flares fail to function and the magnesium pellets in the flare do not burn. The MJU-7A/B flare has improved reliability relative to earlier versions. The reliability of the MJU-7A/B flare is estimated to be approximately 99 percent.[10] Based on a one percent failure rate, 18 dud flares would be potentially deposited into the marine environment annually as a result of EGTTR operations under the proposed action. The unconsumed magnesium in these dud flares can leach into the water column but have been determined to have low risk from toxicity and become diluted from seawater mixing (USAF 1997).

Combat Archer missions would primarily use rectangular cartridges (1 by 1 by 8 inches) of R-188 chaff, containing aluminum-coated glass fibers. The primary chemical constituents of this chaff type are aluminum, silica (silicon dioxide), and stearic acid, which is used in the anti-clumping coating applied to the fibers. Several studies indicate that except at concentrations substantially higher than those that occur during military training, chaff has very little risk of environmental effects or risk of toxicity(Farrell and Siciliano 2004; Hullar et al. 1999; USAF 1997).

The decoy flares and chaff countermeasures are a part of the munition mission activities and excluded from use in the Rice's whale habitat area. Any materials associated with the use of decoy flares and chaff are expected to be dispersed and sink to the seafloor in very low concentrations. The density of sea turtles is low in the action area. Exposure to flares and chaff in measurable amounts is so unlikely to occur as to be discountable and, therefore, these may affect, but not likely to adversely affect sea turtles or the Rice's whale.

Propellant

Missiles are propelled by solid propellant-fueled rocket motors. The solid propellant mixture typically consists of ammonium perchlorate as the oxidizer, aluminum powder as the fuel, iron oxide (catalyst), a polymer that serves as binder for holding the mixture together and acting as a secondary fuel, and an epoxy curing agent. Ammonium perchlorate as the oxidizing agent accounts for most of the propellant by weight. Studies have shown that all but trace amounts of ammonium perchlorate are consumed by solid rocket motors in missiles and rockets (Jenkins et al. 2008). Ammonium perchlorate is highly soluble in water. Research has demonstrated that perchlorate did not bioconcentrate or bioaccumulate, which was consistent with the expectations for a water-soluble compound (Furin et al. 2013). Any ammonium perchlorate that may be released into the marine environment (such as from a failed missile test) is expected to be readily diluted given the dynamic nature of the environment (currents, tides, etc.), long-term impacts from perchlorate in the environment near the expended item are not expected. It is extremely unlikely that perchlorate from failed expendable items would compromise water quality to the point that it would

[10] https://www.globalsecurity.org/military/systems/aircraft/systems/mju-7.htm

result in adverse effects on ESA-listed sea turtles and Rice's whale, therefore, this stressor may affect, but is not likely to adversely affect ESA-listed species.

10.2 Stressors Likely to Adversely Affect

Munition impact with the surface of the water and subsequent detonations of live munitions are the source of potential stressors that have related acoustic impacts that are likely to adversely affect ESA-listed sea turtles and the Rice's whale within the action area. Exposure to such forces at their most severe could result in mortality, with less intense exposures ranging from non-lethal injuries to behavioral harassment.

For munitions detonations that occur in the air, the HOB detonation scenario, EAFB has determined there should be no appreciable effect on protected species because there is negligible transmission of pressure or acoustic energy across the air-water interface. Therefore, the HOB detonation scenario is not included in their exposure estimates. Information in the Disturbance section (see Aircraft subsection in 10.1.1) supports the assertion that sound does not transfer well across the air-water interface and there can be orders of magnitude reduction in the acoustic energy underwater. For that reason and the previously noted unlikely occurrence of a protected species being at the surface under the area of munition testing, especially at the exact moment of airborne detonation, we agree that the HOB detonation scenario is not likely to adversely affect sea turtles or the Rice's whale.

10.2.1 Air-to-Surface Munition Impact and Detonations

When an air-to-surface munition impacts the water, kinetic energy displaces water in the formation of an impact "crater" in the water and some of the kinetic energy is transmitted from the impact point as underwater acoustic energy in a pressure impulse. The kinetic energy released by the physical impact of the munition with the water has been calculated and incorporated into the estimations of munitions energy for both live and inert munitions in the proposed action. The kinetic energy of the munition at impact is calculated as one half the mass of the munition times the square of the velocity of the munition. The initial impact event contributing to the pressure impulse in water is assumed to be one millisecond in duration. To calculate the velocity (and kinetic energy) immediately after impact, the deceleration contributing to the pressure impulse in the water is assumed, for all munitions, to be 1,500 g-forces or 48,300 ft (14.7 km) per square second over 1 millisecond. A substantial portion of the change in kinetic energy at impact is dissipated as a pressure impulse in the water, with the remainder being dissipated in other ways, such as structural deformation of the munition, heat, and displacement of water. The impact energies of the proposed live munitions were calculated and included in their total energy estimations. The impact energies of the inert munitions proposed for use were also calculated.

Following impact, the warhead of a live munition detonates at or slightly below the water surface. The warhead detonation converts explosive material into gas, further displacing water through the rapid creation of a gas bubble in the water and creates a much larger pressure wave than the pressure wave created by the impact. These impulse pressure waves radiate from the impact point at the speed of sound in water, roughly 1,500 m per second. If the detonation is sufficiently deep, the gas bubble goes through a series of expansions and contractions with each cycle being of successively lower energy. When detonations occur below but near the water surface, the initial gas bubble reaches the surface causing venting, which also dissipates energy through the ejection of water and release of detonation gases into the atmosphere. When a detonation occurs below the water surface after the impact crater has fully or partially closed, water can be ejected upward by the pressure impulse and through venting of the gas bubble formed by the detonation.

When detonations occur at the water surface, a large portion of the energy and gases that would otherwise form a detonation bubble are reflected upward from the water. Likewise, when a shallow detonation occurs below the water surface but prior to the impact crater closing, considerable energy is reflected upward from the water.

The impulsive pressure waves generated by munition impact and warhead detonation radiate spherically and are reflected between the water surface and the sea bottom. There is generally some attenuation of the pressure waves by the sea bottom but relatively little attenuation of the pressure waves by the water surface.

10.3 Exposure and Response Analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the action's effects on the environment in space and time, and identify the nature of that co-occurrence. As much as feasible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the population(s) or sub-population(s) those individuals represent are identified. Response analyses evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure.

The EAFB estimated exposure to the underwater noise and pressure from munition impacts and detonations that could result in take, as defined under the MMPA, for all marine mammal species including the ESA-listed Rice's whale. The EAFB also estimated exposure to the underwater noise and pressure from munition impacts and detonations that could result in take, as defined under the ESA for listed sea turtles.

Under the MMPA, take is defined as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (16 U.S.C. §1362(13)). There are two levels of harassment further defined under the MMPA (16 U.S.C. §1362(18)) as any act of pursuit, torment, or annoyance which:

- Has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). Under NMFS

regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.

Under the ESA, take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct" (16 U.S.C. §1532(19)). Harm is defined by regulation (50 C.F.R. §222.102) as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering." NMFS does not have a regulatory definition of "harass." However, on December 21, 2016, NMFS issued interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding, or sheltering."

NMFS' interim ESA harass definition does not equate to MMPA Level A or Level B harassment, but shares some similarities with both in the use of the terms "injury/injure" and a focus on a disruption of behavior patterns.

Because there are some differences between the MMPA and ESA standards for harassment, there may be circumstances in which an act is considered harassment, and thus take, under the MMPA but not the ESA. Harassment under the ESA may involve a wide range of behavioral responses for ESA-listed marine mammals including but not limited to avoidance, changes in vocalizations or dive patterns; or disruption of feeding, migrating, or reproductive behaviors. The MMPA Level B harassment exposure estimates do not differentiate between the types of behavioral responses, nor do they provide information regarding the potential fitness or other biological consequences of the responses on the affected individuals. Therefore, in the following sections we consider the best available scientific evidence to determine if these behavioral responses are reasonably certain to occur and if there is a potential for fitness consequences in accordance with the definitions of "take" related to harm or harass under the ESA for ESA-listed species.

In general, exposure estimates are determined by considering:

1. Acoustic thresholds above which NMFS believes the best available science indicates protected species will be behaviorally harassed or incur some degree of permanent hearing impairment or result in some level of injury;
2. The area or volume of water that will be ensonified above these levels in a day and the number of days that is expected to occur; and
3. The density or occurrence of protected species within these ensonified areas.

Additional information (e.g., previous monitoring results or average group size) can qualitatively inform exposure estimates. We adopted the EAFB's exposure estimates and related analysis by the Permits Division because our independent review determined it represented the best available scientific information and relevant methods to evaluate exposure of ESA-listed species to acoustic stressors resulting from the proposed action.

10.3.1 Acoustic Criteria and Thresholds

Acoustic thresholds are the levels of noise and associated pressure used to infer potential impacts to protected species that range from mortality to harassment. Acoustic criteria and thresholds for cetaceans and sea turtles presented in the 2017 *U.S. Navy Acoustic and Explosive Effects Analysis Phase III* (Navy 2017) were utilized for exposure analysis for proposed munitions use in the EGTTR. The Navy Phase III criteria and threshold technical report has been reviewed and accepted by NMFS for analysis of military operations.

The criteria and thresholds used to analyze detonation impacts for the Rice's whale are presented in Table 8.

Table 8. Criteria and thresholds for the Rice's whale.

Mortality	Level A Harassment			Level B Harassment	
	Slight Lung Injury	GI Tract Injury	PTS	TTS	Behavioral
$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Positive Impulse: 906.2 Pa·s	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Positive Impulse: 417.9 Pa·s	Unweighted SPL: 237 dB re 1 μPa	Weighted SEL: 183 dB re 1 μPa²·s	Weighted SEL: 168 dB re 1 μPa²·s	Weighted SEL: 163 dB re 1 μPa²·s
			Unweighted SPL: 219 dB re 1 μPa	Unweighted SPL: 213 dB re 1 μPa	

D = water depth (meters); dB re 1 µPa = decibel(s) referenced to 1 micropascal; dB re 1 µPa2·s = decibel(s) referenced to 1 micropascal-squared second; GI = gastrointestinal; *M* = animal mass based on species (kilograms); Pa·s = pascal second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

The criteria and thresholds used to analyze detonation impacts for sea turtles are presented in Table 9.

Table 9. Criteria and thresholds for sea turtles.

Mortality	Injury			Disturbance	
	Slight Lung Injury	GI Tract Injury	PTS	TTS	Behavioral
$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Positive Impulse: L/G: 211.9 Pa·s KR: 189.8 Pa·s LB: 337.7 Pa·s	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Positive Impulse: L/G: 97.7 Pa·s KR: 87.5 Pa·s LB: 155.7 Pa·s	Unweighted SPL: 237 dB re 1 μPa	Weighted SEL: 204 dB re 1 μPa²·s	Weighted SEL: 189 dB re 1 μPa²·s	Weighted SEL: 175 dB re 1 μPa²·s
			Unweighted SPL: 232 dB re 1 μPa	Unweighted SPL: 226 dB re 1 μPa	

D = water depth (meters); dB re 1 μPa = decibel(s) referenced to 1 micropascal; dB re 1 μPa2·s = decibel(s) referenced to 1 micropascal-squared second; GI = gastrointestinal; KR = Kemp's ridley sea turtle; LB = leatherback sea turtle; L/G = loggerhead and green sea turtle; *M* = animal mass based on species (kilograms); Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

Primary blast injuries result from the compression of a body exposed to the pressure wave of an explosion and are observed as barotrauma of gas-containing organs, such as the lung and gut, and structural damage to the auditory system. Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injuries to the respiratory system may be fatal depending on their severity. Thresholds established for mortality are taxa and species-specific based on the level of impact predicted to cause the onset of unrecoverable lung injury. The mortality threshold is derived based on the positive impulse pressure of the blast. It is calculated using the onset mortality equation presented in the 2017 Navy Phase III Guidance (DoN 2017) and is expressed as pascal-seconds (Pa·s). The equation incorporates source/animal depths and the representative mass of a newborn calf for the affected cetacean species or of a juvenile for each sea turtle species. The thresholds established for mortality are conservative because animals of greater mass can withstand greater pressure, and even more conservative for cetaceans because newborn calves typically account for a very small percentage of the number of individuals in any cetacean population. The Phase III Guidance mass provided for a Bryde's whale calf (680 kg) is used for the Rice's whale, previously known as the Gulf of Mexico Bryde's whale and closely related to Bryde's whale, and there were no values strictly for the Rice's whale. The Phase III Guidance provided masses for juvenile sea turtles of 8.7 kg for the loggerhead and green sea turtle, 6.25 kg for the Kemp's ridley, and 35.18 kg for the leatherback.

Categories of non-lethal injuries from underwater explosions include slight lung injury, gastrointestinal (GI) tract injury, and PTS. Non-injurious impacts from underwater explosions include the harassment categories of TTS and behavioral disturbances.

Similar to the mortality threshold, the onset of slight lung injury is calculated with an equation presented in the 2017 *Navy Phase III Guidance* (Navy 2017) using the cetacean calf mass or the juvenile sea turtle mass. Slight GI tract injuries are correlated to the peak pressure of the blast and have been found to be independent of the animal's size (Goertner 1982). An unweighted SPL of 237 dB re one μPa is used as the GI tract threshold that indicates absolute pressures without adjustments for species- or organ-specific sensitivities and is, therefore, applied to all marine mammals and sea turtles.

Auditory damage that does not fully heal is PTS and it results in a permanent decrease in hearing sensitivity. A recoverable loss of hearing sensitivity is TTS and it is not considered to be an injury because auditory structures are temporarily fatigued and not permanently damaged. Two thresholds are used for PTS and TTS, one based on cumulative SEL and one based on peak SPL of an underwater blast. The more conservative of the two thresholds is applied to afford the most protection to marine mammals. The PTS and TTS thresholds for the Rice's whale are those for low-frequency hearing cetaceans, which are applied to all of the baleen whales. All sea turtles are placed in a single hearing group.

10.3.2 Exposure Estimates

The physical impact of each munition and the unconsumed propellant in certain munitions is added to the NEW of the warhead to derive the NEWi for each live munition, which results in a more accurate estimate of the actual energy released by each detonation. Propellant in solid rocket motors can contribute to the detonation energy and the impact analysis assumes that 20 percent of the solid rocket motor propellant could remain unconsumed in missiles at impact. This assumption by EAFB was based on input from EGGTR user groups and considered a reasonable estimate for analysis.

Different explosive formulations can produce unique correlations to explosive performance metrics. The peak pressure and pressure decay constant depend on the NEWi, explosive formulation, and distance from the detonation. The peak pressure and duration of the impulse for each munition can be calculated empirically with similitude equations, with constants used in these equations determined from experimental data (NSWC 2017). The munition-specific peak pressure and pressure decays for all munitions were used, as well as a time-series input for cumulative SEL (24-hour), in the underwater acoustic model (App B) to determine the distances to acoustic criteria and thresholds for mortality, slight lung injury, PTS, TTS, and behavioral effects for each protected species and mission-day category.

To assess the potential impacts of inert munitions, the proposed inert munitions were categorized into four classes based on their impact energies, and the threshold distances for each class were modeled and calculated as described for the mission-day categories. Table 10 presents the impact energy classes developed for the proposed inert munitions. The four impact energy classes represent the entire suite of inert munitions proposed to be used in the EGTTR during the next mission period (Table 1, App A). The impact energy is the portion of the kinetic energy at impact that is transmitted as an underwater pressure impulse, expressed in units of TNT-equivalent (TNTeq). The 2 lb class represents the largest inert bombs and the 1 lb class represents the largest inert missile. As indicated in Table 10, the JASSM has greater mass but lower impact energy than the GBU-31. This is due to the JASSM's lower velocity at impact and associated change in velocity over the deceleration period contributing to the pressure impulse. The 0.5 lb and 0.15 lb impact energy classes each represent the approximate average impact energy of multiple munitions, with the 0.5 lb class representing a mid-level energy category and the 0.15 lb class representing the munitions with the lowest energies.

Table 10. Impact energy classes for proposed inert munitions

Impact Energy Class (lb TNT_{eq})	Representative Munitions	Approximate Weight (lb)	Approximate Velocity (Mach)
2	Mk-84, GBU-10, and GBU-31	2,000	1.1
1	AGM-158 JASSM	2,250	0.9
0.5	GBU-54 and AIM-120	250 to 650	Variable
0.15	AIM-9, GBU-39, and PGU-15	1 to 285	Variable

AGM = Air-to-Ground Missile; AIM = Air Intercept Missile; GBU = Guided Bomb Unit; JASSM = Joint Air-to-Surface Standoff Missile; lb = pound(s); Mk = Mark; PGU = Projectile Gun Unit; TNTeq = trinitrotoluene-equivalent

Threshold distances were used to calculate the ZOI (see Zone of Influence, in Section 3.3.2) for each effect threshold. The ZOI is the circular area around the detonation point within which the various established thresholds for pressure and impulsive noise are experienced by the animal. The thresholds resemble concentric circles within the ZOI, with the most severe (mortality) being closest to the center (detonation point) and the least severe (behavioral disturbance) being farthest from the center. The areas encompassed by the concentric thresholds are the impact areas associated with the applicable criteria. The model was run assuming that the detonation point is at the center of the existing LIA, the SEL threshold distances are the same for the proposed East LIA, and all missions are conducted in either the existing LIA or proposed East LIA. Model outputs for the two LIAs are statistically the same as a result of similarities in water depths, sea bottom profiles, water temperatures, and other environmental characteristics.

The NOAA Southeast Fisheries Science Center developed spatial density models for several protected species in the Gulf of Mexico, including the Rice's whale and sea turtles in this opinion[11] (NMFS 2022). The density models integrated visual observations from aerial and shipboard surveys conducted in the Gulf of Mexico from 2003 to 2019 and are considered the best available information to inform density estimates for the action area.

The spatial density models generate densities for 40 km^2 areas in a hexagon-shaped grid as a raster layer in the geographic information system (GIS). The grid area within each ZOI were computed in GIS and coupled with their respective modeled average annual densities to estimate the number of animals that could be exposed to sound at or above threshold levels for each mission-day category. The resulting abundance estimates were summed together and then multiplied by the number of annual missions proposed to estimate annual takes.

- [11] https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:0256800

Rice’s Whale

The threshold distances estimated for the Rice’s whale for live missions in the existing LIA are presented in Table 6a and inert munitions in Table 6b, Appendix A. Figure 22 shows the estimated Rice’s whale threshold distances and associated ZOIs for mission-day category A, J, and P and use of a 2 lb class inert munition at the location where the GRATV is typically anchored in the existing LIA. Mission-day category A has the largest total cumulative energy of all the mission-day categories. Mission-day category J represents the most powerful single detonation proposed, which would be a subsurface detonation of a bomb with a NEW of 945 lb. Mission-day category P represents a mission with relatively low cumulative energy, and the 2 lb class inert munition is the largest inert munition in terms of kinetic energy at impact and is represented by a 2,000 lb inert bomb. As indicated in Figure 22, portions of the ZOIs of mission-day categories A and J extend into Rice's whale habitat, whereas the ZOIs for mission-day category P and the largest inert munition are entirely outside Rice’s whale habitat.

Figure 23 shows the ZOIs of mission-day category A at the current GRATV anchoring site. Portions of the TTS and behavioral disturbance ZOIs are within grids of modeled density greater than zero individuals per 40 km^2. These areas have lower probability of occurrence for the Rice’s whale than farther to the southwest, outside the LIA. Estimated annual take calculations summed for all missions in the LIA centered at the GRATV resulted in a total of 0.04 TTS and 0.10 behavioral disturbance. This indicates that, if all the missions for a given year were conducted at the current GRATV site, they would not result in a single take of the Rice’s whale.

For comparison, Figure 24 shows the ZOIs of mission-day category A at the center of the proposed East LIA. A small portion of the behavioral disturbance ZOI encompasses a grid of low modeled density, with grids of higher density being farther to the southwest.

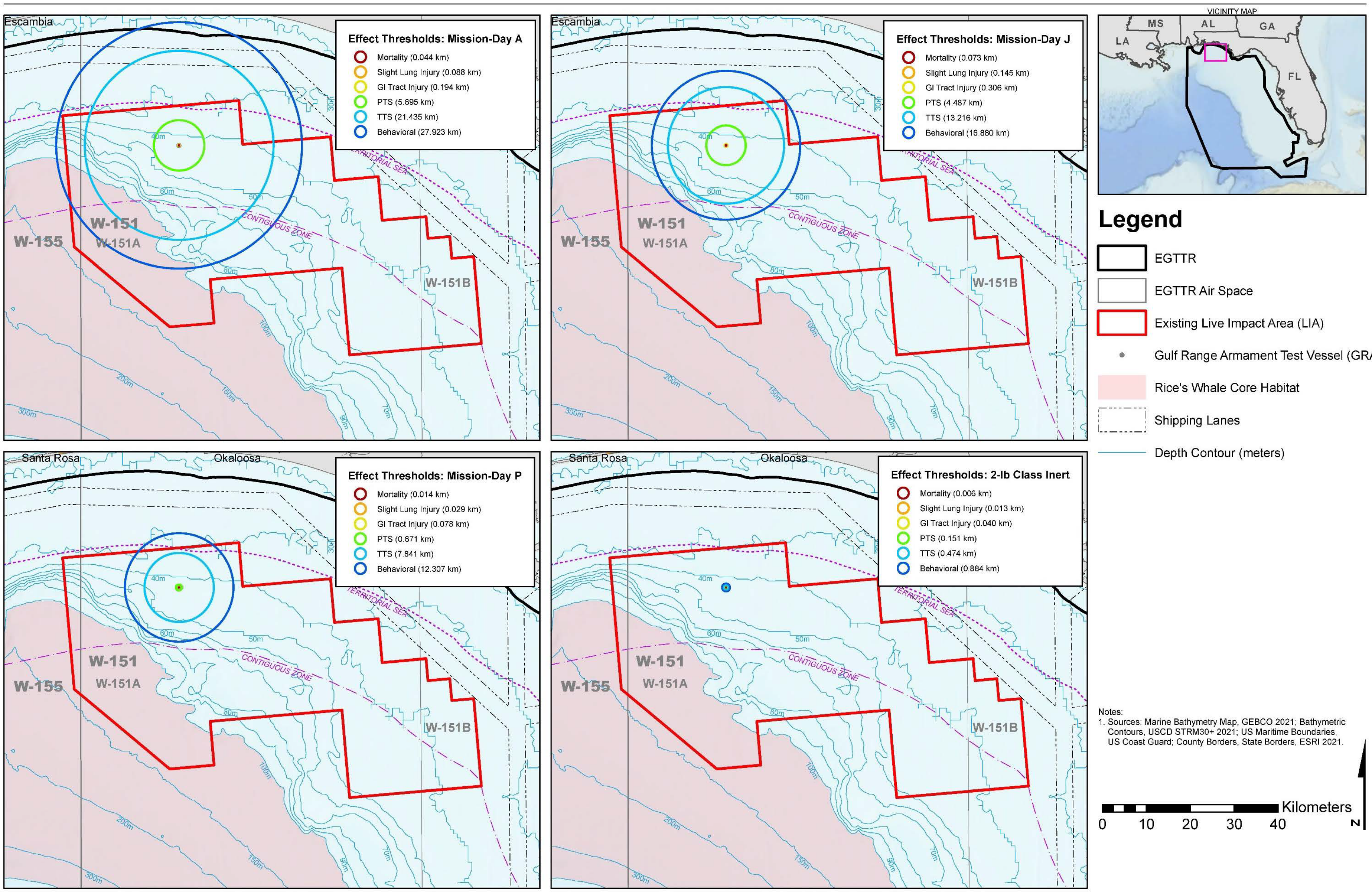

Figure 22. GRATV site ZOIs for Rice's whale.

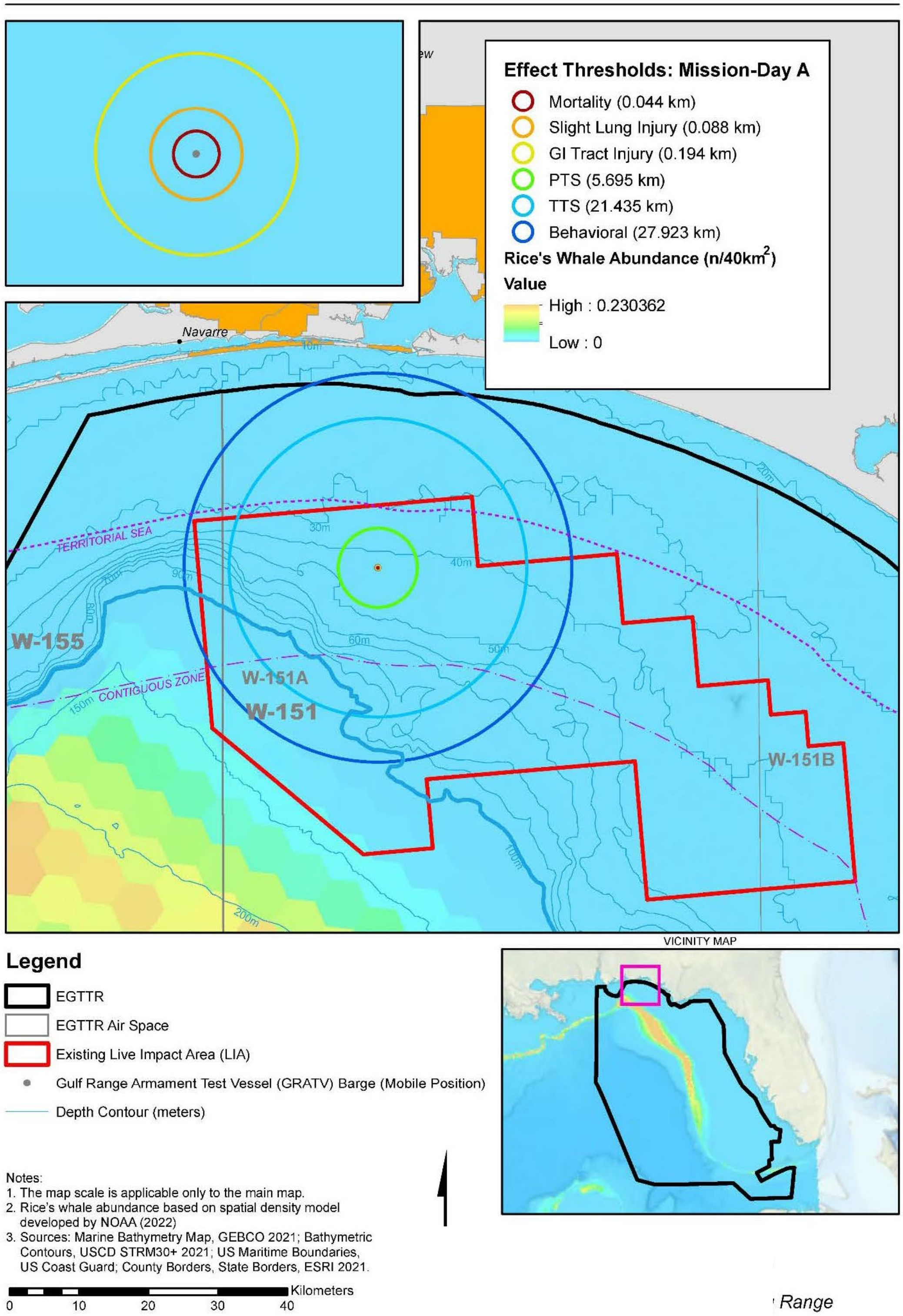

Figure 23. Mission-day A LIA GRATV site ZOIs for Rice's whale.

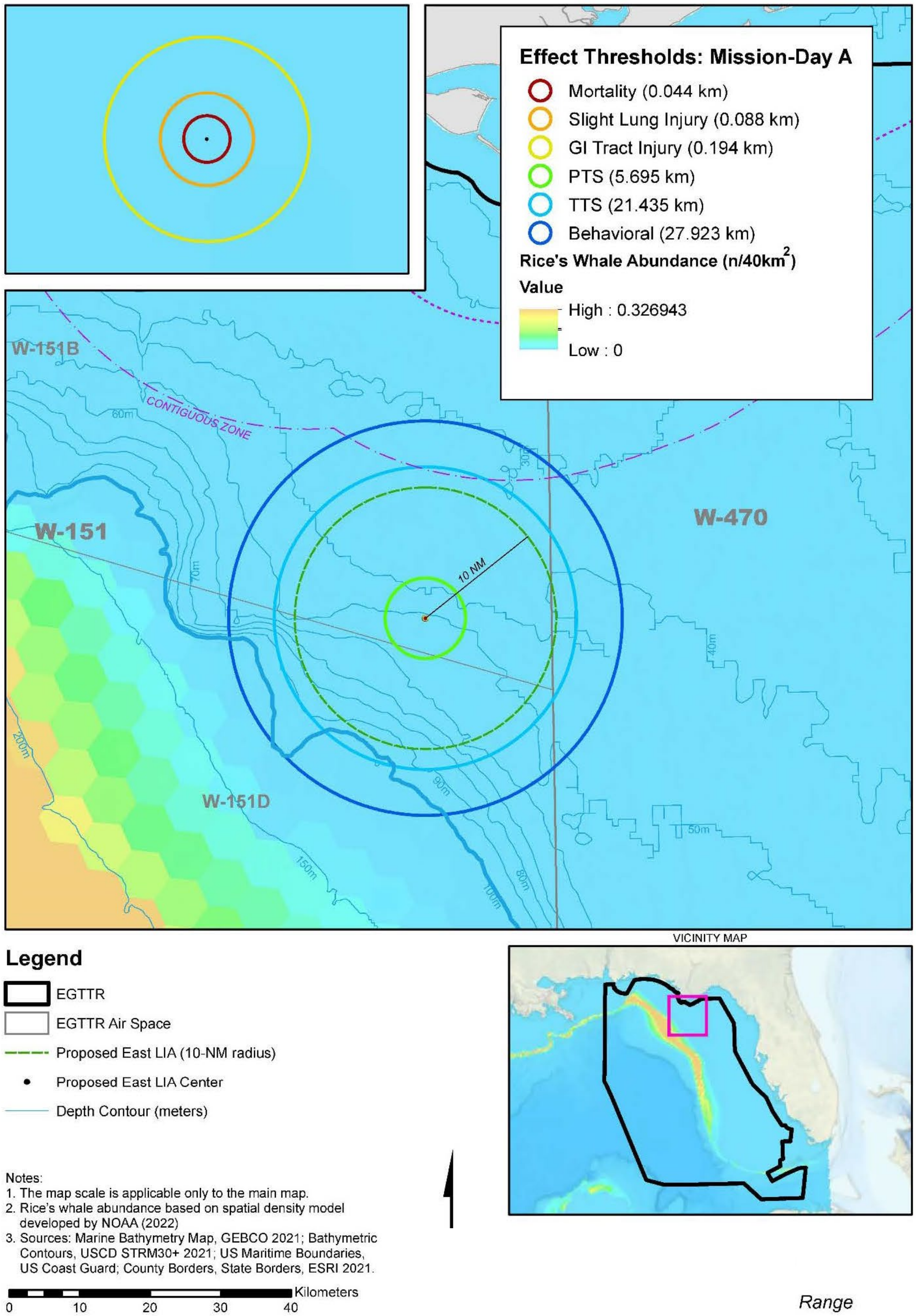

Figure 24. Mission-day A central East LIA ZOIs for Rice's whale.

Certain missions could have a PTS impact if they were to be conducted farther to the southwest within the LIAs closer to Rice's whale habitat, as defined by the 100-m isobath. The modeled threshold distances were used to determine the locations in the existing LIA and proposed East LIA where each mission-day category would cause the onset of PTS, measured as a setback from the 100 m isobath. At the setback locations, the missions would avoid PTS and result only in non-injury MMPA Level B harassment, if one or more Rice's whales were in the affected habitat. The setback distances are based on the longest distance predicted by the dBSea model for a cumulative SEL of 168 dB within the ZOI; the predicted average cumulative SEL is used as the basis of effect for estimating takes. The setback distances determined for the mission-day categories (Table 5, App A) are shown for the existing LIA and proposed East LIA on Figure 25 and Figure 26, respectively.

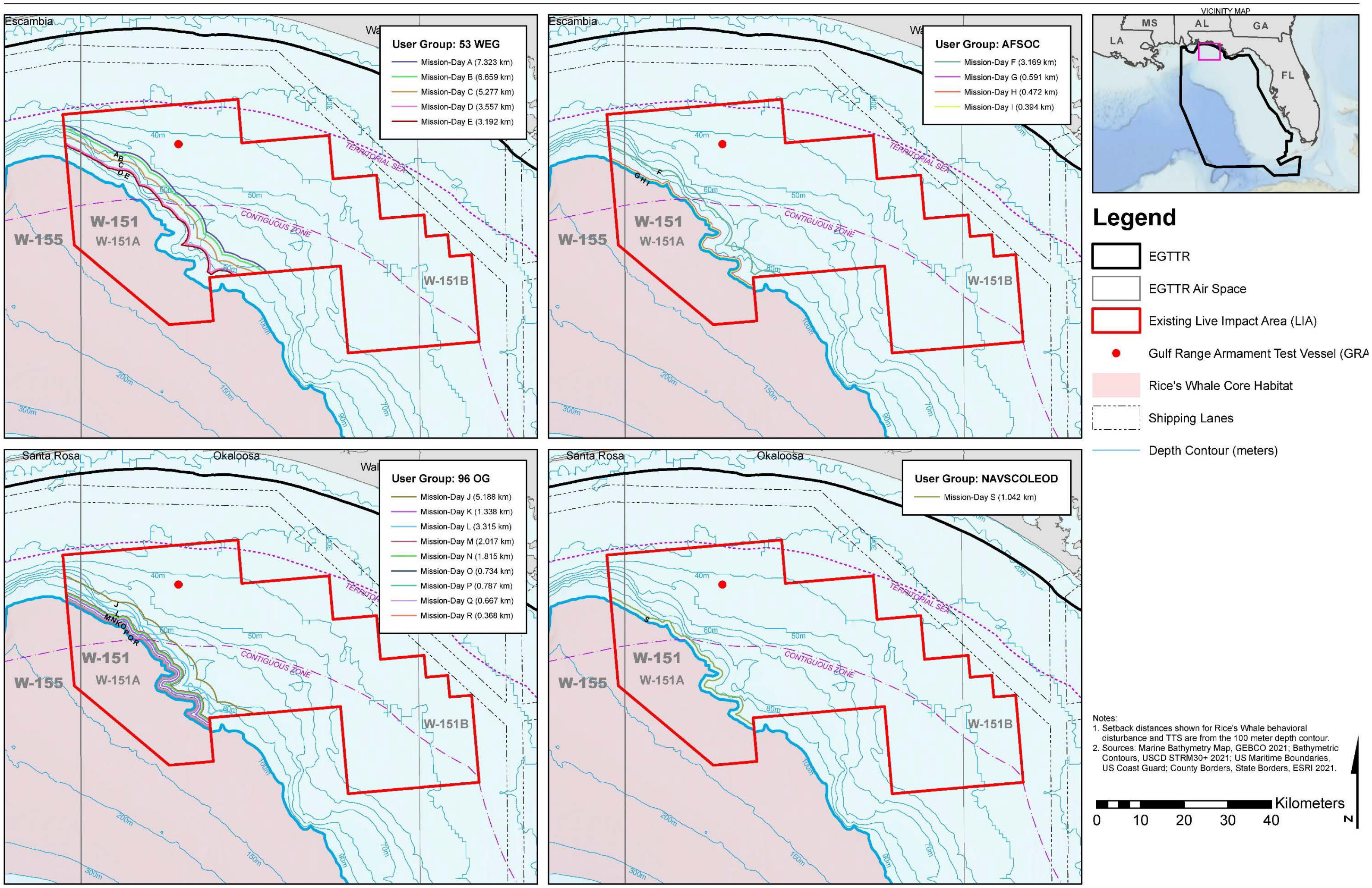

Figure 25. Mission-day setbacks for Rice's whale in the LIA.

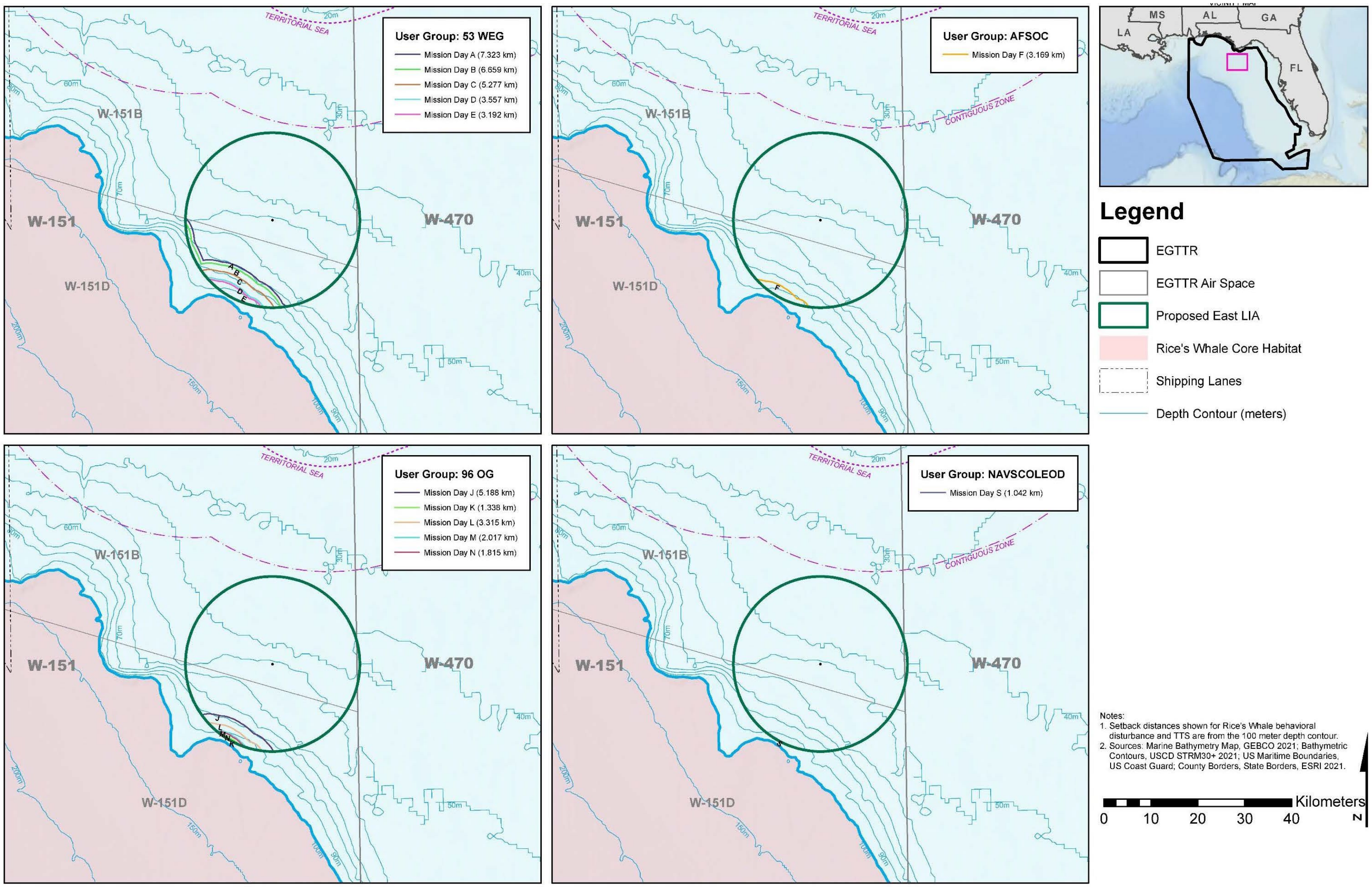

Figure 26. Mission-day setbacks for Rice's Whale in the East LIA.

Locating a given mission in the LIA at its respective setback distance would represent the maximum Level B harassment scenario for the mission. Conducting all missions at their respective setbacks is analyzed to provide a worst-case estimate of takes but it is not a realistic scenario as missions are often focusing on targets closer to the GRATV or center of the ELIA. The take calculations for the maximum MMPA Level B harassment scenario for detonations in the existing LIA resulted in a total of 0.49 annual TTS take and 1.19 annual behavioral disturbance takes (Table 11). These takes are overestimates because a considerable portion of all missions in the LIA are expected to continue to be conducted at or near the currently used GRATV site. These takes would not be exceeded because all missions would be conducted behind their identified setbacks as a new mitigation measure to prevent injury to the Rice's whale. Take calculations for the maximum MMPA Level B harassment scenario for detonations in the East LIA resulted in 0.63 annual TTS take and 2.33 annual behavioral disturbance takes (Table 11).

Table 11. Annual takes of the Rice's whale under the proposed action.

Mission	Mortality	Level A Harassment		Level B Harassment	
		Injury[a]	PTS	TTS	Behavioral
Missions at Existing LIA	0	0	0	0.49	1.19
Missions at East LIA	0	0	0	0.63	2.33
90 Percent of Existing LIA Missions	0	0	0	0.441	1.071
10 Percent of East LIA Missions	0	0	0	0.063	0.233
Daytime Gunnery Missions	0	0	0	0.08	0.30
Nighttime Gunnery Missions	0	0	0	0.03	0.09
Total	0	0	0	0.61	1.69
Total Takes Requested	0	0	0	2[b]	4[b]

a Slight lung and/or gastrointestinal tract injury

b Estimated takes rounded to nearest whole number and then doubled based on an average group size of two animals

LIA = Live Impact Area; PTS = permanent threshold shift; TTS = temporary threshold shift

As a mitigation measure to prevent any PTS impacts to the Rice's whale during the next mission period, the EAFB will restrict live munitions use in the LIAs in accordance with the identified setback distances. The energy and effects of the actual mission will not exceed the energy and effects estimated for the corresponding mission-day category.

All gunnery missions during the 2023–2030 period will be conducted at least 500 m landward of the 100 m isobath to prevent any PTS impacts to the Rice's whale. This setback distance is based on the modeled PTS threshold distance for daytime gunnery missions (mission-day G) of 494 m (Table 6a, App A). The PTS ZOI of a nighttime gunnery mission, which is 401 m in radius, is contained farther landward of the habitat boundary. If all gunnery missions were conducted at the 500 m setback from the habitat boundary, the resulting effects would represent the maximum MMPA Level B harassment takes that would result for all gunnery missions. The take calculations estimated 0.003 TTS and 0.012 behavioral disturbance per daytime gunnery mission and 0.0006 TTS and 0.002 behavioral disturbance per nighttime gunnery mission. The resulting annual takes for all 25 proposed daytime gunnery missions are 0.08 TTS take and 0.30 behavioral disturbance take, and the resulting annual takes for all 45 proposed nighttime gunnery missions are 0.03 TTS take and 0.09 behavioral disturbance take (Table 11). This is a conservative estimation of MMPA Level B harassment takes because all gunnery missions would not be conducted precisely 500 m landward of the 100 m isobath as assumed under this worst-case take scenario. Gunnery mission locations are expected to continue to be conducted in waters considerably shallower than 100 m.

The annual maximum MMPA Level B harassment takes estimated for daytime gunnery missions (mission-day G) and nighttime gunnery missions (mission-day H) are combined with the annual maximum Level B harassment takes estimated for the other mission-day categories to determine the total takes of the Rice's whale from all EGTTR operations during the next mission period. The total takes must account for missions conducted in both the existing LIA and proposed East LIA during the next mission period. To estimate detonation takes in both LIAs collectively, the take estimates for each LIA were weighted based on the expected usage of each LIA over the 7-year mission period, which was determined based on input provided by the user groups. Of the total number of missions proposed, 90 percent are expected to be conducted in the existing LIA, and 10 percent are expected to be conducted in the proposed East LIA. Therefore, the collective detonation takes are the sum of 90 percent of the takes in the existing LIA and 10 percent of the takes in the proposed East LIA. It is possible the usage ratio could change over time as mission needs change. If the usage ratio changes substantially in the future, Eglin AFB would re-evaluate the exposure estimates and confer with NMFS to determine whether to reinitiate consultation.

The calculated annual takes of the Rice's whale that could occur from the proposed activities were 0.61 TTS and 1.69 behavioral (Table 11). As guided by the Permits Division, the annual requested takes are derived by rounding the calculated takes to the nearest whole number and multiplying by two based on the average group size of two animals for the Rice's whale (Maze-Foley and Mullin 2007), resulting in 2 TTS takes and 4 behavioral takes requested annually.

Because the whole population of Rice's whale is endemic to the Gulf of Mexico and present all year, there is no expected difference in the probabilities of exposure based on sex or age classes of the Rice's whale.

Sea Turtles

The sea turtle species threshold distances to exposure to acoustic stressors estimated for the live missions in the existing LIA are presented in Table 4a, App A. When compared to threshold distances for the Rice's whale (Table 6a, App A), sea turtles have much smaller threshold distances and associated ZOIs for PTS, TTS, and behavioral disturbance. This is a result of sea turtles having higher established threshold values based on lower sensitivity to these effects. Unlike for the Rice's whale, the peak SPL-based PTS and TTS thresholds for sea turtles are more conservative than the SEL-based thresholds; therefore, they were used to estimate the associated PTS and TTS effects on sea turtles. In contrast, the mortality and slight lung injury threshold distances are greater for sea turtles than the Rice's whale because those include the weight of the individual animal and a young whale weighs considerably more than sea turtles.

The annual takes of sea turtles estimated from the proposed munition impact and detonation activities are presented in Table 12. In the same manner as calculated for the Rice's whale takes, takes of each sea turtle species for each LIA were weighted based on the expected usage of the area. Calculations resulted in a total annual estimate of 9 mortalities, 21 injuries, 13 PTS, 53 TTS and 6 behavioral disturbances during the next 7-year mission period. Some of the calculated takes were less than 0.5; however, a take of one is assigned to these because, during the course of the 7-year mission period, it is reasonable to expect that a take may happen in any given year.

The unweighted peak SPL values for PTS and TTS resulted in substantially larger threshold distances than the weighted SELs (see Table 4a, App A). Only the weighted SEL is applied for the sea turtle behavioral disturbance criterion (see Table 9, Acoustic Criteria); therefore, those take estimates were considerably lower.

Table 12. Annual takes of sea turtles under the proposed action.

Species	Mortality	Injury[a]	PTS	TTS	Behavioral Disturbance
Loggerhead sea turtle	6	17	10	47	3
Kemp's ridley sea turtle	1	2	1	3	1[b]
Leatherback sea turtle	1[b]	1[b]	1	2	1[b]
Green sea turtle	1[b]	1[b]	1[b]	1[b]	1[b]
Total	9	21	13	53	6

a Slight lung injury or gastrointestinal tract injury.
b Calculated take estimate was less than 0.5, but assigned a value of one as that take could happen in any one given year.

The presented takes are overestimates of actual exposure based on the conservative assumption that all proposed detonations would occur at or just below the water surface instead of a portion occurring upon impact with targets. These take estimates also do not take into account the protected species monitoring and mitigation measures implemented for EGTTR operations, which are expected to reduce the overall potential for injurious and non-injurious impacts to sea turtles.

10.3.3 Response Analysis

As a result of using live munitions during the proposed activities, ESA-listed sea turtles and Rice's whale may be exposed to sound at or above acoustic thresholds that NMFS believes the best available science indicates protected species could be behaviorally harassed or incur some degree of permanent hearing impairment or result in some level of injury. Our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might result in reduced fitness of ESA-listed individuals. Response analyses consider and weigh evidence of adverse consequences, as well as evidence suggesting the absence of such consequences.

Rice's whale

The underwater acoustic modeling and associated analyses indicate that all the proposed live EGTTR missions combined could result in a total of two annual TTS and four annual behavioral disturbances resulting in harassment of the Rice's whale during the 2023–2030 mission period. The requested takes are conservative estimates because they represent the maximum MMPA Level B harassment scenario for all missions, which we have determined are equivalent to ESA take in this case as explained previously. These takes are also based on the conservative assumption that all proposed detonations would occur at or just below the water surface instead of a portion occurring upon impact with targets. Even with the conservation assumptions, there is no expectation of mortality or injuries from exposures.

Mysticetes exposed to impulsive sounds may react in a variety of ways, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, changing vocalization, or showing no response at all (Nowacek et al. 2007; Richardson et al. 1995a; Southall et al. 2008). Mysticetes may be more reactive to acoustic disturbance when a noise source is located directly in their path or the source is nearby (somewhat independent of the sound level) (Dunlop et al. 2016; Dunlop et al. 2018; Ellison et al. 2012a; Friedlaender et al. 2016; Henderson et al. 2019; Malme et al. 1985; Richardson et al. 1995a; Southall et al. 2007a). Impulsive sounds with a rapid rise and high peak pressures, such as from explosives, are more likely to cause startle or avoidance responses than longer duration sounds without high peaks. Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012b; Harris et al. 2018)

We expect the greatest response of marine mammals to munition impact and detonation sounds in terms of number of responses and overall impact will be in the form of changes in behavior. ESA-listed individuals may briefly respond to underwater sound by slightly changing their behavior or relocating a short distance. Displacement from important feeding or breeding areas over a prolonged period would likely be more significant for individuals and could affect the population depending on the extent of the feeding area and duration of displacement. Avoiding an area for some amount of time could impact an animal's feeding effort and moving to another spot that may or may not have the same value of prey items at that time. If an animal happens to get close enough to the sound source to receive a comparatively higher level, it could result in a more severe flight response, leaving a larger area for a day or more, and potentially reduced feeding opportunities.

Interference, or masking, occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Clark et al. 2009; Erbe et al. 2016). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options (Francis and Barber 2013). Masking of biologically important sound is more likely to occur in the presence of relatively continuous noise sources and less likely during intermittent impulsive sounds.

A TTS results in a temporary change to hearing sensitivity (Finneran 2013), and the impairment can last minutes to days, but full recovery of hearing sensitivity is expected. We also assume that any individuals exposed to sound levels sufficient to trigger onset of TTS will also experience physiological stress response (NMFS 2006; NRC 2003c). Finally, we assume that some individuals exposed at sound levels below those required to induce a TTS, but above the 160 dB re: one μPa (rms) threshold for significant behavioral response, will experience some sort of stress response, which may also be associated with an overt behavioral response. However, exposure to munition sounds are expected to be temporary so we expect any such stress responses to be short-term. Given the available data, animals will be expected to return to baseline state (e.g., baseline cortisol level) within hours to days, with the duration of the stress response depending on the severity of the exposure (i.e., we expect a TTS exposure will result in a longer duration response before returning to a baseline state as compared to exposure to levels below the TTS threshold).

The utilization of the mission category-based setback distances from the 100 m isobath will avoid having more intense sounds encroach on areas with higher probabilities of Rice's whale occurrence. The few estimated instances of lower level exposures could result in some degree of harassment on an annual basis. These exposures are based on conservative assumptions, suggesting they are not likely to be of high intensity. There could be a startle response that is relatively mild and possibly an aversion to the stimulus such as change in swimming direction to create distance from the sound source. This could result in a low level physiological stress responses (e.g., brief change in respiration or heart rate) but is likely to be short-term and therefore unlikely to result in serious fitness consequences.

Sea turtles

The underwater acoustic modeling and associated analyses indicate that detonations under the proposed activities have the potential to kill, injure, cause hearing threshold shifts, and disturb sea turtles species. The presented exposure estimates are overestimates of actual exposure based on the conservative assumptions used and they do not take into account marine species monitoring and mitigation measures implemented for the protection of sea turtles and marine mammals during EGTTR missions. Based on the potential for sea turtles to not be detected during pre-mission monitoring due to be being submerged or other factors, detonations are expected to potentially impact sea turtles; the actual number of sea turtles that may be impacted are expected to be lower than estimated by the acoustic modeling and associated analyses because these estimates are conservative.

Potential impacts include non-injurious and injurious effects. Injurious effects include non-lethal and lethal injury (Viada et al. 2008). Non-injurious effects include behavioral disturbance such as a momentary startle response or temporary disorientation that could result from detonations of lower intensity or of sufficient distance to be detected but not injurious (Viada et al. 2008).

Death of an individual sea turtle could impact the reproductive potential it might have contributed to the population or sub-population. This lost reproductive potential will vary depending on the sex (male or female) and maturity of the individual. The death of a male would have less of an effect on the population than the loss of a female. Loss of a sexually mature female will have immediate effects on recruitment while lost reproductive potential from mortality of a juvenile female might not be realized for several years.

Hearing loss from TTS recovers to the original hearing threshold over a period of several minutes to several days, depending on the intensity and duration of the sound exposure that induced the threshold shift. An animal may not notice the TTS, but may require louder sound stimulus (relative to the amount of TTS) to detect a sound within the affected frequencies. PTS is a permanent hearing loss at a certain frequency range. PTS is non-recoverable due to the destruction of tissues within the auditory system. The animal does not become deaf, but requires a louder sound stimulus (relative to the amount of PTS) to detect a sound within the affected frequencies.

Sea turtles are not known to rely heavily on sound for life functions (Nelms et al. 2016; Popper et al. 2014). They have relatively poor auditory sensitivity, and their functional hearing is restricted to relatively low frequencies, below approximately 2 kHz (DoN 2017). Based on knowledge of their sensory biology (Bartol and Ketten 2006; Moein Bartol and Musick 2003), sea turtles may be able to detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on their vision than auditory cues (Hazel et al. 2007). Similarly, while sea turtles may rely on acoustic cues to identify nesting beaches, they appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann and Lohmann 1996a; Lohmann and Lohmann 1996b) and light (Avens and Lohmann 2003). Additionally, they are not known to produce sounds underwater for communication.

Effects that could occur at lower exposure levels include masking, temporary habitat displacement, or short term behavioral responses (e.g., a startle response, changes in respiration, alteration of swim speed, or direction). The response of a sea turtle to an explosion from EGTTR activities may depend on the animal's prior experience with the sound, the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure) and distance from the sound source.

When noise has a sound level above a sound of interest, and in a similar frequency band, auditory masking could occur, which reduces an animal's ability to detect the sound of interest. A continuous sound would have more potential for masking than an intermittent sound source (e.g., explosives) as masking only occurs in the presence of the sound stimulus. Intermittent explosive use is not expected to result in prolonged periods where masking could occur, reducing the likelihood of the proposed action causing masking that could result in negative fitness impacts to sea turtles.

Instances of disturbance where a sea turtle avoids the area where detonations are occurring is expected to result in an energy expenditure by the sea turtle to move away. Leaving the area or other behavioral responses (e.g., startle response) also have the potential for disrupted feeding or resting opportunities. Proposed missions consist of a limited number of detonations and in the past five years there was an average of 4 days per year for live targeting missions (see Section 12). Such instances of disturbance are expected to be temporary, with the sea turtle being able to return to the area shortly after detonations cease. There could be some fitness consequences for a sea turtle if an individual could not compensate for reduced feeding opportunities by feeding nearby or within a short time after cessation of acoustic exposure. There is no indication that foraging habitat would not be available in the environment following the cessation of acoustic exposure. Similarly, if an animal's rest was disrupted, we would expect the individual would be able to resume resting immediately after the detonations ceased or rest in alternative locations once the animal moves from the area. For these reasons, disturbance of sea turtles from EGTTR activities is unlikely to lead to long-term fitness consequences.

11 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). The development of offshore wind and offshore aquaculture are expected to begin within the next few years in the central and western portions of the Gulf of Mexico. However, most if not all of this development has a Federal nexus and future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The Gulf of Mexico is a busy place with high vessel activity, both commercial and private, and anthropogenic noise sources. We expect aspects described in the Environmental Baseline (Section 9) will continue to impact ESA-listed resources into the foreseeable future.

There have been efforts towards fisheries bycatch reduction for sea turtles, most notably in the use of Turtle Excluder Devices.[12]

During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions that were reasonably certain to occur in the action area. Results from electronic search engines (i.e., *Google*) indicate plans for coastal projects focused on development, resilience, habitat restoration, and beach renourishment. Coastal projects near the water's edge are likely going to require Federal authorization (e.g., US Army Corp of Engineers permits), especially if they reach the intertidal or subtidal zone, that will be subject to consultation pursuant to section 7 of the ESA and are not considered part of the cumulative effects. Future tribal, state, and local government activities will likely be limited in the action area because of the restrictions needed to maintain range clearance and safety for military testing and training operations.

12 Integrated Risk Assessment

In order to comprehensively assess the risk posed to the ESA-listed species that are likely to be adversely affected by the proposed action, we integrate the *Effects of the Action* (Section 10), with the *Status of the Species* (Section 8), the *Environmental Baseline* (Section 9), and the *Cumulative Effects* (Section 11). The resulting synthesis supports the agency's biological opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing its numbers, reproduction, or distribution.

Estimates of exposure from the proposed action stressors that are likely to adversely affect Rice's whale and sea turtles, specifically acoustic stressors from detonations, is fundamental for the risk assessment. Assumptions applied in calculating exposures make the estimates conservative, which likely results in some level of overestimation of take. It was assumed that all proposed detonations would occur at or just below the water surface instead of a considerable portion occurring upon impact with target above the surface of the water, which would result in less acoustic impulse propagating underwater. Mission-day categories were chosen to ensure the expected cumulative acoustic energy from the mission is contained in the category, but the amounts may not be an exact match and the mission-day category could be a greater total then the actual cumulative acoustic energy from the munitions expended. These conservative assumptions reduce the overall likelihood of exposure and the intensity of species' response to exposures that result in take.

The potential for exposures is reduced by conducting pre-mission surveys to minimize impacts to protected species by restricting activities when animals are observed. Sea state, daylight, and visibility restriction criteria help ensure the ability of observers to visually detect protected

[12] https://www.fisheries.noaa.gov/southeast/bycatch/fishing-gear-turtle-excluder-devices

species during the surveys. The use of live video of the target area during missions supplements monitoring to help reduce the potential for animals to enter the ZOI.

Another consideration is the total number of missions that actually happen on an annual basis, which has been significantly less than what has been proposed historically. Mission-day activities are often cancelled due to weather (e.g., low cloud cover not conducive to air operations) or technical issues (e.g., equipment malfunction). There were 70 strictly-gunnery missions and 45 live weapons missions per year proposed during the 2018-2023 mission period, but the actual mission-days in 2018, 2019, 2020, 2021, and 2022, were: 0, 8, 6, 10, 3 gunnery and 4, 3, 4, 3, 5 live weapons. Additionally, many mission-days feature only a single or limited number of explosive munitions. It should also be noted that there has been no evidence of any adverse impact to any sea turtles or marine mammals found during monitoring of past EGTTR operations by trained marine species observers.

The following subsections separately summarize the integrated risk assessments for the Rice's whale and sea turtles.

12.1 Rice's whale

Although the Gulf of Mexico was not considered 'prime' whaling grounds, records indicate commercial whaling did happen from approximately the mid-1700s up to the late 1800s (Reeves et al. 2011b). Efforts focused on sperm whales, but whaling logbooks note occasional records of attempting to take finback whales, which could have been Rice's whales because other baleens are considered extra-limital to the area (Reeves et al. 2011b). The extent whaling had an impact on the Rice's whale historic population is not known.

More recent impacts to the Rice's whale occurred from the DWH oil spill. Modeling results indicate there may have been up to a 22% reduction in their population size due to the spill (DWH MMIQT 2015). It should be noted the population model had a number of sources of uncertainty; parameters were derived from literature sources for Bryde's whales occupying waters outside of the Gulf of Mexico and proxy values for the effects of DWH oil exposure were based upon estimated values for common bottlenose dolphins. The actual reduction in population size may be uncertain but evidence still supports a substantial impact to Rice's whales from that catastrophic oil spill.

Ongoing threats include vessel strike. Ports in the Gulf of Mexico handle nearly half the tonnage of the top 150 US ports (USACE 2015), primarily in Louisiana and Texas, which results in a considerable amount of large vessel traffic which poses a risk of vessel strike, especially to large whales like the Rice's whale (Laist et al. 2001).

The best abundance estimate for the Rice's whale (formerly the Gulf of Mexico Bryde's whale) is 51 animals with a minimum population estimate of 34 (NMFS 2021). These estimates are from surveys conducted by the US and it is not known if there are areas in the Mexico portion of the Gulf of Mexico waters that have other Rice's whales that could be a part of this population. Genetic data displays low genetic diversity for Rice's whale (NMFS 2021), which is often the case for small population sizes, suggesting low capacity for resilience in response to random demographic events. The restricted range also limits capacity for resilience in response to significant environmental changes.

The EAFB has been training and testing in the EGTTR for decades and the mitigation measures for the proposed 7-year mission period that is the subject of this consultation have incorporated considerable improvements in conservation measures that should benefit Rice's whale conservation. Most notable is that all live missions, including gunnery missions, will be conducted according to setback distances (based on PTS threshold distances) landward from the 100 m isobath. Previously there were no setbacks and missions were restricted landward of the 200 m isobaths. The EAFB will also prohibit the use of inert munitions in a Rice's whale exclusion area, between the 100 m and 400 m isobaths throughout the EGTTR, during the next mission period. A result of these proposed measures is that the EAFB is removing activities from an appreciable amount of testing and training area in the Gulf of Mexico to protect the Rice's whale.

Estimates of exposure to effects from munition impact and detonations anticipate two TTS and four behavioral disturbances annually for Rice's whale. As previously stated, there are assumptions that make the estimates conservative. Another conservative assumption for Rice's whale exposure is that missions will be conducted at its respective setback distance, representing the maximum MMPA Level B harassment scenario for that mission. Conducting all missions at their respective setbacks was analyzed to provide a worst-case estimate of takes, but it is not a realistic scenario because missions are often focusing on targets closer to the GRATV or center of the ELIA.

In the response analysis, we noted that cases of TTS are temporary and expected to be of short duration. TTS categorized as of longer duration is expected to last hours or at most a few days (Finneran 2015). The brief amount of time marine mammals are expected to experience TTS is unlikely to significantly impair their ability to communicate, forage, or breed and is not expected to have long-term fitness consequences for the individuals affected. We also determined that any instances of behavioral response due to acoustic stressors resulting from the use of explosives are likely to be temporary. The Rice's whale may alert to the sound source, alter foraging behavior, or exhibit avoidance behavior. However, these responses are expected to be temporary with behavior returning to a baseline state shortly after the use of explosives ends. Due to the short duration of any expected behavioral responses to explosives and the limited number of behavioral responses rising to the level of take that are reasonably certain to occur, we do not anticipate behavioral responses due to explosive use will result in long-term fitness consequences to affected Rice's whales. This is supported by several studies that indicate infrequent exposures resulting in behavioral disruptions lasting a short time are unlikely to result in long-term consequences to the exposed animals (Farmer et al. 2018; Harris et al. 2017; King et al. 2015; NAS 2017; New et al. 2014; Southall et al. 2007b; Villegas-Amtmann et al. 2015).

The *Rice's Whale Recovery Outline*[13]identifies vessel interactions and anthropogenic noise as leading concerns for Rice's whale conservation. The *Recovery Outline* provides an interim recovery strategy with a primary focus on controlling threats to the species in its known range and an interim recovery action is to include Rice's whales in relevant ESA Section 7 Consultations. This EGTTR consultation includes measures to exclude activities in the Rice's whale known range to reduce the potential for exposure to anthropogenic noise and vessel interactions.

In summary, because instances of behavioral response and TTS due to explosives are not anticipated to result in long-term fitness consequences to affected Rice's whales, we do not anticipate reductions in overall reproduction, abundance, or distribution of this species or impeding the recovery objectives for the species. For this reason, the effects of the proposed action are not expected to cause an appreciable reduction in the likelihood of survival and recovery of Gulf of Mexico Bryde's whales in the wild.

12.2 Sea turtles

Most sea turtle populations have suffered reductions from human harvesting of multiple sea turtle life stages (from eggs to adult sea turtles), degradation of beach nesting habitats, as well as bycatch in fishing industries worldwide.

Total estimates of annual exposure and associated response, for all four of the sea turtles species analyzed, to effects from munition impact and detonations are expected to result in nine mortalities, 21 injuries, 13 PTS, 53 TTS and 6 behavioral disturbances (see Table 12). Most of the takes are expected to be Northwest Atlantic Ocean DPS loggerheads due to their anticipated abundance. These estimates are based on conservative assumptions, discussed earlier, and the actual number of sea turtles exposed to sound above the thresholds is likely to be lower. Conservation measures for EGTTR include pre-mission monitoring that is conducted to verify that the ZOI is free of visually detectable protected species and of indicators that protected species could be present, such as aggregations of jellyfish or floating vegetation (e.g., *Sargassum*) for sea turtles. Although small sea turtles, either young individuals or a smaller species (e.g., kemp's ridley), are difficult to see and some may not get noticed, pre-mission monitoring should help reduce potential exposure of sea turtles to adverse levels of impulsive sound from munition impacts and detonations.

Instances of disturbance are expected to be episodic and temporary, with the sea turtle being able to return to typical behaviors without severe effects that would reduce an individual's fitness. Sea turtles are considered to have relatively poor auditory sensitivity and they are not known to produce sounds underwater for communication. As a result, we do not expect instances of TTS to have long-term fitness consequences for individual turtles. An action that is not likely to reduce the fitness of individual turtles would not be likely to reduce the viability of the

[13] https://media.fisheries.noaa.gov/2021-08/RIWH-Recovery-Outline-Final-508-Compliant.pdf.pdf

populations those individual turtles represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

It is reasonable to assume that a certain amount of the sea turtles estimated to receive injurious effects may recover over time through normal healing processes and some may not, which could lead to mortality at a later time from complications. Complications could arise from increased risks due to secondary infection, predation, disease, or severely reduced ability to forage. We do not have information to estimate what percentage of injured sea turtles will recover or die. Although not realistic, the worst case scenario assumes that all of the injured turtles would die and that could result in 30 total annual mortalities, the most conservative value to evaluate impacts to the respective populations of these sea turtles.

Death of an individual sea turtle would result in a reduction in their absolute population number, and could impact the reproductive potential it might have contributed. For a population to remain stable sea turtles must replace themselves through successful reproduction at least once over the course of their reproductive lives and at least one offspring must survive to reproduce itself. If the hatchling survival rate to maturity is greater than the mortality rate of the population, the loss of breeding individuals would be exceeded through recruitment of new breeding individuals from successful reproduction of the remaining sea turtles. There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005).

The North Atlantic DPS of green sea turtles is the largest of the 11 green turtle DPSs with an estimated abundance of over 167,000 adult females from 73 nesting sites. All major nesting populations demonstrate long-term increases in abundance (Seminoff et al. 2015b). The estimated takes, which could be one mortality and one injury per year, are not expected to have a measurable effect on population level reproduction or the trend in nesting abundance. The proposed action is not reasonably expected to cause an appreciable reduction in the likelihood of survival or recovery of green sea turtles from the North Atlantic DPS green turtles in the wild.

The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560. Over 90 percent of loggerhead sea turtle nesting in the U.S. occurs in Florida (Ceriani et al. 2021). Using a stage/age demographic model, the adult female population size of the Northwest Atlantic Ocean DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS 2009a). In 2010, there were estimated to be approximately 801,000 loggerhead turtles (greater than 30 cm in size, inter-quartile range of approximately 521,000–1,111,000) in northwestern Atlantic continental shelf region based on aerial surveys (NMFS 2011d). Since 1989, the Fish and Wildlife Research Institute has coordinated the Index Nesting Beach Survey (INBS), a detailed sea turtle nesting-trend monitoring program. Witherington and others (2009) analyzed an 18-year time series (1989–2006) of INBS nest-count data and although there appears to be a net decrease over the series, nesting on Florida Panhandle index beaches, which represent the majority of nesting for this recovery unit, have trended upward since 2012, increasing to levels comparable to the late 1990s, with a record number of nests in 2016 (FFWCC 2018). The estimated 6 mortalities and 17 injuries are not expected to have a measurable effect on population level reproduction or the trend in nesting abundance. The proposed action is not reasonably expected to cause an appreciable reduction in the likelihood of survival or recovery of green sea turtles from the Northwest Atlantic DPS loggerhead sea turtles in the wild.

The Kemp's ridley sea turtle was once abundant in the Gulf of Mexico with nesting abundance at Rancho Nuevo, Mexico, where large aggregations (arribadas) have occurred, estimated at 40,000 females in 1947. The region has declined significantly from to 300 nesting females by the mid-80's. However, more recent nesting counts in this same region have shown an increase. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS and USFWS 2015). The number of nests in Padre Island, Texas has increased over the past two decades, with one nest observed in 1985, four in 1995, 50 in 2005, 197 in 2014 (NMFS and USFWS 2015b). It was estimated that only one Kemp's ridley sea turtle could be killed from explosives on an annual basis and, if the two Kemp's ridley's estimated to be injured died from complications of the injuries, which is not likely, this still is a very small number. The increased nesting demonstrates capacity for this population to rebound, and the limited number of estimated takes are not expected to have a measurable effect on population level reproduction or the trend in nesting abundance. The proposed activities are not reasonably expected to cause an appreciable reduction in the likelihood of survival or recovery of Kemp's ridley sea turtles in the wild.

The review by NMFS USFWS (2013) suggests the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean. Some of the closest nesting areas, to the action area, have shown signs of improvement, with nesting females increasing at an annual rate of nine to 13 percent in Florida and the U.S. Virgin Islands (TEWG 2007a). The estimated one mortality and one injury per year are not expected to have a measurable effect on population level reproduction or the trend in nesting abundance. The proposed activities are not reasonably expected to cause an appreciable reduction in the likelihood of survival or recovery of leatherback sea turtles in the wild.

Recovery plans for the sea turtles in this opinion all cite the need to protect nesting habitat and most of them also mention protecting marine habitats. None of the proposed activities are expected to have impacts on sea turtle nesting habitat. Feeding is a main component of marine habitats for sea turtles. The proposed pre-mission monitoring includes indicators for sea turtles, such as aggregations of jellyfish or floating vegetation (e.g., *Sargassum*). If those indicators are observed within target locations the target mission would be postponed. The proxy indicator for sea turtle presence are indicators of prey habitat for sea turtles. The pre-mission monitoring helps conserve marine habitat for sea turtles. Given the status of the Northwest Atlantic DPS loggerhead, North Atlantic DPS green, Kemp's ridley, and leatherback sea turtle populations relevant to the action area, the loss of a very small percentage of individuals is not expected to translate to population or species-level consequences. The generally stable or increasing sea turtle populations of each of these species indicates some resilience to the threats occurring from various sources, including activities undertaken in the EGTTR, that have been occurring in the action area for the last few decades. As such, the proposed action is not likely to reduce appreciably the likelihood of the survival and recovery of these ESA-listed sea turtles in the wild by substantially reducing their abundance, reproduction, or distribution or impeding the recovery objectives for the species. Therefore, we do not expect that the proposed action will reduce the likelihood of both the survival and recovery of these ESA-listed sea turtle species in the action area.

13 Conclusion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Rice's whale or the following sea turtles: Northwest Atlantic DPS loggerhead, North Atlantic DPS green, Kemp's ridley, and leatherback.

NMFS has also determined that the proposed action may affect, but is not likely to adversely affect the following listed or proposed species and designated or proposed critical habitat: sperm whale, hawksbill sea turtle, Northwest Atlantic DPS loggerhead sea turtle designated critical habitat, giant manta ray, oceanic whitetip shark, smalltooth sawfish, Gulf sturgeon and their designated critical habitat, Nassau grouper and their proposed critical habitat; elkhorn and staghorn corals, and their designated critical habitat; boulder star coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, and their proposed critical habitat; proposed queen conch.

14 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (see 50 CFR §222.102).

Incidental take is defined as take that results from, but is not the purpose of, carrying out an otherwise lawful activity (see 50 CFR §402.02). When an action will result in incidental take of ESA-listed marine mammals, ESA section 7(b)(4) requires that such taking be authorized under the MMPA section 101(a)(5) before the Secretary can issue an ITS for ESA-listed marine mammals and that an ITS specify those measures that are necessary to comply with Section 101(a)(5) of the MMPA. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS, including those specified as necessary to comply with the MMPA, Section 101(a)(5). Accordingly, the terms of this ITS and the exemption from Section 9 of the ESA for ESA-listed marine mammals become effective only upon the issuance of MMPA authorization to take the marine mammals identified here.

14.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact of such incidental taking on the species, which may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (see 80 FR 26832).

The methodology used to estimate the amount of take resulting from the EGTTR activities is summarized in the Exposure and Response, Section 10.3, of this opinion. As mentioned in that section, we reviewed and accepted EAFB's take estimates, including MMPA Level B take for Rice's whale, as being equivalent to ESA take because they represented the best available scientific information and relevant methods to evaluate exposure to protected species. Only a few MMPA Level B harassment, TTS and behavioral disturbances, were estimated for the Rice's whale on an annual basis (Table 11). Annual estimates for sea turtles include harassment, TTS, PTS, injuries and some potential mortalities (Table 12).

14.2 Reasonable and Prudent Measures

The measures described below are nondiscretionary, and must be undertaken by the USAF and the Permits Division so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures, and terms and conditions identified in the ITS are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

Reasonable and prudent measures are nondiscretionary measures to minimize the amount or extent of incidental take (50 C.F.R. §402.02). The reasonable and prudent measures described below assumes that the USAF will ensure that the proposed Conservation Measures (see Section 3.3) will be implemented for the appropriate mission operations. NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take on the ESA-listed species discussed in detail in this opinion:

1. The USAF shall submit a report to the ESA Interagency Cooperation Division on an annual basis, containing the information described in Section 14.3 Terms and Conditions.

2. The Permits Division must ensure that the provisions of the MMPA rule and Letter of Authorization are carried out.

14.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d), the USAF and Permits Division must comply with the following terms and conditions, which implement the RPMs described above. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). If the USAF and Permits Division fail to ensure compliance with these terms and conditions to implement the RPMs applicable to the authorities of the agencies, the protective coverage of section 7(o)(2) may lapse.

The following terms and conditions will inform us of the implementation of the reasonable and prudent measures:

1. On an annual basis, the USAF shall submit a report to the ESA Interagency Cooperation Division, containing the following information:
    a. Date and time of the EGTTR missions;
    b. A complete description of the pre-exercise and post-exercise activities related to mitigating and monitoring the effects of the EGTTR missions on ESA-listed species;
    c. Results of the protected species monitoring including observations of ESA-listed species and note any individuals injured, killed, or harassed as a result of the EGTTR missions; and
    d. Analysis the overall effectiveness of the conservation measures.
2. The Permits Division shall inform us if take is exceeded for the Rice's whale.
    a. In addition to other reporting requirements for dead and stranded animals, any reports of injured or dead ESA-listed species must be provided by the USAF to the ESA Interagency Cooperation Division within 24 hours by e-mail at nmfs.hq.esa.consultations@noaa.gov.

15 Conservation Recommendation

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

We want to take this opportunity to address debris that originates from EGTTR operations, even though there are efforts to collect debris at the target sites after the missions and other items are expected to sink and settle, any reduction of debris in the marine environment could benefit all marine wildlife, including ESA-listed species. We also would like to see more effort to collect underwater sound data in the EGTTR to confirm assumptions used in acoustic modeling and verify accuracy of results from the model. This could provide useful information for analyzing munition impact and detonations under various mission scenarios.

We recommend the following discretionary conservation recommendations that may be considered in relation to action agency 7(a)(1) responsibilities:

1. We recommend that the EAFB conduct sound verification studies in the EGTTR to validate predicted and modeled distances to acoustic thresholds used to assess harm and harassment to ESA-listed species.
2. We recommend collaboration with the NOAA Marine Debris Program (MDP) in order to evaluate how activities of the MDP may apply to debris that originates from EGTTR operations (e.g., consider areas for seabed or beach clean ups).
3. We recommend the monitoring data (i.e., visual sightings) be submitted to the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations online database so that it can be added to the aggregate marine mammal, seabird, sea turtle, and fish observation data from around the world.

In order for NMFS' Office of Protected Resources ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, action agencies should notify the ESA Interagency Cooperation Division of any conservation recommendations they implement in their final action.

16 Reinitiation Notice

This concludes formal consultation for EAFB's proposed operations in the EGTTR and the Permits Division's issuance of an LOA pursuant to section 101(a)(5)(D) of the MMPA. Consistent with 50 C.F.R. §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

1. The amount or extent of taking specified in the ITS is exceeded.
2. New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
3. The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered.
4. A new species is listed or critical habitat designated under the ESA that may be affected by the action.

17 References

68 FR 15674. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Smalltooth Sawfish (Pristis pectinata) in the United States. N. O. A. A. National Marine Fisheries Service, Commerce, editor.

Ackerman, R. A. 1997a. The nest environment and the embryonic development of sea turtles. Pages 83-106 *in* P. L. M. Lutz, J. A. , editor. The Biology of Sea Turtles. CRC Press, Boca Raton.

Ackerman, R. A. 1997b. The nest environment, and the embryonic development of sea turtles. Pages 83-106 *in* P. L. Lutz, and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Addison, R. F., and P. F. Brodie. 1987. Transfer of organochlorine residues from blubber through the circulatory system to milk in the lactating grey seal Halichoerus grypus. Canadian Journal of Fisheries and Aquatic Sciences 44:782-786.

Aguirre, A. A., and coauthors. 2006. Hazards associated with the consumption of sea turtle meat and eggs: A review for health care workers and the general public. Ecohealth 3(3):141-153.

Al-Bahry, S. N., and coauthors. 2009. Ultrastructural features and elemental distribution in eggshell during pre and post hatching periods in the green turtle, Chelonia mydas at Ras Al-Hadd, Oman. Tissue and Cell 41(3):214-221.

Allen, M. R., and coauthors. 2018. Technical Summary. In: *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)].

Amaral, K., and C. Carlson. 2005. Summary of non-lethal research techniques for the study of cetaceans. United Nations Environment Programme UNEP(DEC)/CAR WG.27/REF.5. 3p. Regional Workshop of Experts on the Development of the Marine Mammal Action Plan for the Wider Caribbean Region. Bridgetown, Barbados, 18-21 July.

Amos, A. F. 1989. Recent strandings of sea turtles, cetaceans and birds in the vicinity of Mustang Island, Texas. Pages 51 *in* C. W. C. Jr., and A. M. Landry, editors. Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management.

Anan, Y., T. Kunito, I. Watanabe, H. Sakai, and S. Tanabe. 2001. Trace element accumulation in hawksbill turtles (Eretmochelys imbricata) and green turtles (Chelonia mydas) from Yaeyama Islands, Japan. Environmental Toxicology and Chemistry 20(12):2802-2814.

Antonelis, G. A., J. D. Baker, T. C. Johanos, R. C. Braun, and A. L. Harting. 2006. Hawaiian monk seal (*Monachus schauinslandi*): status and conservation issues. Atoll Research Bulletin 543:75-101.

Au, W. W. L., and M. Green. 2000. Acoustic interaction of humpback whales and whale-watching boats. Marine Environmental Research 49(5):469-481.

Avens, L., and K. Lohmann. 2003. Use of multiple orientation cues by juvenile loggerhead sea turtles *Caretta caretta*. Journal of Experimental Biology 206:4317–4325.

Avens, L., J. Taylor, L. R. Goshe, T. T. Jones, and M. Hastings. 2009a. Use of skeletochronological analysis to estimate the age of leatherback sea turtles Dermochelys coriacea in the western North Atlantic. Endangered Species Research 8:165-177.

Avens, L., J. C. Taylor, L. R. Goshe, T. T. Jones, and M. Hastings. 2009b. Use of skeletochronological analysis to estimate the age of leatherback sea turtles *Dermochelys coriacea* in the western North Atlantic. Endangered Species Research 8(3):165-177.

Bain, D. E., D. Lusseau, R. Williams, and J. C. Smith. 2006. Vessel traffic disrupts the foraging behavior of southern resident killer whales (*Orcinus* spp.). International Whaling Commission.

Baird, R. W., and coauthors. 2015. False killer whales and fisheries interactions in Hawaiian waters: Evidence for sex bias and variation among populations and social groups. Marine Mammal Science 31(2):579-590.

Baker, C. S., L. M. Herman, B. G. Bays, and G. B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory.

Baker, J. D., C. L. Littnan, and D. W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 2:21-30.

Barber, J. R., K. R. Crooks, and K. M. Fristrup. 2010. The costs of chronic noise exposure for terrestrial organisms. Trends in Ecology and Evolution 25(3):180–189.

Barbieri, E. 2009. Concentration of heavy metals in tissues of green turtles (Chelonia mydas) sampled in the Cananeia Estuary, Brazil. Brazilian Journal of Oceanography 57(3):243-248.

Bartol, S. M., and D. R. Ketten. 2006. Turtle and tuna hearing. Pages 98-103 *in* R. W. Y. B. Swimmer, editor. Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries, volume Technical Memorandum NMFS-PIFSC-7. U.S Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fisheries Science Center.

Bartol, S. M., J. A. Musick, and M. Lenhardt. 1999. Auditory Evoked Potentials of the Loggerhead Sea Turtle (*Caretta caretta*). Copeia 3:836-840.

Bauer, G. B. 1986. The behavior of humpback whales in Hawaii and modifications of behavior induced by human interventions. (Megaptera novaeangliae). University of Hawaii. 314p.

Baulch, S., and C. Perry. 2014a. Evaluating the impacts of marine debris on cetaceans. Mar Pollut Bull 80(1-2):210-21.

Baulch, S., and C. Perry. 2014b. Evaluating the impacts of marine debris on cetaceans. Marine Pollution Bulletin 80(1-2):210-221.

Becker, N. M. 1995. Fate of selected high explosives in the environment: A literature review.

Bejder, L., S. M. Dawson, and J. A. Harraway. 1999. Responses by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. Marine Mammal Science 15(3):738-750.

Bejder, L., and D. Lusseau. 2008. Valuable lessons from studies evaluating impacts of cetacean-watch tourism. Bioacoustics 17-Jan(3-Jan):158-161. Special Issue on the International Conference on the Effects of Noise on Aquatic Life. Edited By A. Hawkins, A. N. Popper & M. Wahlberg.

Bejder, L., A. Samuels, H. Whitehead, H. Finn, and S. Allen. 2009. Impact assessment research: Use and misuse of habituation, sensitisation and tolerance to describe wildlife responses to anthropogenic stimuli. Marine Ecology Progress Series 395:177-185.

Benson, S. R., and coauthors. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere 2(7):art84.

Berenshtein, I., and coauthors. 2020a. Invisible oil beyond the Deepwater Horizon satellite footprint. Science Advances 6(February 2020):12.

Berenshtein, I., and coauthors. 2020b. Comparison of the Spatial Extent, Impacts to Shorelines, and Ecosystem and Four-Dimensional Characteristics of Simulated Oil Spills. Pages 340-354 *in* Scenarios and Responses to Future Deep Oil Spills. Springer.

Bigalow, H., and W. Schroeder. 1953. Fishes of the western North Atlantic, Part 2—Sawfishes, Guitarfishes, Skates and Rays. Mem. Sears Found 1:588pp.

Bjorndal, K. A., A. B. Bolten, and M. Y. Chaloupka. 2005. Evaluating trends in abundance of immature green turtles, *Chelonia mydas*, in the greater Caribbean. Ecological Applications 15(1):304-314.

Blair, H. B., N. D. Merchant, A. S. Friedlaender, D. N. Wiley, and S. E. Parks. 2016. Evidence for ship noise impacts on humpback whale foraging behaviour. Biol Lett 12(8).

Blane, J. M., and R. Jaakson. 1994. The impact of ecotourism boats on the St. Lawrence beluga whales (*Delphinapterus leucas*). Environmental Conservation 21(3):267-269.

BOEM. 2016. Gulf of Mexico OCS Proposed Geological and Geophysical Activities Draft Programmatic Environmental Impact Statement Volume I: Chapters 1-8. US Department of the Interior, Bureau of Ocean Energy Management, New Orleans.

Bolten, A. B., and coauthors. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecological Applications 8:1-7.

Boren, L. J., N. J. Gemmell, and K. J. Barton. 2001. Controlled approaches as an indicator of tourist disturbance on New Zealand fur seals (Arctocephalus forsteri). Fourteen Biennial Conference on the Biology of Marine Mammals, 28 November-3 December Vancouver Canada. p.30.

Borrell, A., D. Bloch, and G. Desportes. 1995. Age trends and reproductive transfer of organochlorine compounds in long-finned pilot whales from the Faroe Islands. Environmental Pollution 88(3):283-292.

Bouchard, S., and coauthors. 1998. Effects of exposed pilings on sea turtle nesting activity at Melbourne Beach, Florida. Journal of Coastal Research 14(4):1343-1347.

Brewer, P. G., and K. Hester. 2009. Ocean acidification and the increasing transparency of the ocean to low-frequency sound. Oceanography 22(4):86-93.

Briggs, C., S. M. Shjegstad, J. Silva, and M. Edwards. 2016a. Distribution of chemical warfare agent, energetics, and metals in sediments at a deep-water discarded military munitions site. Deep Sea Research Part II: Topical Studies in Oceanography, 128, 63–69.

Briggs, C., S. M. Shjegstad, J. A. Silva, and M. H. Edwards. 2016b. Distribution of chemical warfare agent, energetics, and metals in sediments at a deep-water discarded military munitions site. Deep Sea Research Part II: Topical Studies in Oceanography 128:63-69.

Bryant, P. J., C. M. Lafferty, and S. K. Lafferty. 1984. Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales. (*Eschrichtius robustus*). M. L. Jones, S. L. Swartz, and S. Leatherwood, editors. The Gray Whale, *Eschrichtius robustus*. Academic Press, New York.

Bugoni, L., L. Krause, and M. Virginia Petry. 2001. Marine debris and human impacts on sea turtles in southern Brazil. Marine Pollution Bulletin 42(12):pp. 1330-1334.

Carlson, J. K., and S. Gulak. 2012. Habitat use and movement patterns of oceanic whitetip, bigeye thresher and dusky sharks based on archival satellite tags. Collect. Vol. Sci. Pap. ICCAT 68(5):1922-1932.

Carlson, J. K., S. J. B. Gulak, M. P. Enzenauer, L. W. Stokes, and P. M. Richards. 2016. Characterizing loggerhead sea turtle, Caretta caretta, bycatch in the US shark bottom longline fishery. Bulletin of Marine Science 92(4):513-525.

Carr, A. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Marine Pollution Bulletin 18(6B):352-356.

Cassoff, R. M. K. M. M. W. A. M. S. G. B. D. S. R. M. J. M. 2011. Lethal entanglement in baleen whales. Diseases of Aquatic Organisms 96(3):175-185.

Caurant, F., P. Bustamante, M. Bordes, and P. Miramand. 1999. Bioaccumulation of cadmium, copper and zinc in some tissues of three species of marine turtles stranded along the French Atlantic coasts. Marine Pollution Bulletin 38(12):1085-1091.

Ceriani, S. A., B. Brost, A. B. Meylan, P. A. Meylan, and P. Casale. 2021. Bias in sea turtle productivity estimates: error and factors involved. Marine Biology 168(4):41.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf.Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Chaloupka, M. 2002. Stochastic simulation modelling of southern Great Barrier Reef green turtle population dynamics. Ecological Modelling 148(1):79-109.

Chaloupka, M., and coauthors. 2008. Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Global Ecology and Biogeography 17(2):297-304.

Chapman, N. R., and A. Price. 2011. Low frequency deep ocean ambient noise trend in the Northeast Pacific Ocean. Journal of the Acoustical Society of America 129(5):EL161-EL165.

Clapham, P. J., S. B. Young, and R. L. Brownell Jr. 1999. Baleen whales: Conservation issues and the status of the most endangered populations. Mammal Review 29(1):35-60.

Clark, C. W., and coauthors. 2009. Acoustic masking in marine ecosystems: Intuitions, analysis, and implication. Marine Ecology Progress Series 395:201-222.

Clarke, R. 1956. Sperm whales of the Azores. Discovery Reports 28:237-298.

Collard, S. B., and L. H. Ogren. 1990. Dispersal scenarios for pelagic post-hatchling sea turtles. Bulletin of Marine Science 47:233-243.

Conant, T. A., and coauthors. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service August 2009:222 pages.

Conn, P. B., and G. K. Silber. 2013. Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. Ecosphere 4(4):43.

Constantine, R. 2001. Increased avoidance of swimmers by wild bottlenose dolphins (Tursiops truncatus) due to long-term exposure to swim-with-dolphin tourism. Marine Mammal Science 17(4):689-702.

Corkeron, P. J. 1995. Humpback whales (*Megaptera novaeangliae*) in Hervey Bay, Queensland: Behaviour and responses to whale-watching vessels. Canadian Journal of Zoology 73(7):1290-1299.

Crouse, D. T. 1999. Population Modeling and Implications for Caribbean Hawksbill Sea Turtle Management Chelonian Conservation and Biology 3(2):185-188.

Dalton, T., and D. Jin. 2010. Extent and frequency of vessel oil spills in US marine protected areas. Marine Pollution Bulletin 60(11):1939-1945.

Davenport, J. J. W. J. M. V. C.-I. 1990. Metal and PCB concentrations in the "Harlech" leatherback. Marine Turtle Newsletter 48:1-6.

David, L. 2002. Disturbance to Mediterranean cetaceans caused by vessel traffic. Cetaceans of the Mediterranean and Black Seas: State of Knowledge and Conservation Strategies. G. Notarbartolo de Sciara (ed.). Section 11. 21pp. A report to the ACCOBAMS Secretariat, Monaco, February.

Davis, R. W., and coauthors. 2007. Diving behavior of sperm whales in relation to behavior of a major prey species, the jumbo squid, in the Gulf of California, Mexico. Marine Ecology Progress Series 333:291-302.

Deepwater Horizon NRDA Trustees. 2016. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement. NOAA.

Deepwater Horizon Trustees. 2016. *Deepwater Horizon* Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. Deepwater Horizon Natural Resource Damage Assessment Trustees.

Derraik, J. G. B. 2002. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44(9):842-852.

Dodd, C. K. 1988. Synopsis of the biological data on the loggerhead sea turtle: *Caretta caretta* (Linnaeus 1758). Fish and Wildlife Service Biological Report 88(14):110.

Doney, S. C., and coauthors. 2012. Climate change impacts on marine ecosystems. Marine Science 4.

Dunlop, R. A., and coauthors. 2016. Response of humpback whales (Megaptera novaeangliae) to ramp-up of a small experimental air gun array. Marine Pollution Bulletin 103(1-2):72-83.

Dunlop, R. A., and coauthors. 2018. A behavioural dose-response model for migrating humpback whales and seismic air gun noise. Marine Pollution Bulletin 133:506-516.

Dutton, P. H., B. W. Bowen, D. W. Owens, A. Barragan, and S. K. Davis. 1999. Global phylogeography of the leatherback turtle (*Dermochelys coriacea*). Journal of Zoology 248:397-409.

Dutton, P. H., V. Pease, and D. Shaver. 2006. Characterization of mtDNA variation among Kemp's ridleys nesting on Padre Island with reference to Rancho Nuevo genetic stock. Pages 189 *in* Twenty-Sixth Annual Conference on Sea Turtle Conservation and Biology.

Eckert, K., B. Wallace, J. Frazier, S. Eckert, and P. Pritchard. 2012. Synopsis of the biological data on the leatherback sea turtle (*Dermochelys coriacea*) U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication, BTP-R4015-2012, Washington, District of Columbia.

Edds, P. L., and J. A. F. Macfarlane. 1987. Occurrence and general behavior of balaenopterid cetaceans summering in the St. Lawrence Estuary, Canada. Canadian Journal of Zoology 65(6):1363-1376.

Edwards, M. H., and coauthors. 2016. The Hawaii Undersea Military Munitions Assessment. Deep-Sea Research II, 128, 4–13.

Efroymson, R. A., W. H. Rose, S. Nemeth, and G. W. Suter II. 2000. Ecological risk assessment framework for low-altitude overflights by fixed-wing and rotary-wing military aircraft. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Ehrhart, L., W. Redfoot, D. Bagley, and K. Mansfield. 2014. Long-term trends in loggerhead (Caretta caretta) nesting and reproductive success at an important western Atlantic rookery. Chelonian Conservation and Biology 13(2):173-181.

Ehrhart, L. M., D. A. Bagley, and W. E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: Geographic distribution, abundance, and population status. Pages 157-174 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D. C.

Ellison, W., B. Southall, C. Clark, and A. Frankel. 2012a. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology 26(1):21-28.

Ellison, W. T., B. L. Southall, C. W. Clark, and A. S. Frankel. 2012b. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology 26(1):21–28.

Epperly, S., and coauthors. 2002. Analysis of Sea Turtle Bycatch in the Commercial Shrimp Fisheries of Southeast U.S. Waters and the Gulf of Mexico. U.S. Dept. of Commerce, Miami, FL.

Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. Marine Mammal Science 18(2):394-418.

Erbe, C., and coauthors. 2019. The effects of ship noise on marine mammals—a review. Frontiers in Marine Science:606.

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: A review and research strategy. Marine Pollution Bulletin 103(1-2):15-38.

Evans, P. G. H., and A. Bjørge. 2013. Impacts of climate change on marine mammals. Marine Climate Change Impacts Parternship: Science Review:134-148.

Evans, P. G. H., P. J. Canwell, and E. Lewis. 1992. An experimental study of the effects of pleasure craft noise upon bottle-nosed dolphins in Cardigan Bay, West Wales. European Research on Cetaceans 6:43-46. Proceedings of the Sixth Annual Conference of the European Cetacean Society, San Remo, Italy, 20-22 February.

Evans, P. G. H., and coauthors. 1994. A study of the reactions of harbour porpoises to various boats in the coastal waters of southeast Shetland. European Research on Cetaceans 8:60-64.

Fabry, V. J., B. A. Seibel, R. A. Feely, and J. C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES Journal of Marine Science 65:414-432.

Farmer, N. A., and coauthors. 2022. The distribution of manta rays in the western North Atlantic Ocean off the eastern United States. Scientific reports 12(1):6544.

Farmer, N. A., D. P. Noren, E. M. Fougères, A. Machernis, and K. Baker. 2018. Resilience of the endangered sperm whale Physeter macrocephalus to foraging disturbance in the Gulf of Mexico, USA: a bioenergetic approach. Marine Ecology Progress Series 589:241-261.

Farrell, R. E., and S. D. Siciliano. 2004. Environmental Effects of Radio Frequency (RF) Chaff Released during Military Training Exercises: A Review of the Literature.

Félix, F. 2001. Observed changes of behavior in humpback whales during whalewatching encounters off Ecuador. 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, Canada.

FFWCC. 2018. Trends in Nesting by Florida Loggerheads. Florida Fish and Wildlife Conservation Commission, http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trend/.

Finneran, J. J. C. E. S. 2013. Effects of fatiguing tone frequency on temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*). Journal of the Acoustical Society of America 133(3):1819-1826.

Foley, A. M., B. A. Schroeder, and S. L. MacPherson. 2008. Post-nesting migrations and resident areas of Florida loggerhead turtles (Caretta caretta). Pages 75-76 *in* H. J. Kalb, A. Rohde, K. Gayheart, and K. Shanker, editors. Twenty-Fifth Annual Symposium on Sea Turtle Biology and Conservation.

Fox, D. A., J. E. Hightower, and F. M. Parauka. 2002. Estuarine and Nearshore Marine Habitat Use by Gulf Sturgeon from the Choctawhatchee River System, Florida. Pages 111-126 *in* American Fisheries Society Symposium. American Fisheries Society.

Francis, C. D., and J. R. Barber. 2013. A framework for understanding noise impacts on wildlife: An urgent conservation priority. Frontiers in Ecology and the Environment 11(6):305-313.

Frasier, K. E. 2020. Evaluating Impacts of Deep Oil Spills on Oceanic Marine Mammals. Pages 419-441 *in* Scenarios and Responses to Future Deep Oil Spills.

Frazer, N. B., and L. M. Ehrhart. 1985. Preliminary Growth Models for Green, Chelonia mydas, and Loggerhead, Caretta caretta, Turtles in the Wild. Copeia 1985(1):73-79.

Friedlaender, A. S., and coauthors. 2016. Prey-mediated behavioral responses of feeding blue whales in controlled sound exposure experiments. Ecological Applications 26(4):1075-1085.

Fritts, T. H., and M. A. McGehee. 1981. Effects of petroleum on the development and survival of marine turtles embryos. U.S. Fish and Wildlife Service, Contract No. 14-16-00009-80-946, FWSIOBS-81-3, Washington, D.C.

Fujihara, J., T. Kunito, R. Kubota, and S. Tanabe. 2003. Arsenic accumulation in livers of pinnipeds, seabirds and sea turtles: Subcellular distribution and interaction between arsenobetaine and glycine betaine. Comparative Biochemistry and Physiology C-Toxicology & Pharmacology 136(4):287-296.

Fulling, G. L., K. D. Mullin, and C. W. Hubard. 2003. Abundance and distribution of cetaceans in outer continental shelf waters of the US Gulf of Mexico. Fishery Bulletin 101(4):923-932.

Furin, C. G., F. von Hippel, B. Hagedorn, and T. O'Hara. 2013. Perchlorate trophic transfer increases tissue concentrations above ambient water exposure alone in a predatory fish. Journal of Toxicology and Environmental Health. Part A, 76(18), 1072–1084. .

FWC, F. F. a. W. C. C. 2021. Sea Turtle Nesting 2020 Statewide.

Gabriele, C., B. Kipple, and C. Erbe. 2003. Underwater acoustic monitoring and estimated effects of vessel noise on humpback whales in Glacier Bay, Alaska. Pages 56-57 *in* Fifteenth Biennial Conference on the Biology of Marine Mammals, Greensboro, North Carolina.

Gall, S. C., and R. C. Thompson. 2015. The impact of debris on marine life. Marine Pollution Bulletin 92(1-2):170–179.

Gallo, F., and coauthors. 2018. Marine litter plastics and microplastics and their toxic chemicals components: the need for urgent preventive measures. Environmental Sciences Europe 30(1).

Garcia-Fernandez, A. J., and coauthors. 2009. Heavy metals in tissues from loggerhead turtles (Caretta caretta) from the southwestern Mediterranean (Spain). Ecotoxicology and Environmental Safety 72(2):557-563.

Gardner, S. C., S. L. Fitzgerald, B. A. Vargas, and L. M. Rodriguez. 2006. Heavy metal accumulation in four species of sea turtles from the Baja California peninsula, Mexico. Biometals 19:91-99.

Garrett, C. 2004. Priority Substances of Interest in the Georgia Basin - Profiles and background information on current toxics issues. Canadian Toxics Work Group Puget Sound/Georgia Basin International Task Force, GBAP Publication No. EC/GB/04/79.

Geraci, J. R. 1990. Physiological and toxic effects on cetaceans.Pp. 167-197 *In:* Geraci, J.R. and D.J. St. Aubin (eds), Sea Mammals and Oil: Confronting the Risks. Academic Press, Inc.

Glass, A. H., T. V. N. Cole, and M. Garron. 2010. Mortality and serious injury determinations for baleen whale stocks along the United States and Canadian Eastern Seaboards, 2004-2008. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center.

Godley, B. J., D. R. Thompson, and R. W. Furness. 1999. Do heavy metal concentrations pose a threat to marine turtles from the Mediterranean Sea? Marine Pollution Bulletin 38:497-502.

Goertner, J. F. 1982. Prediction of Underwater Explosion Safe Ranges for Sea Mammals. Naval Surface Weapons Center, Silver Spring, Maryland. Research and Technology Department. NSWC TR 82-188.

Gomez, C., and coauthors. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy. Canadian Journal of Zoology 94(12):801–819.

Goodwin, L., and P. A. Cotton. 2004. Effects of boat traffic on the behaviour of bottlenose dolphins (*Tursiops truncatus*). Aquatic Mammals 30(2):279-283.

Goold, J. C., and R. F. W. Coates. 2006. Near source, high frequency air-gun signatures. Paper SC/58/E30, prepared for the International Whaling Commmission (IWC) Seismic Workshop, St. Kitts, 24-25 May 2006. 7p.

Gordon, A. N., A. R. Pople, and J. Ng. 1998. Trace metal concentrations in livers and kidneys of sea turtles from south-eastern Queensland, Australia. Marine and Freshwater Research 49(5):409-414.

Grant, S. C. H., and P. S. Ross. 2002a. Southern Resident killer whales at risk: Toxic chemicals in the British Columbia and Washington environment. Department of Fisheries and Oceans Canada, Sidney, B.C.

Grant, S. C. H., and P. S. Ross. 2002b. Southern Resident killer whales at risk: toxic chemicals in the British Columbia and Washington environment. Fisheries and Oceans Canada., Sidney, B.C.

Groombridge, B. 1982a. Kemp's ridley or Atlantic ridley, *Lepidochelys kempii* (Garman 1980). The IUCN Amphibia, Reptilia Red Data Book:201-208.

Groombridge, B. 1982b. Kemp’s Ridley or Atlantic Ridley, *Lepidochelys kempii* (Garman 1880). Pages 201-208 *in* The IUCN Amphibia, Reptilia Red Data Book.

Hansen, L. J., K. D. Mullin, T. A. Jefferson, and G. P. Scott. 1996a. Visual surveys aboard ships and aircraft. In: R. W. Davis and G. S. Fargion (eds). Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final report. Volume II: Technical report:OCS Study MMS 96- 0027, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans. p.55-132.

Hansen, L. J., K. D. Mullin, T. A. Jefferson, and G. P. Scott. 1996b. Visual surveys aboard ships and aircraft. Pages 55-132 *in* R. W. Davis, and G. S. Fargion, editors. Distribution and Abundance of Cetaceans in the North-central and Western Gulf of Mexico: Final Report. Texas Institute of Oceanography.

Harris, C. M., and coauthors. 2018. Marine mammals and sonar: Dose-response studies, the risk-disturbance hypothesis and the role of exposure context. Journal of Applied Ecology 55(1):396-404.

Harris, C. M., L. J. Wilson, C. G. Booth, and J. Harwood. 2017. Population consequences of disturbance: A decision framework to identify priority populations for PCoD modelling. 22nd Biennial Conference on the Biology of Marine Mammals, Halifax, Nova Scotia, Canada.

Hart, K. M., M. M. Lamont, I. Fujisaki, A. D. Tucker, and R. R. Carthy. 2012. Common coastal foraging areas for loggerheads in the Gulf of Mexico: Opportunities for marine conservation. Biological Conservation 145(1):185-194.

Hartwell, S. I. 2004. Distribution of DDT in sediments off the central California coast. Marine Pollution Bulletin 49(4):299-305.

Haver, S. M., and coauthors. 2018. Monitoring long-term soundscape trends in U.S. Waters: The NOAA/NPS Ocean Noise Reference Station Network. Marine Policy 90:6–13.

Hayhoe, K., and coauthors. 2018. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (Reidmiller, D.R., et al. [eds.]). U.S. Global Change Research Program, Washington, DC, USA.

Hays, G. C. 2000. The implications of variable remigration intervals for the assessment of population size in marine turtles. Journal of Theoretical Biology 206(2):221-7.

Hazel, J., and E. Gyuris. 2006. Vessel-related mortality of sea turtles in Queensland, Australia. Wildlife Research 33(2):149-154.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research 3:105-113.

Henderson, E. E., J. Aschettino, M. Deakos, G. Alongi, and T. Leota. 2019. Quantifying the behavior of humpback whales (Megaptera novaeangliae) and potential responses to sonar. Nueva Sociedad (284):612-631.

Heppell, S. S., and coauthors. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. Chelonian Conservation and Biology 4(4):767-773.

Heppell, S. S., L. B. Crowder, and T. R. Menzel. 1999. Life table analysis of long-lived marine species with implications for conservation and management. Pages 137-148 *in* American Fisheries Society Symposium.

Heppell, S. S., M. L. Snover, and L. Crowder. 2003. Sea turtle population ecology. Pages 275-306 *in* P. Lutz, J. A. Musick, and J. Wyneken, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Hildebrand, H. H. 1983. Random notes on sea turtles in the western Gulf of Mexico. Western Gulf of Mexico Sea Turtle Workshop Proceedings, January 13-14, 1983:34-41.

Hildebrand, J. A. 2005. Impacts of anthropogenic sound. Pages 101-124 *in* J. E. Reynolds, editor. Marine Mammal Research: Conservation Beyond Crisis. The John Hopkins University Press.

Hildebrand, J. A. 2009a. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395:20-May.

Hildebrand, J. A. 2009b. Metrics for characterizing the sources of ocean anthropogenic noise. Journal of the Acoustical Society of America 125(4):2517.

Holst, M., and coauthors. 2011. Responses of pinnipeds to Navy missile launches at San Nicolas Island, California. Aquatic Mammals 37(2):139-150.

Holt, M. M. 2008. Sound exposure and Southern Resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. U.S. Department of Commerce, NMFS-NWFSC-89.

Howey-Jordan, L. A., and coauthors. 2013. Complex Movements, Philopatry and Expanded Depth Range of a Severely Threatened Pelagic Shark, the Oceanic Whitetip (Carcharhinus longimanus) in the Western North Atlantic. PLoS One 8(2):e56588.

Howey, L. A., and coauthors. 2016. Into the deep: the functionality of mesopelagic excursions by an oceanic apex predator. Ecology and Evolution 6(15):5290-5304.

Hullar, T. L., and coauthors. 1999. Environmental Effects of RF Chaff: A Select Panel Report to the Undersecretary of Defense for Environmental Security.

IPCC. 2014. Climate change 2014: Impacts, adaptation, and vulnerability. IPCC Working Group II contribution to AR5. Intergovernmental Panel on Climate Change.

IPCC. 2018. Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland:32pp.

IPCC. 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. IPPC, Cambridge, UK and New York, NY, USA.

Iwata, H., S. Tanabe, N. Sakai, and R. Tatsukawa. 1993. Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate. Environmental Science and Technology

27:1080-1098.

James, M. C., R. A. Myers, and C. A. Ottensmeyer. 2005. Behaviour of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. Proceedings of the Royal Society Biological Sciences Series B 272(1572):1547-1555.

Jenkins, T. F., and coauthors. 2008. Characterization and Fate of Gun and Rocket Propellant Residues on Testing and Training Ranges: Final Report. (ERDC TR-08-1). Arlington, VA: Strategic Environmental Research and Development Program.

Jensen, A. S., and G. K. Silber. 2004. Large whale ship strike database. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

Juhasz, A. L., and R. Naidu. 2007. Explosives: fate, dynamics, and ecological impact in terrestrial and marine environments. Reviews of environmental contamination and toxicology:163-215.

Keinath, J. A., J. A. Musick, and W. M. Swingle. 1991. First verified record of the hawksbill sea turtle (Eretmochelys imbricata) in Virginia waters. Catesbeiana 11(2):35-38.

Keller, J. M., P. D. McClellan-Green, J. R. Kucklick, D. E. Keil, and M. M. Peden-Adams. 2006. Effects of organochlorine contaminants on loggerhead sea turtle immunity: Comparison of a correlative field study and *in vitro* exposure experiments. Environmental Health Perspectives 114(1):70-76.

Kelley, C., G. Carton, M. Tomlinson, and A. Gleason. 2016. Analysis of towed camera images to determine the effects of disposed mustard-filled bombs on the deep water benthic community off south Oahu. Deep Sea Research Part II: Topical Studies in Oceanography. .

Ketten, D. R., and S. M. Bartol. 2005. Functional Measures of Sea Turtle Hearing.

Ketten, D. R., and S. M. Bartol. 2006. Functional measures of sea turtle hearing. Office of Naval Research, Arlington, VA.

King, S. L., and coauthors. 2015. An interim framework for assessing the population consequences of disturbance. Methods in Ecology and Evolution 6(10):1150–1158.

Kintisch, E. 2006. As the seas warm: Researchers have a long way to go before they can pinpoint climate-change effects on oceangoing species. Science 313:776-779.

Kipple, B., and C. Gabriele. 2004. Underwater noise from skiffs to ships. S. M. J. F. G. Piatt, editor Fourth Glacier Bay Science Symposium.

Kohler, N. E., J. G. Casey, and P. A. Turner. 1998. NMFS cooperative shark tagging program, 1962-93: An atlas of shark tag and recapture data. Marine Fisheries Review 60(2):Jan-87.

Koide, S., J. Silva, V. Dupra, and M. Edwards. 2016a. Bioaccumulation of chemical warfare agents, energetic materials, and metals in deep-sea shrimp from discarded military munitions sites off Pearl Harbor. Deep Sea Research Part II: Topical Studies in Oceanography, 128, 53–62. .

Koide, S., J. A. Silva, V. Dupra, and M. Edwards. 2016b. Bioaccumulation of chemical warfare agents, energetic materials, and metals in deep-sea shrimp from discarded military munitions sites off Pearl Harbor. Deep Sea Research Part II: Topical Studies in Oceanography 128:53-62.

Koski, W. R., J. W. Lawson, D. H. Thomson, and W. J. Richardson. 1998. Point Mugu Sea Range marine mammal technical report. Naval Air Warfare Center, Weapons Division and Southwest Division, Naval Facilities Engineering Command.

Krahn, M. M., and coauthors. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales (*Orcinus orca*). Marine Pollution Bulletin 54(12):1903-1911.

Krahn, M. M., and coauthors. 2009. Effects of age, sex and reproductive status on persistent organic pollutant concentrations in ‘‘Southern Resident” killer whales. Marine Pollution Bulletin.

Kraus, S. D., and coauthors. 2005. North Atlantic right whales in crisis. Science 309(5734):561-562.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17(1):35-75.

Landry, A. M., Jr., and D. Costa. 1999. Status of sea turtle stocks in the Gulf of Mexico with emphasis on the Kemp's ridley. Pages 248-268 *in* H. Kumpf, K. Steidinger, and K. Sherman, editors. The Gulf of Mexico large marine ecosystem: Assessment, sustainability, and management. Blackwell Science, Malden, Massachusetts.

Laurent, L., and coauthors. 1998. Molecular resolution of marine turtle stock composition in fishery bycatch: a case study in the Mediterranean. Molecular Ecology 7:1529-1542.

Law, K. L., and coauthors. 2010. Plastic accumulation in the North Atlantic subtropical gyre. Science 329(5996):1185-1188.

Learmonth, J. A., and coauthors. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology: an Annual Review 44:431-464.

Lee, D. S., and W. M. Palmer. 1981. Records of leatherback turtles, Dermochelys coriacea (Linnaeus) and other marine turtles in North Carolina waters. Brimleyana 5:95-106.

Lemon, M., T. P. Lynch, D. H. Cato, and R. G. Harcourt. 2006. Response of travelling bottlenose dolphins (Tursiops aduncus) to experimental approaches by a powerboat in Jervis Bay, New South Wales, Australia. Biological Conservation 127(4):363-372.

Lenhardt, M. L., S. E. Moein, J. A. Musick, and D. E. Barnard. 1994. Evaluation of the Response of Loggerhead Sea Turtles (Caretta caretta) to a Fixed Sound Source. Draft Final Report Submitted to the U.S. Army Corps of Engineers, Waterways Experiment Station:13.

Li, W. C., H. F. Tse, and L. Fok. 2016. Plastic waste in the marine environment: A review of sources, occurrence and effects. Sci Total Environ 566-567:333-349.

Lohmann, K. J., and C. M. F. Lohmann. 1996a. Detection of magnetic field intensity by sea turtles. Nature 380:59-61.

Lohmann, K. J., and C. M. F. Lohmann. 1996b. Orientation and open-sea navigation in sea turtles. Journal of Experimental Biology 199(1):73-81.

Lotufo, G. R., A. B. Gibson, and J. L. Yoo. 2010. Toxicity and bioconcentration evaluation of RDX and HMX using sheepshead minnows in water exposures. Ecotoxicology and Environmental Safety 73(7):1653-1657.

Loureiro, N., and D. Matos. 2009. Presence of fibropapillomatosis in green turtles Chelonia mydas at Príncipe Island in the Gulf of Guinea. Arquipelago. Life and Marine Sciences 26:79-83.

Lubchenco, J., and N. Sutley. 2010. Proposed U.S. policy for ocean, coast, and great lakes stewardship. Science 328:2.

Luksenburg, J. A., and E. C. M. Parsons. 2009a. The effects of aircraft on cetaceans: Implications for aerial whalewatching. Sixty First Meeting of the International Whaling Commission, Madeira, Portugal.

Luksenburg, J. A., and E. C. M. Parsons. 2009b. The effects of aircraft on cetaceans: implications for aerial

whalewatching. Unpublished report to the International Whaling Commission.

Lusseau, D. 2003. Effects of tour boats on the behavior of bottlenose dolphins: Using Markov chains to model anthropogenic impacts. Conservation Biology 17(6):1785-1793.

Lusseau, D. 2006. The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. Marine Mammal Science 22(4):802-818.

Lutcavage, M. E., P. Plotkin, B. E. Witherington, and P. L. Lutz. 1997. Human impacts on sea turtle survival. Pages 387-409 *in* P. L. Lutz, and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, New York, New York.

MacLeod, C. D., and coauthors. 2005. Climate change and the cetacean community of north-west Scotland. Biological Conservation 124(4):477-483.

Magalhaes, S., and coauthors. 2002. Short-term reactions of sperm whales (Physeter macrocephalus) to whale-watching vessels in the Azores. Aquatic Mammals 28(3):267-274.

Malme, C., P. Miles, P. Tyack, C. Clark, and J. Bird. 1985. Investigation of the potential effects of underwater noise from petroleum-industry activities on feeding humpback whale behavior. Final report. Bolt, Beranek and Newman, Inc., Cambridge, MA (USA).

Manci, K. M., D. N. Gladwin, R. Villella, and M. G. Cavendish. 1988. Effects of aircraft noise and sonic booms on domestic animals and wildlife: A literature synthesis. U.S. Fish and Wildlife Service, National Ecology Research Center, Ft. Collins, Colorado.

Mann, J., R. C. Connor, L. M. Barre, and M. R. Heithaus. 2000. Female reproductive success in bottlenose dolphins (Tursiops sp.): Life history, habitat, provisioning, and group-size effects. Behavioral Ecology 11(2):210-219.

Matkin, C. O., and E. Saulitis. 1997. Restoration notebook: killer whale (*Orcinus orca*). Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

Maze-Foley, K., and K. Mullin. 2007. Cetaceans of the oceanic northern Gulf of Mexico: Distributions, group sizes and interspecific associations. Journal of Cetacean Research and Management 8(2):203.

Maze-Foley, K., and K. D. Mullin. 2006. Cetaceans of the oceanic northern Gulf of Mexico: Distributions, group sizes and interspecific associations. Journal of Cetacean Research and Management 8(2):203-213.

McDonald, T. L., and coauthors. 2017. Density and exposure of surface-pelagic juvenile sea turtles to Deepwater Horizon oil. Endangered Species Research 33:69-82.

McKenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. Journal of the Acoustical Society of America 131(2):92-103.

McKenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2013. Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions. Scientific reports 3:1760.

McMahon, C. R., and G. C. Hays. 2006. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology 12(7):1330-1338.

Miksis-Olds, J. L., and S. M. Nichols. 2016. Is low frequency ocean sound increasing globally? J Acoust Soc Am 139(1):501-11.

Mintz, J., and C. Parker. 2006. Vessel traffic and speed around the US coasts and around Hawaii. CNA Corporation, Alexandria, Virginia.

Mitchell, R., I. MacDonald, and K. Kvenvolden. 1999. Estimates of total hydrocarbon seepage into the Gulf of Mexico based on satellite remote sensing images. EOS Supplement 80(49):OS242.

Mitchelmore, C. L., C. A. Bishop, and T. K. Collier. 2017. Toxicological estimation of mortality of oceanic sea turtles oiled during the Deepwater Horizon oil spill. Endangered Species Research 33:39-50.

MMC. 2007. Marine mammals and noise: A sound approach to research and management. Marine Mammal Commission.

Moein Bartol, S., and J. A. Musick. 2003. Sensory biology of sea turtles. Pages 90-95 *in* P. L. J. A. M. J. W. Lutz, editor. The Biology of Sea Turtles, volume II. CRC Press, Boca Raton, Florida.

Mongillo, T. M., and coauthors. 2012. Predicted polybrominated diphenyl ether (PBDE) and polychlorinated biphenyl (PCB) accumulation in southern resident killer whales. Marine Ecology Progress Series 453:263-277.

Moore, S. E., and R. P. Angliss. 2006. Overview of planned seismic surveys offshore northern Alaska, July-October 2006. Paper SC/58/E6 presented to IWC Scientific Committee, St Kitts and Nevis.

Mrosovsky, N., G. D. Ryan, and M. C. James. 2009. Leatherback turtles: The menace of plastic. Marine Pollution Bulletin 58(2):287–289.

Mullin, K., and coauthors. 1994a. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. Fishery Bulletin 92(773-786).

Mullin, K. D., and G. L. Fulling. 2004. Abundance of cetaceans in the oceanic northern Gulf of Mexico, 1996-2001. Marine Mammal Science 20(4):787-807.

Mullin, K. D., and W. Hoggard. 2000. Visual surveys of cetaceans and sea turtles from aircraft and ships. MMS.

Mullin, K. D., W. Hoggard, and L. J. Hansen. 2004. Abundance and seasonal occurrence of cetaceans in outer continental shelf and slope waters of the north-central and northwestern Gulf of Mexico. Gulf of Mexico Science 22(1):62-73.

Mullin, K. D., and coauthors. 1994b. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. Fishery Bulletin 92(4):773-786.

Murphy, T. M., and S. R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Final Report to NOAA/NMFS/SEFC, U.S. Department of Commerce, 73p.

NAS. 2017. Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals. National Academies of Sciences, Engineering, and Medicine. The National Academies Press, Washington, District of Columbia.

Navy. 2013a. Water Range Sustainability Environmental Program Assessment, Potomac River Test Range Complex. Dahlgren, VA.

Navy, U. S. 2013b. Water Range Sustainability Environmental Program Assessment: Potomac River Test Range. Dahlgren, Virginia: Naval Surface Warfare Center.

Navy, U. S. 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III) Technical Report.

Navy, U. S. 2018. Atlantic Fleet Training and Testing, Final Environmental Impact Statement/Overseas Environmental Impact Statement.

Nelms, S. E., W. E. Piniak, C. R. Weir, and B. J. Godley. 2016. Seismic surveys and marine turtles: An underestimated global threat? Biological Conservation 193:49-65.

New, L. F., and coauthors. 2014. Using short-term measures of behaviour to estimate long-term fitness of southern elephant seals. Marine Ecology Progress Series 496:99-108.

Nieukirk, S. L., K. M. Stafford, D. k. Mellinger, R. P. Dziak, and C. G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean Journal of the Acoustical Society of America 115:1832-1843.

NMFS. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic.

NMFS. 2002. Endangered Species Act Section 7 Consultation - Biological Opinion on Shrimp Trawling in the Southeastern United States, under the Sea Turtle Conservation Regulations and as managed by the Fishery Management Plans for Shrimp in the South Atlantic and Gulf of Mexico. Biological Opinion.

NMFS. 2004a. Biological opinion on the authorization of pelagic fisheries under the fisheries management plan for the pelagic. National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 2004b. Endangered Species Act Section 7 Consultation - Biological Opinion on the Eglin Gulf test and training range.

NMFS. 2005. Endangered Species Act Section 7 Consultation - Biological Opinion on Eglin Gulf Test and Training Range, Precision Strike Weapons (PSW) Test (5-Year Plan).

NMFS. 2006. Biological Opinion on the 2006 Rim-of-the-Pacific Joint Training Exercises (RIMPAC). Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, FPR-2005-6879, Silver Spring, Maryland.

NMFS. 2009a. An assessment of loggerhead sea turtles to estimate impacts of mortality reductions on population dynamics. National Marine Fisheries Service, Southeast Fisheries Science Center.

NMFS. 2009b. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act : Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service.

NMFS. 2009c. Smalltooth sawfish recovery plan (Pristis pectinata). N. O. A. A. National Marine Fisheries Service, Commerce, editor. Smalltooth Sawfish Recovery Team, Silver Spring, Maryland.

NMFS. 2010. Smalltooth sawfish (Pristis pectinata) 5-year review: summary and evaluation. N. O. A. A. National Marine Fisheries Service, Commerce, editor. Protected Resources Division, St. Petersburg, FL.

NMFS. 2011a. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii), Second Revision. Pages 156 *in* USFWS, editor, Silver Spring, MD.

NMFS. 2011b. Biological Opinion on the Continued Authorization of Reef Fish Fishing under the Gulf

of Mexico (Gulf) Reef Fish Fishery Management Plan (RFFMP). National Marine Fisheries Service, SER-2011-3584, St. Petersburg, FL.

NMFS. 2011c. Endangered Species Act Section 7 Consultation - Biological Opinion on the Continued Authorization of Reef Fish Fishing under the Gulf of Mexico (Gulf) Reef Fish Fishery Management Plan (RFFMP). Sumbitted on September 30, 2011, St. Petersburg, Florida.

NMFS. 2011d. Preliminary Summer 2010 Regional Abundance Estimate of Loggerhead Turtles (Caretta caretta) in Northwestern Atlantic Ocean Continental Shelf Waters. Northeast and Southeast Fisheries Science Centers, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Reference Document 11-03, Woods Hole, Massachusetts.

NMFS. 2012. Reinitiation of Endangered Species Act (ESA) Section 7 Consultation on the Continued Authorization of the Atlantic Shark Fisheries via the Consolidated HMS Fishery Management Plan as Amended by Amendments 3 and 4 and the Federal

Authorization of a Smoothhound Fishery. Biological Opinion. NOAA, NMFS, SERO, Protected Resources Division (F/SER3) and Sustainable Fisheries Division (F/SER2).

NMFS. 2015. Biological Opinion on the reinitiation of the Endangered Species Act (ESA) Section 7 Consultation on the Continued Authorization of the Fishery Management Plan (FMP) for Coastal Migratory Pelagic (CMP) Resources in the Atlantic and Gulf of Mexico under the Magnuson-Stevens Fishery Management and Conservation Act (MSFMCA). National Marine Fisheries Service.

NMFS. 2018a. Biological and Conference Opinion on Navy Atlantic Fleet Training and Testing Activities, FPR-2018-9259.

NMFS. 2018b. Biological and Conference Opinion on U.S. Navy Atlantic Fleet Training and Testing.

NMFS. 2018c. Biological and Conference Opinion on U.S. Navy Atlantic Fleet Training and Testing and the National Marine Fisheries Service's Promulgation of Regulations Pursuant to the Marine Mammal Protection Act for the Navy to "Take" Marine Mammals Incidental to Atlantic Fleet Training and Testing. Department of Commerce, National Marine Fisheries Service, Silver Spring, MD.

NMFS. 2018d. Manual for Optional User Spreadsheet Tool (Version 2.0) for: 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, Maryland.

NMFS. 2021. US Atlantic and Gulf of Mexico marine mammal stock assessments 2020.

NMFS. 2022. Cetacean and sea turtle spatial density model outputs from visual observations using line-transect survey methods aboard NOAA vessel and aircraft platforms in the Gulf of Mexico from 2003-06-12 to 2019-07-31 (NCEI Accession 0256800).

NMFS, and USFWS. 1992. Recovery plan for leatherback turtles *Dermochelys coriacea* in the U. S. Carribean, Atlantic and Gulf of Mexico. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, and USFWS. 1993. Recovery Plan for the hawksbill turtle in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico, St. Petersburg, Florida.

NMFS, and USFWS. 1998. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle. Prepared by the Pacific Sea Turtle Recovery Team.

NMFS, and USFWS. 2007a. 5-year review: Summary and evaluation, green sea turtle (*Chelonia mydas*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Fish and Wildlife Service.

NMFS, and USFWS. 2007b. Loggerhead sea turtle (*Caretta caretta*) 5-year review: Summary and evaluation. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, and USFWS. 2008. Recovery plan for the northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS, and USFWS. 2013a. Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: Summary and evaluation National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, and USFWS. 2013b. Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service and United States Fish and Wildlife Service, Silver Spring, Maryland.
NMFS, and USFWS. 2013c. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.
NMFS, and USFWS. 2013d. Leatherback Sea Turtle, 5-Year Review: Summary and Evaluation.
NMFS, and USFWS. 2015a. Kemp's ridley sea turtle (*Lepidochelys kempii*) 5-year review: Summary and evaluation. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.
NMFS, and USFWS. 2015b. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-year Review: Summary and Evaluation. National Marine Fisheries Service and United States Fish and Wildlife Service, Silver Spring, Maryland.
NMFS, USFWS, and SEMARNAT. 2011a. Bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), second revision. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.
NMFS, USFWS, and SEMARNAT. 2011b. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. Pages 156 *in*. National Marine Fisheries Service, Silver Spring, Maryland.
NMFS, USFWS, SEMARNET, CNANP, and PROFEPA. 2011c. Bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), second revision. National Marine Fisheries Service, United States Fish and Wildlife Service, Secretariat of Environment & Natural Resources, National Commissioner of the Natural Protected Areas, Administrator of the Federal Attorney of Environmental Protection, Silver Spring, Maryland.
NMFS and USFWS. 2010. Final draft report: Summary report of a meeting of the NMFS/USFWS cross-agency working group on joint listing of North Pacific and northwest Atlantic loggerhead turtle distinct population segments. NMFS and USFWS, Washington, D.C.
NMFS/SEFSC. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic.U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-455.
NOAA. 2018. Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, Maryland.
Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2):81-115.
Nowacek, S. M., R. S. Wells, and A. R. Solow. 2001. Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Marine Mammal Science 17(4):673-688.
Nowacek, S. M. W., R. S.; Solow, A. R. 2001. Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Marine Mammal Science 17(4):673-688.

NRC. 1990. Sea turtle mortality associated with human activities. Pages 74-117 *in* N. R. Council, editor. Decline of the Sea Turtles: Causes and Prevention. National Academy Press, National Research Council Committee on Sea Turtle Conservation, Washington, D. C.

NRC. 2003a. National Research Council: Ocean noise and marine mammals. National Academies Press, Washington, D.C.

NRC. 2003b. Ocean Noise and Marine Mammals. National Academies Press.

NRC. 2003c. Ocean Noise and Marine Mammals. National Research Council of the National Academies of Science. The National Academies Press, Washington, District of Columbia.

NRC. 2008. Tackling marine debris in the 21st Century. National Research Council of the National Academies of Science. The National Academies Press, Washington, District of Columbia.

NSWC, N. S. W. C. 2017. Characterization of Bulk Charge Underwater Explosion Performance. IHTR 3615 Revision 2.

O'Hern, J. E., and D. C. Biggs. 2009. Sperm whale (Physeter macrocephalus) habitat in the Gulf of Mexico: Satellite observed ocean color and altimetry applied to small-scale variability in distribution. Aquatic Mammals 35(3):358-366.

Oros, J. G.-D., O. M.; Monagas, P. 2009. High levels of polychlorinated biphenyls in tissues of Atlantic turtles stranded in the Canary Islands, Spain. Chemosphere 74(3):473-478.

Pait, A., A. Mason, D. Whitall, J. Christensen, and S. Hartwell. 2010. Assessment of chemical contaminants in sediments and corals in Vieques. An ecological characterization of the marine resources of Vieques, Puerto Rico Part II: Field studies of habitats, nutrients, contaminants, fish, and benthic communities. NOAA Technical Memorandum NOS NCCOS 110:174.

Palka, D., and M. Johnson. 2007. Cooperative research to study dive patterns of sperm whales in the Atlantic Ocean. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region.

Parker, D. M., W. J. Cooke, and G. H. Balazs. 2005. Diet of oceanic loggerhead sea turtles (Caretta caretta) in the central North Pacific. Fishery Bulletin 103:142-152.

Parker, L. G. 1995. Encounter with a juvenile hawksbill turtle offshore Sapelo Island, Georgia. Marine Turtle Newsletter:19-22.

Patenaude, N. J., and coauthors. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science 18(2):309-335.

Payne, P. M., J. R. Nicolas, L. O'brien, and K. D. Powers. 1986. The distribution of the humpback whale, Megaptera novaeangliae, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, Ammodytes americanus. Fishery Bulletin 84(2):271-277.

Payne, P. M., and coauthors. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in prey abundance. Fishery Bulletin 88(4):687-696.

Pecl, G. T., and G. D. Jackson. 2008. The potential impacts of climate change on inshore squid: Biology, ecology and fisheries. Reviews in Fish Biology and Fisheries 18:373-385.

Pham, C. K., and coauthors. 2017. Plastic ingestion in oceanic-stage loggerhead sea turtles (*Caretta caretta*) off the North Atlantic subtropical gyre. Mar Pollut Bull.

Pirotta, V., A. Grech, I. D. Jonsen, W. F. Laurance, and R. G. Harcourt. 2019. Consequences of global shipping traffic for marine giants. Frontiers in Ecology and the Environment 17(1):39-46.

Plotkin, P. T. 1995. National Marine Fisheries Service and the U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973.

Popper, A. N., and coauthors. 2014. Sound Exposure Guidelines. Pages 33-51 *in* ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer International Publishing, Cham.

Poulakis, G., and J. Seitz. 2004. Recent occurrence of the smalltooth sawfish, *Pristis pectinata* (Elasmobranchiomorphi: Pristidae), in Florida Bay and the Florida Keys, with comments on sawfish ecology. Florida Scientist 67(1):27-35.

Poulakis, G. R., P. W. Stevens, A. A. Timmers, T. R. Wiley, and C. A. Simpfendorfer. 2011. Abiotic affinities and spatiotemporal distribution of the endangered smalltooth sawfish, *Pristis pectinata*, in a south-western Florida nursery. Marine and Freshwater Research 62(10):1165-1177.

Price, E. R., and coauthors. 2004. Size, growth, and reproductive output of adult female leatherback turtles *Dermochelys coriacea*. Endangered Species Research 5:1-8.

Rabalais, S. C., and N. N. Rabalais. 1980. The Occurrence of Sea Turtles on the South Texas Coast. Contributions in Marine Science Vol. 23:123-129.

Reeves, R. R., J. N. Lund, T. D. Smith, and E. A. Josephson. 2011a. Insights from whaling logbooks on whales, dolphins, and whaling in the Gulf of Mexico. Gulf of Mexico Science 29(1):41-67.

Reeves, R. R., J. N. Lund, T. D. Smith, and E. A. Josephson. 2011b. Insights from whaling logbooks on whales, dolphins, and whaling in the Gulf of Mexico. Gulf of Mexico Science 29(1):4.

Reeves, R. R., and H. Whitehead. 1997. Status of the sperm whale, *Physeter macrocephalus*, in Canada. Canadian Field-Naturalist 111(2):293-307.

Reina, R. D., P. A. Mayor, J. R. Spotila, R. Piedra, and F. V. Paladino. 2002. Nesting ecology of the leatherback turtle, *Dermochelys coriacea*, at Parque Nacional Marino Las Baulas, Costa Rica: 1988-1989 to 1999-2000. Copeia 2002(3):653-664.

Renaud, M. L., and J. A. Carpenter. 1994. Movements and submergence patterns of loggerhead turtles (Caretta caretta) in the Gulf of Mexico determined through satellite telemetry. Bulletin of Marine Science 55(1):1-15.

Rester, J., and R. Condrey. 1996. The occurrence of the hawksbill turtle, Eretmochelys imbricata, along the Louisiana coast. Gulf of Mexico Science 1996(2):112-114.

Reynolds, C. 1993. Gulf Sturgeon sightings, historic and recent-a summary of public responses. US Fish and Wildlife Service, Panama City, Florida.

Rice, D. W. 1989. Sperm whale, *Physeter macrocephalus* Linnaeus, 1758. Pp.177-233 In: S. H. Ridgway and R. Harrison (Eds), Handbook of Marine Mammals: Volume 4, River Dolphins and the Larger Toothed Whales. Academy Press, London.

Richardson, W. J. 1995. Marine mammal hearing. Pages 205-240 *in* C. R. W. J. G. J. Richardson, C. I. Malme, and D. H. Thomson, editors. Marine Mammals and Noise. Academic Press, San Diego, California.

Richardson, W. J., R. A. Davids, C. R. Evans, and P. Norton. 1985. Distribution of bowheads and industrial activity. Pages 255-306 *in* W. J. Richardson, editor. Behavior, disturbance and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1980-84. Report from LGL Ecological Research Associates, Inc. for U.S. Minerals Management Service, Bryan, Texas, and Reston, Virginia.

Richardson, W. J., C. R. Greene, C. I. Malme, and D. H. Thomson. 1995a. Marine Mammals and Noise. Academic Press, Inc., San Diego, California.

Richardson, W. J., C. R. G. Jr., C. I. Malme, and D. H. Thomson. 1995b. Marine Mammals and Noise. Academic Press, Inc., San Diego, California.

Richter, C. F., S. M. Dawson, and E. Slooten. 2003. Sperm whale watching off Kaikoura, New Zealand: Effects of current activities on surfacing and vocalisation patterns. Department of Conservation, Wellington, New Zealand. Science For Conservation 219. 78p.

Ridgway, S. H., E. G. Wever, J. G. McCormick, J. Palin, and J. H. Anderson. 1969. Hearing in the giant sea turtle, Chelonoa mydas. Proceedings of the National Academies of Science 64.

Roberts, J. J., and coauthors. 2016. Habitat-based cetacean density models for the US Atlantic and Gulf of Mexico. Scientific reports 6(1):1-12.

Robinson, R. A., and coauthors. 2005. Climate change and migratory species. Defra Research, British Trust for Ornithology, Norfolk, U.K. .

Rockwood, R. C., J. Calambokidis, and J. Jahncke. 2017. High mortality of blue, humpback and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection. PLoS One 12(8):e0183052.

Rolland, R. M., and coauthors. 2012. Evidence that ship noise increases stress in right whales. Proc Biol Sci 279(1737):2363-8.

Romero, A., A. I. Agudo, S. M. Green, and G. Notarbartolo Di Sciara. 2001. Cetaceans of Venezuela: Their Distribution and Conservation Status. NOAA Technical Report NMFS-151. Seattle, Washington. 60p.

Rosel, P. E., and coauthors. 2016a. Status Review of Bryde's Whales (*Balaenoptera edeni*) in the Gulf of Mexico under the Endangered Species Act. Pages 149 *in* N. U.S. Department of Commerce, editor. Southeast Fisheries Science Center, Lafayette, Louisiana.

Rosel, P. E., and coauthors. 2016b. Status Review of Bryde's Whales (Balaenoptera edeni) in the Gulf of Mexico under the Endangered Species Act. NMFS Southeast Fisheries Science Center, NOAA Technical Memorandum NMFS-SEFSC-692, Lafayette, Louisiana.

Rosel, P. E., Wilcox, Lynsey A., Yamada, Tadasu K., Mullin, Keith D. 2021. A new species of baleen whale (Balaenoptera) from the Gulf of Mexico, with a review of its geographic distribution. Marine Mammal Science.

Ross, D. 1976. Mechanics of Underwater Noise. Pergamon Press, New York.

Ross, D. 1993. On ocean underwater ambient noise. Acoustics Bulletin 18:8-May.

Ross, D. 2005. Ship Sources of Ambient Noise. IEEE Journal of Oceanic Engineering 30(2):257-261.

Ross, P. S. 2002. The role of immunotoxic environmental contaminants in facilitating the emergence of infectious diseases in marine mammals. Human and Ecological Risk Assessment 8(2):277-292.

Ross, S. T., and coauthors. 2009. Estuarine and Coastal Habitat Use of Gulf Sturgeon (Acipenser oxyrinchus desotoi) in the North-Central Gulf of Mexico. Estuaries and Coasts 32(2):360-374.

Saeki, K., H. Sakakibara, H. Sakai, T. Kunito, and S. Tanabe. 2000. Arsenic accumulation in three species of sea turtles. Biometals 13(3):241-250.

Sahoo, G., R. K. Sahoo, and P. Mohanty-Hejmadi. 1996. Distribution of heavy metals in the eggs and hatchlings of olive ridley sea turtle, Lepidochelys olivacea, from Gahirmatha, Orissa. Indian Journal of Marine Sciences 25(4):371-372.

Samuels, A., L. Bejder, and S. Heinrich. 2000. A review of the literature pertaining to swimming with wild dolphins. Final report to the Marine Mammal Commission. Contract No. T74463123. 58pp.

Santidrián-Tomillo, P., and coauthors. 2007. Reassessment of the leatherback turtle (Dermochelys coriacea) population nesting at Parque Nacional Marino Las Baulas. Effects of conservation efforts. Chelonian Conservation and Biology.

Sarti Martínez, L., and coauthors. 2007. Conservation and Biology of the Leatherback Turtle in the Mexican Pacific. Chelonian Conservation and Biology 6(1):70-78.

Scheidat, M., C. Castro, J. Gonzalez, and R. Williams. 2004. Behavioural responses of humpback whales (Megaptera novaeangliae) to whalewatching boats near Isla de la Plata, Machalilla National Park, Ecuador. Journal of Cetacean Research and Management 6(1):63-68.

Schmid, J. R. 1998. Marine turtle populations on the west-central coast of Florida: results of tagging studies at the Cedar Keys, Florida, 1986-1995. Fishery Bulletin 96(3):589-602.

Schuyler, Q., B. D. Hardesty, C. Wilcox, and K. Townsend. 2012. To eat or not to eat? Debris selectivity by marine turtles. PLoS One 7(7):e40884.

Seitz, J., and G. R. Poulakis. 2002. Recent occurrence of sawfishes (Elasmobranchiomorphi: Pristidae) along the southwest coast of Florida (USA). Florida Scientist 65(4):256-266.

Seminoff, J. A., and coauthors. 2015a. Status reviw of the green turtle (*Chelonia mydas*) under the Endnagered Species Act. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Seminoff, J. A., and coauthors. 2015b. Status review of the green turtle (*Chelonia Mydas*) under the endangered species act. NOAA Technical Memorandum, NMFS-SWFSC-539.

Seminoff, J. A., C.D. Allen, G.H. Balazs, T. Eguchi, H.L. Haas, S.A. Hargrove, M. P. Jensen, D.L. Klemm, A.M. Lauritsen, S.L. MacPherson, P. Opay, E.E. Possardt, S.L. Pultz, E.E. Seney, K.S. Van Houtan, R.S. Waples. 2015. Status Review of the Green Turtle (Chelonia mydas) Under the U.S. Endangered Species Act. Pages 571 *in*. NOAA Technical Memorandum, La Jolla, CA.

Shamblin, B. M., and coauthors. 2016. Mexican origins for the Texas green turtle foraging aggregation: A cautionary tale of incomplete baselines and poor marker resolution. Journal of Experimental Marine Biology and Ecology 488:111-120.

Shoop, C. R., and R. D. Kenney. 1992a. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetological Monographs 6:43-67.

Shoop, C. R., and R. D. Kenney. 1992b. Seasonal distributions and abundances of loggerhead and leatherback seaturtles in waters of the northeastern United States. Herpetological Monographs 6:43-67.

Simmonds, M. P. 2005. Whale watching and monitoring: some considerations. Unpublished paper submitted to the Scientific Committee of the International Whaling Commission SC/57/WW5, Cambridge, United Kingdom.

Simmonds, M. P., and W. J. Eliott. 2009. Climate change and cetaceans: Concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom 89(1):203-210.

Simmonds, M. P., and S. J. Isaac. 2007. The impacts of climate change on marine mammals: Early signs of significant problems. Oryx 41(1):19-26.
Simpfendorfer, C., G. Poulakis, P. O'Donnell, and T. Wiley. 2008. Growth rates of juvenile smalltooth sawfish *Pristis pectinata* Latham in the western Atlantic. Journal of Fish Biology 72(3):711-723.
Simpfendorfer, C. A., and T. R. Wiley. 2004. Determination of the distribution of Florida's remnant sawfish population, and identification of areas critical to their conservation. Mote Marine Laboratory Technical Report.
Simpfendorfer, C. A., and coauthors. 2011. Environmental influences on the spatial ecology of juvenile smalltooth sawfish (*Pristis pectinata*): results from acoustic monitoring. PLoS One 6(2):e16918.
Smultea, M. A., J. R. Mobley Jr., D. Fertl, and G. L. Fulling. 2008. An unusual reaction and other observations of sperm whales near fixed-wing aircraft. Gulf and Caribbean Research 20:75-80.
Soldevilla, M. S., A. J. Debich, L. P. Garrison, J. A. Hildebrand, and S. M. Wiggins. 2022. Rice's whales in the northwestern Gulf of Mexico: call variation and occurrence beyond the known core habitat. Endangered Species Research 48:155-174.
Southall, B. L., and coauthors. 2007a. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4).
Southall, B. L., and coauthors. 2008. Marine mammal noise-exposure criteria: initial scientific recommendations. Bioacoustics 17(1-3):273-275.
Southall, B. L., and coauthors. 2007b. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):411-521.
Southall, B. L., D. P. Nowacek, P. J. O. Miller, and P. L. Tyack. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research 31:293-315.
Spotila, J. R., and coauthors. 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):209-222.
Spotila, J. R., R. D. Reina, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405(6786):529-530.
Stacy, N. I., and coauthors. 2017. Clinicopathological findings in sea turtles assessed during the Deepwater Horizon oil spill response. Endangered Species Research 33:25-37.
Stewart, K. R. K., J. M.; Templeton, R.; Kucklick, J. R.; Johnson, C. 2011. Monitoring persistent organic pollutants in leatherback turtles (*Dermochelys coriacea*) confirms maternal transfer. Marine Pollution Bulletin 62(7):1396-1409.
Steyn. 2010. Exxon Valdez Oil Spill.
Storelli, M., M. G. Barone, and G. O. Marcotrigiano. 2007. Polychlorinated biphenyls and other chlorinated organic contaminants in the tissues of Mediterranean loggerhead turtle Caretta caretta. Science of the Total Environment 273 (2-3:456-463.
Storelli, M., M. G. Barone, A. Storelli, and G. O. Marcotrigiano. 2008. Total and subcellular distribution of trace elements (Cd, Cu and Zn) in the liver and kidney of green turtles (Chelonia mydas) from the Mediterranean Sea. Chemosphere 70(5):908-913.
Swingle, W. M., S. G. Barco, T. D. Pitchford, W. A. Mclellan, and D. A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Marine Mammal Science 9(3):309-315.

Tapilatu, R. F., and coauthors. 2013. Long-term decline of the western Pacific leatherback, *Dermochelys coriacea*: A globally important sea turtle population. Ecosphere 4:15.
TEWG. 1998a. An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the Western North Atlantic. Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation.
TEWG. 1998b. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. U. S. Dept. Commerce.
TEWG. 2000a. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Turtle Expert Working Group, NOAA Technical Memorandum NMFS-SEFSC-444.
TEWG. 2000b. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Turtle Expert Working Group.
TEWG. 2007a. An Assessment of the Leatherback Turtle Population in the Atlantic Ocean. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Turtle Expert Working Group, Technical Memorandum NMFS-SEFSC-555.
TEWG. 2007b. An Assessment of the Leatherback Turtle Population in the Atlantic Ocean. NOAA.
TEWG. 2009. An Assessment of the Loggerhead Turtle Population in the Western North Atlantic Ocean. NOAA.
Tolotti, M. T., P. Bach, F. Hazin, P. Travassos, and L. Dagorn. 2015. Vulnerability of the Oceanic Whitetip Shark to Pelagic Longline Fisheries. PLoS One PLoS ONE 10(10).
Tomas, J., and J. A. Raga. 2008. Occurrence of Kemp's ridley sea turtle (*Lepidochelys kempii*) in the Mediterranean. Marine Biodiversity Records 1(01).
Trustees, D. H. N. 2016. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement. NOAA, http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan.
Tucker, A. D. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology 383(1):48-55.
USAF, U. S. A. F. 1997. Environmental Effects of Self-Protection Chaff and Flares.
USAF, U. S. A. F. 2000. Supersonic Aircraft Noise at and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals. .
USAF, U. S. A. F. 2015. Range Environmental Assessment for Eglin Gulf Test and Training Range, Eglin Air Force Base, Florida.
USFWS, and NMFS. 2003. Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. F. a. U. S. D. o. C. U.S. Department of the Interior, NOAA, editor. Federal Register.
Vanderlaan, A. S., and C. T. Taggart. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. Marine Mammal Science 23(1):144-156.

Viada, S. T., and coauthors. 2008. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. Environmental Impact Assessment Review 28:267–285.

Villegas-Amtmann, S., L. K. Schwarz, J. L. Sumich, and D. P. Costa. 2015. A bioenergetics model to evaluate demographic consequences of disturbance in marine mammals applied to gray whales. Ecosphere 6(10).

Wallace, B., and coauthors. 2015. Estimating degree of oiling of sea turtles and surface habitat during the Deepwater Horizon oil spill: implications for injury quantification.(ST_TR. 02). DWH Sea Turtles NRDA Technical Working Group Report.

Wallace, B. P., S. S. Heppell, R. L. Lewison, S. Kelez, and L. B. Crowder. 2008. Impacts of fisheries bycatch on loggerhead turtles worldwide inferred from reproductive value analyses. Journal of Applied Ecology 45(4):1076-1085.

Wallace, B. P., and coauthors. 2007. Maternal investment in reproduction and its consequences in leatherback turtles. Oecologia 152(1):37-47.

Wallace, R. L., S. Gilbert, and J. E. Reynolds, 3rd. 2019. Improving the Integration of Restoration and Conservation in Marine and Coastal Ecosystems: Lessons from the Deepwater Horizon Disaster. Bioscience 69(11):920-927.

Walsh, M. R., M. E. Walsh, I. Poulin, S. Taylor, and T. A. Douglas. 2011. Energetic residues from the detonation of common US ordnance. International Journal of Energetic Materials and Chemical Propulsion 10(2).

Wardle, C. S., and coauthors. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21:1005-1027.

Waring, G. T., Elizabeth Josephson, Katherine Maze-Foley, Patricia E. Rosel. 2016. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2015. NMFS Northeast Fisheries Science Center, NFMS-NE-238, Woods Hole, Massachusetts.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2013. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments--2012. NOAA Tech Memo NMFS NE 223(419):02543-1026.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2016a. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2015. National Marine Fisheries Service Northeast Fisheries Science Center

NMFS-NE-238, Woods Hole, Massachusetts.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2016b. US Atlantic and Gulf of Mexico Marine

Mammal Stock Assessments - 2015. NOAA National Marine Fisheries Service, NOAA Technical Memorandum NMFS-NE-238, Woods Hole, Massaschusetts.

Watkins, W. A. 1977. Acoustic behavior of sperm whales. Oceanus 20:50-58.

Watkins, W. A. 1986. Whale Reactions to Human Activities in Cape-Cod Waters. Marine Mammal Science 2(4):251-262.

Watters, D. L., M. M. Yoklavich, M. S. Love, and D. M. Schroeder. 2010. Assessing marine debris in deep seafloor habitats off California. Marine Pollution Bulletin 60:131–138.

Wiggins, S. M., J. M. Hall, B. J. Thayre, and J. A. Hildebrand. 2016. Gulf of Mexico low-frequency ocean soundscape impacted by airguns. The Journal of the Acoustical Society of America 140(1):176-183.

Wiley, D. N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. Fishery Bulletin 93(1):196-205.

Williams, R. M., A. W. Trites, and D. E. Bain. 2002. Behavioral responses of killer whales (*Orcinus orca*) to whale-watching boats: Opportunistic observations and experimental approaches. Journal of Zoology 256(2):255-270.

Wise, C. F., and coauthors. 2014. Chemical dispersants used in the Gulf of Mexico oil crisis are cytotoxic and genotoxic to sperm whale skin cells. Aquat Toxicol 152:335-40.

Wise, J. P. J., and coauthors. 2018. A three year study of metal levels in skin biopsies of whales in the Gulf of Mexico after the DWH oil crisis. Comp Biochem Physiol C Toxicol Pharmacol. 205(February 2018):27.

Witherington, B., S. Hirama, and R. Hardy. 2012. Young sea turtles of the pelagic Sargassum-dominated drift community: habitat use, population density, and threats. Marine Ecology Progress Series 463:1-22.

Witherington, B., P. Kubilis, B. Brost, and A. Meylan. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19(1):30-54.

Witherington, B. E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48(1):31-39.

Witherington, B. E. 1994. Flotsam, jetsam, post-hatchling loggerheads, and the advecting surface smorgasbord. Pages 166-168 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, editors. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation.

Witherington, B. E., and K. A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles Caretta caretta. Biological Conservation 55:139-149.

Witzell, W. N. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO.

Witzell, W. N. 2002. Immature Atlantic loggerhead turtles (*Caretta caretta*): Suggested changes to the life history model. Herpetological Review 33(4):266-269.

Wooley, C. M., and E. J. Crateau. 1985. Movement, microhabitat, exploitation, and management of Gulf of Mexico sturgeon, Apalachicola River, Florida. North American Journal of Fisheries Management 5(4):590-605.

Work, P. A., A. L. Sapp, D. W. Scott, and M. G. Dodd. 2010. Influence of small vessel operation and propulsion system on loggerhead sea turtle injuries. Journal of Experimental Marine Biology and Ecology 393(1-2):168-175.

Wuebbles, D. J., and coauthors. 2017. Executive Summary. Pages 12-34 *in* D. J. Wubbles, and coeditors, editors. Climate Science Special Report: Fourth National Climate Assessment, volume 1. U.S. Global Change Research Program, Washington D.C.

Wursig, B., S. K. Lynn, T. A. Jefferson, and K. D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals 24(1):41-50.

Young, C. N., Carlson, J., Hutchinson, M., Hutt, C., Kobayashi, D., McCandless, C.T., Wraith, J. 2016. Status Review Report: oceanic whitetip shark (*Carcharhinius longimanus*). Final report to the National Marine Fisheries Service, Office of Protected Resourses.:162.

Young, C. N., and coauthors. 2016. Status review report: oceanic whitetip shark (Carcharhinius longimanus). . DOC National Oceanic and Atmospheric Administration.

Zwinenberg, A. J. 1977a. Kemp's ridley, *Lepidochelys kempii* (Garman, 1880), undoubtedly the most endangered marine turtle today (with notes on the current status of *Lepidochelys olivacea*). Bulletin Maryland Herpetological Society 13(3):170-192.

Zwinenberg, A. J. 1977b. Kemp’s ridley, *Lepidochelys kempii* (Garman 1880), undoubtedly the most endangered marine turtle today (with notes on the current status of *Lepidochelys olivacea*). Bulletin of the Maryland Herpetological Society 13(3):378-384.

18 APPENDIX A

18.1 Table 1. Summary of munitions proposed for EGTTR during the 2023–2030 mission period.

User Group	Type	Category	Net Explosive Weight (lb)	Detonation Scenario	Annual Quantity
53 WEG	*Live Munitions*				
	AGR-20	Rocket	9.1	Surface	12
	AGM-158D JASSM XR	Missile	240.26	Surface	4
	AGM-158B JASSM ER	Missile	240.26	Surface	3
	AGM-158A JASSM	Missile	240.26	Surface	3
	AGM-65D	Missile	150	Surface	5
	AGM-65G2	Missile	145	Surface	5
	AGM-65H2	Missile	150	Surface	5
	AGM-65K2	Missile	145	Surface	4
	AGM-65L	Missile	150	Surface	5
	AGM-114 N-6D with TM	Missile	29.1	Surface	4
	AGM-114 N-4D with TM	Missile	29.94	Surface	4
	AGM-114 R2 with TM (R10)	Missile	27.41	Surface	4
	AGM-114 R-9E with TM (R11)	Missile	27.38	Surface	4
	AGM-114Q with TM	Missile	20.16	Surface	4
	CBU-105D	Bomb	108.6	HOB	8
	GBU-53/B (GTV)	Bomb	0.34[a]	HOB/Surface	8
	GBU-39 SDB (GTV)	Bomb	0.39[a]	Surface	4
	AGM-88C w/FTS	Missile	0.70[a]	Surface	2
	AGM-88B w/FTS	Missile	0.70[a]	Surface	2
	AGM-88F w/FTS	Missile	0.70[a]	Surface	2
	AGM-88G w/FTS	Missile	0.70[a]	Surface	2
	AGM-179 JAGM	Missile	27.47	Surface	4
	GBU-69	Bomb	6.88	Surface	2
	GBU-70	Bomb	6.88	Surface	1
	AGM-176	Missile	8.14	Surface	4
	GBU-54 KMU-572C/B	Bomb	193	Surface	1
	GBU-54 KMU-572B/B	Bomb	193	Surface	1
	PGU-43 (105 mm)	Gun Ammunition	4.7	Surface	100
	AIM-120D	Missile	113.05	HOB	24
	AIM-120C7	Missile	113.05	HOB	10
	AIM-120C5/6	Missile	113.05	HOB	8
	AIM-120C3	Missile	102.65	HOB	14
	AIM-120C3	Missile	117.94	HOB/Surface	4
	AIM-120B	Missile	102.65	HOB	18
	AIM-9X Blk I	Missile	60.25	HOB	7

User Group	Type	Category	Net Explosive Weight (lb)	Detonation Scenario	Annual Quantity
53 WEG	AIM-9X Blk I	Missile	67.9	HOB/Surface	10
	AIM-9X Blk II	Missile	60.25	HOB	24
	AIM-9M-9	Missile	60.55	HOB	90
	Inert Munitions				
	ADM-160B MALD	Missile	N/A	N/A	4
	ADM-160C MALD-J	Missile	N/A	N/A	4
	ADM-160C-1 MALD-J	Missile	N/A	N/A	4
	ADM-160D MALD-J	Missile	N/A	N/A	4
	GBU-10	Bomb	N/A	N/A	8
	GBU-12	Bomb	N/A	N/A	32
	GBU-49	Bomb	N/A	N/A	16
	GBU-24/B (84)	Bomb	N/A	N/A	16
	GBU-24A/B (109)	Bomb	N/A	N/A	2
	GBU-31B(v)1	Bomb	N/A	N/A	16
	GBU-31C(v)1	Bomb	N/A	N/A	16
	GBU-31B(v)3	Bomb	N/A	N/A	2
	GBU-31C(v)3	Bomb	N/A	N/A	2
	GBU-32C	Bomb	N/A	N/A	8
	GBU-38B	Bomb	N/A	N/A	4
	GBU-38C w/BDU-50 (No TM)	Bomb	N/A	N/A	4
	GBU-38C	Bomb	N/A	N/A	10
	GBU-54 KMU-572C/B	Bomb	N/A	N/A	4
	GBU-54 KMU-572B/B	Bomb	N/A	N/A	4
	GBU-69	Bomb	N/A	N/A	2
	BDU-56A/B	Bomb	N/A	N/A	4
	PGU-27 (20 mm)	Gun Ammunition	0.09	N/A	16,000
	PGU-15 (30 mm)	Gun Ammunition	N/A	N/A	16,000
	PGU-25 (25 mm)	Gun Ammunition	N/A	N/A	16,000
	ALE-50	Decoy System	N/A	N/A	6
	AIM-260A JATM	Missile	N/A	N/A	4
	PGU-27 (20 mm)	Gun Ammunition	N/A	N/A	80,000
	PGU-23 (25 mm)	Gun Ammunition	N/A	N/A	6,000
	MJU-7A/B Flare	Flare	N/A	N/A	1,800
	R-188 Chaff	Chaff	N/A	N/A	6,000
	R-196 (T-1) Chaff	Chaff	N/A	N/A	1,500

User Group	Type	Category	Net Explosive Weight (lb)	Detonation Scenario	Annual Quantity
AFSOC	***Live Munitions***				
	105 mm HE (FU)	Gun Ammunition	4.7	Surface	750
	105 mm HE (TR)	Gun Ammunition	0.35	Surface	1,350
	30 mm HE	Gun Ammunition	0.1	Surface	35,000
	AGM-176 Griffin	Missile	4.58	HOB	100
	AGM-114R9E/R2 Hellfire	Missile	20.0	HOB	70
	2.75-inch Rocket (including APKWS)	Rocket	2.3	Surface	400
	GBU-12	Bomb	198.0/298.0	Surface	30
	Mk-81 (GP 250 lb)	Bomb	151.0	Surface	30
	GBU-39 (SDB I)	Bomb	37.0	HOB	30
	GBU-69	Bomb	36.0	HOB	40
	Inert Munitions				
	.50 caliber	Gun Ammunition	N/A	N/A	30,000
	GBU-12	Bomb	N/A	N/A	30
	MkK-81 (GP 250 lb)	Bomb	N/A	N/A	30
	BDU-50	Bomb	N/A	N/A	30
	BDU-33	Bomb	N/A	N/A	50
96 OG	***Live Munitions***				
	AGM-176 Griffin	Missile	4.58	Surface	10
	AGM-114 Hellfire	Missile	20.0	Surface	10
	GBU-39 (SDB I)	Bomb	37.0	Surface	6
	GBU-39 (LSDB)	Bomb	37.0	Surface	10
	105 mm HE (FU)	Gun Ammunition	4.7	Surface	60
	105 mm HE (TR)	Gun Ammunition	0.35	Surface	60
	30 mm HE	Gun Ammunition	0.1	Surface	99
	AGM-114R Hellfire	Missile	20.0	Surface	36
	AIM-9X	Missile	7.9	HOB	1
	GBU-39B/B LSDB	Bomb	37.0	Surface	2
	AGM-158 (JASSM)	Missile	240.26	Surface	2
	GBU-39 (SDB I)	Bomb	37.0	HOB/Surface	2
	GBU-39 (SDB I) Simultaneous Launch[b]	Bomb	74.0	HOB/Surface	2
	GBU-53 (SDB II)	Bomb	22.84	HOB/Surface	2
	AGM-114L Longbow	Missile	35.95	HOB	6
	AGM-179A JAGM	Missile	27.47	HOB	8

User Group	Type	Category	Net Explosive Weight (lb)	Detonation Scenario	Annual Quantity
96 OG	Spike NLOS	Missile	34.08	Surface	3
	PAC-2	Missile	145.0[c]	N/A (drone target)	8
	PAC-3	Missile	145.0[c]	N/A (drone target)	2
	HACM	Hypersonic Weapon	350[e]	Surface	1
	PrSM	Hypersonic Weapon	46[e]	HOB	2
	SINKEX	Vessel Sinking Exercise	Not Available	Not Available	2
	GBU-10, 24, or 31 (QUICKSINK)	Bomb	945	Subsurface	4 to 8
	2,000 lb bomb with JDAM kit	Bomb	945 or less	HOB	2
	Inert GBU-39 (LSDB) with live fuze	Bomb	0.4	HOB/Surface	4
	Inert GBU-53 (SDB II) with live fuze	Bomb	0.4	HOB/Surface	4
	Inert Munitions				
	GBU-39B/B LSDB	Bomb	N/A	N/A	2
	GBU-49	Bomb	N/A	N/A	10
	GBU-48	Bomb	N/A	N/A	1
	AGM-158 (JASSM)	Missile	N/A	N/A	4
	GBU-39 (SDB I)	Bomb	N/A	N/A	4
	GBU-39 (SDB I) Simultaneous Launch	Bomb	N/A	N/A	4
	GBU-53 (SDB II)	Bomb	N/A	N/A	1
	AIM-260 JATM - Inert	Missile	N/A	N/A	6
	AIM-9X - Inert	Missile	N/A	N/A	10
	AIM-120 AMRAAM - Inert	Missile	N/A	N/A	15
	PrSM - Inert	Hypersonic Weapon	N/A	N/A	2
	SiAW AARGM-ER	Missile	N/A	N/A	7
	Multipurpose Booster	Booster	N/A	N/A	1
	JDAM ER	Bomb	N/A	N/A	3
	Navy HAAWC	Torpedo	N/A	N/A	2
	Mk-84 (GP 2,000 lb)[c]	Bomb	N/A	N/A	9
NAVSCOLEOD	Underwater Mine Charge	Charge	20[d]	Subsurface	32
	Floating Mine Charge	Charge	5[d]	Surface	80

[a] Warhead replaced by FTS/TM. Identified NEW is for the FTS.
[b] NEW is doubled for simultaneous launch.
[c] Assumed for impact analysis.
[d] Estimated.
[e] Net explosive weight at impact/detonation.

WEG = 53rd Weapons Evaluation Group; 780 TS = 780th Test Squadron; 96 OG = 96th 1 Operations Group; AARGM-ER = Advanced Anti-Radiation Guided Missile - Extended Range; ABMS = Advanced Battle Management System; ADM= American Decoy Missile; AFSOC = Air Force Special Operations Command; AGM = Air-to-Ground Missile; AIM = Air Intercept Missile; ALE = Ammunition Loading Equipment; AMRAAM = Advanced Medium-Range Air-to-Air Missile; APKWS = Advanced Precision Kill Weapon System; BDU = Bomb Dummy Unit; C-RAM = Counter, Rocket, Artillery, and Mortar; CBU = Cluster Bomb Unit; EGTTR = Eglin Gulf Test and Training Range; ER = Extended Range; FTS = Flight Termination System; FU = Full Up; GBU = Guided Bomb Unit; GP = General Purpose; GTV = Guided Test Vehicle; HAAWC = High Altitude Anti-Submarine Warfare Weapon Capability; HACM = Hypersonic Attack Cruise Missile; HE = High Explosive; HOB = height of burst; JDAM = Joint Direct Attack Munition; JAGM = Joint Air-to-Ground Missile; JASSM = Joint Air-to-Surface Standoff Missile; JATM = Joint Advanced Tactical Missile; LAICRM = Large Aircraft Infrared Counter Measure; lb = pound(s); LSDB = Laser Small-Diameter Bomb; MALD = Miniature Air-Launched Decoy; MJU = Mobile Jettison Unit; Mk = Mark; mm = millimeter(s); N/A = not applicable; NLOS = Non-Line-of-Sight; NAVSCOLEOD = Naval School Explosive Ordnance Disposal; PAC = Patriot Advanced Capability; PGU = Projectile Gun Unit; SDB = Small-Diameter Bomb; SiAW = Stand-in Attack Weapon; SRI = Santa Rosa Island; TA = Test Area; TBD = to be determined; TM = telemetry; TR = Training Round

18.2 Table 2. Mission-day categories for acoustic impact analysis.

User Group	Mission-Day Category	Munition Type	Category	Warhead NEW (lb)	NEWi (lb)	Detonation Scenario	Munitions per Day	Mission Days per Year	Annual Quantity	NEWi per Mission Day (lb)
53 WEG	A	AGM-158D JASSM XR	Missile	240.26	241.36	Surface	4	1	4	2,413.6
		AGM-158B JASSM ER	Missile	240.26	241.36	Surface	3	1	3	
		AGM-158A JASSM	Missile	240.26	241.36	Surface	3	1	3	
	B	GBU-54 KMU-572C/B	Bomb (Mk-82)	192	192.3	Surface	4	1	4	2,029.9
		GBU-54 KMU-572B/B	Bomb (Mk-82)	192	192.3	Surface	4	1	4	
		AGM-65D	Missile	85	98.3	Surface	5	1	5	
	C	AGM-65H2	Missile	85	98.3	Surface	5	1	5	1,376.2
		AGM-65G2	Missile	85	98.3	Surface	5	1	5	
		AGM-65K2	Missile	85	98.3	Surface	4	1	4	
	D	AGM-65L	Missile	85	98.3	Surface	5	1	5	836.22
		AIM-120C3	Missile	15	36.18	Surface	4	1	4	
		AIM-9X Blk I	Missile	7.7	20	Surface	10	1	10	
	E	AGM-114 N-4D with TM	Missile	9	13.08	Surface	4	1	4	997.62
		AGM-114 N-6D with TM	Missile	9	13.08	Surface	4	1	4	
		AGM-179 JAGM	Missile	9	13.08	Surface	4	1	4	
		AGM-114 R2 with TM (R10)	Missile	9	13.08	Surface	4	1	4	
		AGM-114 R-9E with TM (R11)	Missile	9	13.08	Surface	4	1	4	
		AGM-114Q with TM	Missile	9	13.08	Surface	4	1	4	
		AGR-20 (APKWS)	Rocket	2.3	3.8	Surface	12	1	12	
		AGM-176	Missile	9	13.08	Surface	4	1	4	
		PGU-43 (105 mm)	Gun Ammunition	4.7	4.72	Surface	100	1	100	
		GBU-69	Bomb	36	36.1	Surface	2	1	2	
		GBU-70	Bomb	36	36.1	Surface	1	1	4	
		AGM-88C w/FTS	Missile	0.70[a]	0	Surface	2	1	2	
		AGM-88B w/FTS	Missile	0.70[a]	0	Surface	2	1	2	
		AGM-88F w/FTS	Missile	0.70[a]	0	Surface	2	1	2	
		AGM-88G w/FTS	Missile	0.70[a]	0	Surface	2	1	2	
		GBU-39 SDB (GTV)	Bomb	0.39[a]	0.49	Surface	4	1	4	
		GBU-53/B (GTV)	Bomb	0.34[a]	0.44	Surface	8	1	8	
AFSOC	F	GBU-12	Bomb (Mk-82)	192	192.3	Surface	2	15	30	584.6
		Mk-81 (GP 250 lb)	Bomb	100	100	Surface	2	15	30	

User Group	Mission-Day Category	Munition Type	Category	Warhead NEW (lb)	NEWi (lb)	Detonation Scenario	Munitions per Day	Mission Days per Year	Annual Quantity	NEWi per Mission Day (lb)
AFSOC	G	105 mm HE (FU)	Gun Ammunition	4.7	4.72	Surface	30	25 (daytime)	750	191.6
		30 mm HE	Gun Ammunition	0.1	0.1	Surface	500		12,500	
	H	105 mm HE (TR)	Gun Ammunition	0.35	0.37	Surface	30	45 (nighttime)	1,350	61.1
		30 mm HE	Gun Ammunition	0.1	0.1	Surface	500		22,500	
	I	2.75-inch Rocket (including APKWS)	Rocket	2.3	3.8	Surface	8	50	400	30.4
96 OG	J	GBU-10, 24, or 31 (QUICKSINK)	Bomb (Mk-84)	945	946.8	Subsurface	1	10[b]	10[b]	946.8
	K	HACM	Hypersonic Weapon	Not available	350	Surface	1	1	1	350
	L	AGM-158 (JASSM)	Missile	240.26	241.36	Surface	2	1	2	627.12
		GBU-39 (SDB I) Simultaneous Launch[c]	Bomb	72	72.2	Surface	2	1	2	
	M	GBU-39 (SDB I)	Bomb	36	36.1	Surface	4	2	8	324.9
		GBU-39 (LSDB)	Bomb	36	36.1	Surface	5	2	10	
	N	GBU-39B/B LSDB	Bomb	36	36.1	Surface	2	1	2	238.08
		Spike NLOS	Missile	34.08	40	Surface	3	1	3	
		GBU-53 (SDB II)	Bomb	22.84	22.94	Surface	2	1	2	
	O	AGM-114R Hellfire	Missile	9	13.08	Surface	8	4	36	104.64
	P	AGM-114 Hellfire	Missile	9	13.08	Surface	5	2	10	130.8
		AGM-176 Griffin	Missile	9	13.08	Surface	5	2	10	
	Q	105 mm HE (FU)	Gun Ammunition	4.7	4.72	Surface	20	3	60	94.4
	R	Inert GBU-39 (LSDB) with live fuze	Bomb	0.39	0.49	Surface	4	1	4	35.82
		Inert GBU-53 (SDB II) with live fuze	Bomb	0.34	0.44	Surface	4	1	4	
		105 mm HE (TR)	Gun Ammunition	0.35	0.37	Surface	60	1	60	
		30 mm HE	Gun Ammunition	0.1	0.1	Surface	99	1	99	
NAVSCOLEOD	S	Underwater Mine Charge	Charge	20[d]	20	Subsurface	4	8	32	130
		Floating Mine Charge	Charge	5[d]	5	Surface	10	8	80	

a Warhead replaced by FTS/TM. Identified NEW is for the FTS.
b Includes 2 SINKEX exercises.
c NEW is doubled for simultaneous launch.
d Estimated
53 WEG = 53rd Weapons Evaluation Group; 96 OG = 96th Operations Group; AFSOC = Air Force Special Operations Command; AGM = Air-to-Ground Missile; AIM = Air Intercept Missile; APKWS = Advanced Precision Kill Weapon System; ER = Extended Range; FTS = Flight Termination System; FU = Full Up; GBU = Guided Bomb Unit; GP = General Purpose; GTV = Guided Test Vehicle; HACM = Hypersonic Attack Cruise Missile; HE = High Explosive; JAGM = Joint Air-to-Ground Missile; JASSM = Joint Air-to-Surface Standoff Missile; lb = pound(s); LSDB = Laser Small- Diameter Bomb; Mk = Mark; mm = millimeter(s); NEW = net explosive weight; NEWi = net explosive weight at impact; NLOS = Non-Line-of-Sight; NAVSCOLEOD = Naval School Explosive Ordnance Disposal; PGU = Projectile Gun Unit; SDB = Small-Diameter Bomb; TM = telemetry; TR = Training Round

18.3 Table 3a. Dolphin threshold distances (in kilometers) for live missions.

Mission-Day Category	Mortality	Level A Harassment				Level B Harassment		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse B: 248.4 Pa·s AS: 197.1 Pa·s	Positive Impulse B: 114.5 Pa·s AS: 90.9 Pa·s	Peak SPL 237 dB	Weighted SEL 185 dB	Peak SPL 230 dB	Weighted SEL 170 dB	Peak SPL 224 dB	Weighted SEL 165 dB
Bottlenose Dolphin								
A	0.139	0.276	0.194	0.562	0.389	5.59	0.706	9.538
B	0.128	0.254	0.180	0.581	0.361	5.215	0.655	8.937
C	0.100	0.199	0.144	0.543	0.289	4.459	0.524	7.568
D	0.100	0.199	0.144	0.471	0.289	3.251	0.524	5.664
E	0.068	0.136	0.103	0.479	0.207	3.272	0.377	5.88
F	0.128	0.254	0.180	0.352	0.362	2.338	0.655	4.596
G	0.027	0.054	0.048	0.274	0.093	1.095	0.165	2.488
H	0.010	0.019	0.021	0.225	0.040	0.809	0.071	1.409
I	0.025	0.049	0.045	0.136	0.087	0.536	0.154	0.918
J	0.228	0.449	0.306	0.678	0.615	3.458	1.115	6.193
K	0.158	0.313	0.222	0.258	0.445	1.263	0.808	2.663
L	0.139	0.276	0.194	0.347	0.389	2.35	0.706	4.656
M	0.068	0.136	0.103	0.286	0.207	1.446	0.377	3.508
N	0.073	0.145	0.113	0.25	0.225	1.432	0.404	2.935
O	0.046	0.092	0.078	0.185	0.155	0.795	0.278	1.878
P	0.046	0.092	0.078	0.204	0.155	0.907	0.278	2.172
Q	0.027	0.054	0.048	0.247	0.093	0.931	0.165	1.563
R	0.012	0.024	0.026	0.139	0.052	0.537	0.093	0.91
S	0.053	0.104	0.084	0.429	0.164	1.699	0.294	2.872

Mission-Day Category	Mortality	Level A Harassment				Level B Harassment		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse B: 248.4 Pa·s AS: 197.1 Pa·s	Positive Impulse B: 114.5 Pa·s AS: 90.9 Pa·s	Peak SPL 237 dB	Weighted SEL 185 dB	Peak SPL 230 dB	Weighted SEL 170 dB	Peak SPL 224 dB	Weighted SEL 165 dB
Atlantic Spotted Dolphin								
A	0.171	0.338	0.194	0.562	0.389	5.59	0.706	9.538
B	0.157	0.311	0.180	0.581	0.361	5.215	0.655	8.937
C	0.123	0.244	0.144	0.543	0.289	4.459	0.524	7.568
D	0.123	0.244	0.144	0.471	0.289	3.251	0.524	5.664
E	0.084	0.168	0.103	0.479	0.207	3.272	0.377	5.88
F	0.157	0.312	0.180	0.352	0.362	2.338	0.655	4.596
G	0.033	0.066	0.048	0.274	0.093	1.095	0.165	2.488
H	0.012	0.023	0.021	0.225	0.040	0.809	0.071	1.409
I	0.030	0.060	0.045	0.136	0.087	0.536	0.154	0.918
J	0.279	0.550	0.306	0.678	0.615	3.458	1.115	6.193
K	0.194	0.384	0.222	0.258	0.445	1.263	0.808	2.663
L	0.171	0.338	0.194	0.347	0.389	2.35	0.706	4.656
M	0.084	0.168	0.103	0.286	0.207	1.446	0.377	3.508
N	0.090	0.179	0.113	0.25	0.225	1.432	0.404	2.935
O	0.057	0.113	0.078	0.185	0.155	0.795	0.278	1.878
P	0.057	0.113	0.078	0.204	0.155	0.907	0.278	2.172
Q	0.033	0.066	0.048	0.247	0.093	0.931	0.165	1.563
R	0.015	0.030	0.026	0.139	0.052	0.537	0.093	0.91
S	0.065	0.128	0.084	0.429	0.164	1.699	0.294	2.872

AS = Atlantic spotted dolphin; B = bottlenose dolphin; dB = decibel(s); GI = gastrointestinal; Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

Table 3b. Dolphin threshold distances (in kilometers) for inert munitions.

Inert Impact Class (lb TNT_{eq})	Mortality	Level A Harassment				Level B Harassment		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse B: 248.4 Pa·s AS: 197.1 Pa·s	Positive Impulse B: 114.5 Pa·s AS: 90.9 Pa·s	Peak SPL 237 dB	Weighted SEL 185 dB	Peak SPL 230 dB	Weighted SEL 170 dB	Peak SPL 224 dB	Weighted SEL 165 dB
Bottlenose Dolphin								
2	0.020	0.041	0.040	0.030	0.080	0.205	0.145	0.327
1	0.015	0.031	0.032	0.025	0.063	0.134	0.114	0.250
0.5	0.012	0.023	0.025	0.015	0.050	0.119	0.091	0.198
0.15	0.008	0.015	0.017	0.009	0.034	0.061	0.061	0.119
Atlantic Spotted Dolphin								
2	0.025	0.051	0.040	0.030	0.080	0.205	0.145	0.327
1	0.019	0.038	0.032	0.025	0.063	0.134	0.114	0.250
0.5	0.014	0.029	0.025	0.015	0.050	0.119	0.091	0.198
0.15	0.009	0.018	0.017	0.009	0.034	0.061	0.061	0.119

AS = Atlantic spotted dolphin; B = bottlenose dolphin; dB = decibel(s); GI = gastrointestinal; Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TNTeq = trinitrotoluene-equivalent TTS = temporary threshold shift

18.4 Table 4a. Sea turtle threshold distances (in kilometers) for live missions.

Mission-Day Category	Injury					Disturbance		
	Mortality	Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse L/G: 211.9 Pa·s KR: 189.8 Pa·s LB: 337.7 Pa·s	Positive Impulse L/G: 97.7 Pa·s KR: 87.5 Pa·s LB: 155.7 Pa·s	Peak SPL 237 dB	Weighted SEL 204 dB	Peak SPL 232 dB	Weighted SEL 189 dB	Peak SPL 226 dB	Weighted SEL 175 dB
Loggerhead and Green Sea Turtle								
A	0.160	0.317	0.194	<0.007	0.319	0.023	0.580	0.119
B	0.148	0.292	0.180	<0.007	0.296	0.023	0.540	0.118
C	0.115	0.229	0.144	<0.007	0.237	0.012	0.430	0.082
D	0.115	0.229	0.144	<0.007	0.237	0.011	0.430	0.062
E	0.079	0.157	0.103	<0.007	0.170	0.024	0.308	0.119
F	0.148	0.292	0.180	<0.007	0.296	0.008	0.540	0.032
G	0.031	0.062	0.048	<0.007	0.077	0.027	0.137	0.197
H	0.011	0.022	0.021	<0.007	0.033	<0.007	0.058	0.031
I	0.029	0.057	0.045	<0.007	0.072	<0.007	0.127	<0.007
J	0.262	0.516	0.306	<0.007	0.505	<0.007	0.920	0.038
K	0.182	0.360	0.222	<0.007	0.365	<0.007	0.660	0.014
L	0.160	0.317	0.194	<0.007	0.319	0.009	0.580	0.053
M	0.079	0.157	0.103	<0.007	0.170	<0.007	0.308	0.027
N	0.084	0.167	0.113	<0.007	0.185	<0.007	0.332	0.026
O	0.053	0.106	0.078	<0.007	0.128	<0.007	0.232	0.013
P	0.053	0.106	0.078	<0.007	0.128	<0.007	0.232	0.014
Q	0.031	0.062	0.048	<0.007	0.077	<0.007	0.137	0.013
R	0.014	0.028	0.026	<0.007	0.043	<0.007	0.077	0.008
S	0.061	0.120	0.084	<0.007	0.136	<0.007	0.242	0.024
Kemp's Ridley Sea Turtle								
A	0.177	0.350	0.194	<0.007	0.319	0.023	0.580	0.119
B	0.163	0.322	0.180	<0.007	0.296	0.023	0.540	0.118
C	0.127	0.252	0.144	<0.007	0.237	0.012	0.430	0.082

Mission-Day Category	Mortality	Injury				Disturbance		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse L/G: 211.9 Pa·s KR: 189.8 Pa·s LB: 337.7 Pa·s	Positive Impulse L/G: 97.7 Pa·s KR: 87.5 Pa·s LB: 155.7 Pa·s	Peak SPL 237 dB	Weighted SEL 204 dB	Peak SPL 232 dB	Weighted SEL 189 dB	Peak SPL 226 dB	Weighted SEL 175 dB
D	0.127	0.252	0.144	<0.007	0.237	0.011	0.430	0.062
E	0.087	0.173	0.103	<0.007	0.170	0.024	0.308	0.119
F	0.163	0.322	0.180	<0.007	0.296	0.008	0.540	0.032
G	0.034	0.068	0.048	<0.007	0.077	0.027	0.137	0.197
H	0.012	0.024	0.021	<0.007	0.033	<0.007	0.058	0.031
I	0.032	0.062	0.045	<0.007	0.072	<0.007	0.127	<0.007
J	0.289	0.568	0.306	<0.007	0.505	<0.007	0.920	0.038
K	0.201	0.397	0.222	<0.007	0.365	<0.007	0.660	0.014
L	0.177	0.350	0.194	<0.007	0.319	0.009	0.580	0.053
M	0.087	0.173	0.103	<0.007	0.170	<0.007	0.308	0.027
N	0.093	0.184	0.113	<0.007	0.185	<0.007	0.332	0.026
O	0.058	0.117	0.078	<0.007	0.128	<0.007	0.232	0.013
P	0.058	0.117	0.078	<0.007	0.128	<0.007	0.232	0.014
Q	0.034	0.068	0.048	<0.007	0.077	<0.007	0.137	0.013
R	0.015	0.031	0.026	<0.007	0.043	<0.007	0.077	0.008
S	0.067	0.132	0.084	<0.007	0.136	<0.007	0.242	0.024
Leatherback Sea Turtle								
A	0.106	0.210	0.194	<0.007	0.319	0.023	0.580	0.119
B	0.098	0.194	0.180	<0.007	0.296	0.023	0.540	0.118
C	0.076	0.151	0.144	<0.007	0.237	0.012	0.430	0.082
D	0.076	0.151	0.144	<0.007	0.237	0.011	0.430	0.062
E	0.052	0.104	0.103	<0.007	0.170	0.024	0.308	0.119
F	0.098	0.194	0.180	<0.007	0.296	0.008	0.540	0.032
G	0.021	0.041	0.048	<0.007	0.077	0.027	0.137	0.197

Mission-Day Category	Mortality	Injury				Disturbance		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse L/G: 211.9 Pa·s KR: 189.8 Pa·s LB: 337.7 Pa·s	Positive Impulse L/G: 97.7 Pa·s KR: 87.5 Pa·s LB: 155.7 Pa·s	Peak SPL 237 dB	Weighted SEL 204 dB	Peak SPL 232 dB	Weighted SEL 189 dB	Peak SPL 226 dB	Weighted SEL 175 dB
H	0.007	0.015	0.021	<0.007	0.033	<0.007	0.058	0.031
I	0.019	0.038	0.045	<0.007	0.072	<0.007	0.127	<0.007
J	0.174	0.343	0.306	<0.007	0.505	<0.007	0.920	0.038
K	0.121	0.239	0.222	<0.007	0.365	<0.007	0.660	0.014
L	0.106	0.210	0.194	<0.007	0.319	0.009	0.580	0.053
M	0.052	0.104	0.103	<0.007	0.170	<0.007	0.308	0.027
N	0.056	0.111	0.113	<0.007	0.185	<0.007	0.332	0.026
O	0.035	0.070	0.078	<0.007	0.128	<0.007	0.232	0.013
P	0.035	0.070	0.078	<0.007	0.128	<0.007	0.232	0.014
Q	0.021	0.041	0.048	<0.007	0.077	<0.007	0.137	0.013
R	0.009	0.018	0.026	<0.007	0.043	<0.007	0.077	0.008
S	0.040	0.080	0.084	<0.007	0.136	<0.007	0.242	0.024

< = less than; dB = decibel(s); GI = gastrointestinal; KR = Kemp's ridley sea turtle; LB = leatherback one sea turtle; L/G = loggerhead and green sea turtle; Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

Table 4b. Sea turtle threshold distances (in kilometers) for inert missions.

Inert Impact Class (lb TNT_{eq})	Mortality	Injury				Disturbance		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse L/G: 211.9 Pa·s KR: 189.8 Pa·s LB: 337.7 Pa·s	Positive Impulse L/G: 97.7 Pa·s KR: 87.5 Pa·s LB: 155.7 Pa·s	Peak SPL 237 dB	Weighted SEL 204 dB	Peak SPL 232 dB	Weighted SEL 189 dB	Peak SPL 226 dB	Weighted SEL 175 dB
Loggerhead and Green Sea Turtle								
2	0.023	0.047	0.040	NA*	<.007	NA*	<.007	<.007
1	0.018	0.036	0.032	NA*	<.007	NA*	<.007	<.007
0.5	0.013	0.027	0.025	NA*	<.007	NA*	<.007	<.007
0.15	0.009	0.017	0.017	NA*	<.007	NA*	<.007	<.007
Kemp's Ridley Sea Turtle								
2	0.026	0.052	0.040	NA*	<.007	NA*	<.007	<.007
1	0.019	0.039	0.032	NA*	<.007	NA*	<.007	<.007
0.5	0.015	0.030	0.025	NA*	<.007	NA*	<.007	<.007
0.15	0.009	0.019	0.017	NA*	<.007	NA*	<.007	<.007
Leatherback Sea Turtle								
2	0.015	0.031	0.040	NA*	<.007	NA*	<.007	<.007
1	0.012	0.023	0.032	NA*	<.007	NA*	<.007	<.007
0.5	0.009	0.018	0.025	NA*	<.007	NA*	<.007	<.007
0.15	0.006	0.011	0.017	NA*	<.007	NA*	<.007	<.007

< = less than; dB = decibel(s); GI = gastrointestinal; KR = Kemp's ridley sea turtle; LB = leatherback sea turtle; L/G = loggerhead and green sea turtle; Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TNTeq = trinitrotoluene-equivalent; TTS = temporary threshold shift; NA = Not Applicable

*SEL values for PTS and TTS were much lower that the SPL values and therefore not used to assess the potential for impacts to sea turtles.

18.5 Table 5. Setbacks to prevent permanent threshold shift impacts to the Rice's whale.

User Group	Mission-Day Category	NEWi (lb)	Setback from 100-Meter Isobath (km)
53 WEG	A	2,413.6	7.323
	B	2,029.9	6.659
	C	1,376.2	5.277
	D	836.22	3.557
	E	934.9	3.192
AFSOC	F	584.6	3.169
	I	29.6	0.394
96 OG	J	946.8	5.188
	K	350	1.338
	L	627.1	3.315
	M	324.9	2.017
	N	238.1	1.815
	O	104.6	0.734
	P	130.8	0.787
	Q	94.4	0.667
	R	37.1	0.368
NAVSCOLEOD	S	130	1.042

53 WEG = 53rd Weapons Evaluation Group; 96 OG = 96th Operations Group; AFSOC = Air Force Special Operations Command; km = kilometer(s); lb = pound(s); NAVSCOLEOD = Naval School Explosive Ordnance Disposal; NEW = net explosive weight; NEWi = net explosive weight at impact

18.6 Table 6a. Rice's whale threshold distances (in kilometers) for live missions in the existing Live Impact Area.

		Level A Harassment					Level B Harassment		
	Mortality	Slight Lung Injury	GI Tract Injury	PTS			TTS		Behavioral
Mission-Day Category	Positive Impulse 906.2 Pa·s	Positive Impulse 417.9 Pa·s	Peak SPL 237 dB	Weighted SEL 183 dB	Peak SPL 219 dB		Weighted SEL 168 dB	Peak SPL 213 dB	Weighted SEL 163 dB
A	0.044	0.088	0.194	5.695	1.170		21.435	2.120	27.923
B	0.041	0.81	0.180	5.253	1.076		20.641	1.955	26.845
C	0.031	0.063	0.144	4.332	0.861		18.772	1.562	24.526
D	0.031	0.063	0.144	2.979	0.861		16.419	1.562	21.579
E	0.021	0.043	0.103	2.323	0.617		15.814	1.121	21.22
F	0.041	0.081	0.180	2.208	1.076		14.403	1.955	19.439
G	0.009	0.017	0.048	0.494	0.266		7.532	0.470	12.92
H	0.003	0.006	0.021	0.401	0.114		3.624	0.201	7.065
I	0.008	0.016	0.045	0.305	0.247		2.95	0.437	6.059
J	0.073	0.145	0.306	4.487	1.830		13.216	3.323	16.88
K	0.050	0.100	0.222	0.831	1.320		7.723	2.393	11.809
L	0.044	0.088	0.194	2.325	1.170		15.216	2.120	20.319
M	0.021	0.043	0.103	1.304	0.617		11.582	1.121	16.688
N	0.023	0.046	0.113	1.026	0.658		9.904	1.183	14.859
O	0.015	0.029	0.078	0.611	0.460		6.926	0.832	11.159
P	0.014	0.029	0.078	0.671	0.460		7.841	0.832	12.307
Q	0.009	0.017	0.048	0.549	0.266		6.299	0.470	10.393
R	0.004	0.008	0.026	0.283	0.152		2.383	0.273	5.06
S	0.017	0.034	0.084	0.938	0.473		8.676	0.843	12.874

dB = decibel(s); GI = gastrointestinal; Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

Table 6b. Rice's whale threshold distances (in kilometers) for inert munitions in the existing Live Impact Area.

Inert Impact Class (lb TNT_{eq})	Mortality	Level A Harassment				Level B Harassment		
		Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
	Positive Impulse 906.2 Pa·s	Positive Impulse 417.9 Pa·s	Peak SPL 237 dB	Weighted SEL 183 dB	Peak SPL 219 dB	Weighted SEL 168 dB	Peak SPL 213 dB	Weighted SEL 163 dB
2	0.006	0.013	0.040	0.151	0.238	0.474	0.430	0.884
1	0.005	0.010	0.032	0.110	0.188	0.327	0.340	0.542
0.5	0.004	0.007	0.025	0.055	0.149	0.261	0.270	0.521
0.15	0.002	0.005	0.017	0.026	0.100	0.154	0.181	0.284

dB = decibel(s); GI = gastrointestinal; lb = pound(s); Pa·s = pascal-second(s); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TNTeq = trinitrotoluene-equivalent; TTS = temporary threshold shift

19 APPENDIX B. UNDERWATER ACOUSTIC IMPACT MODELING AND ANALYSIS

The following is copy of an appendix in the Biological Assessment provided by EAFB:

Potential impacts to marine mammals and sea turtles from Eglin Gulf Test and Training Range (EGTTR) operations would primarily result from detonations of live munitions at or near the water surface. The pressure and impulsive noise from munition detonations have the potential to cause mortality, injury, hearing impairment, or behavioral responses in marine animals, depending on the impulsive energy released to the water by the munition and the distance of the animal from the source of the impulse. Impulsive sound waves lose energy as they spread from the detonation point; therefore, adverse effects on animals decrease exponentially with distance from the explosion. Animals farther from the detonation may experience temporary hearing impairment or disturbance that may evoke a behavioral response and interrupt normal activities. This appendix supplements information presented in Section 4 of this Biological Assessment (BA) regarding the modeling and analysis of underwater acoustic impacts to the Rice's whale and four sea turtle species as a result of EGTTR operations.

1.1 Munition Impact and Detonation Characteristics

Munitions traveling through air to an impact point have a kinetic energy equal to one half of the munition mass times the square of the munition velocity. When an air-to-surface munition impacts the water, some of the kinetic energy displaces water in the formation of an impact "crater" in the water, some of the kinetic energy is transmitted from the impact point as underwater acoustic energy in a pressure impulse, and the remaining kinetic energy is retained by the munition continuing to move through the water.

Following impact, the warhead of a live munition detonates at or slightly below the water surface. The warhead detonation converts explosive material into gas, further displacing water through the rapid creation of a gas bubble in the water, and creates a much larger pressure wave than the pressure wave created by the impact. These impulse pressure waves radiate from the impact point at the speed of sound in water, roughly 1,500 meters per second.

If the detonation is sufficiently deep, the gas bubble goes through a series of expansions and contractions, with each cycle being of successively lower energy. When detonations occur below but near the water surface, the initial gas bubble reaches the surface and causes venting, which also dissipates energy through the ejection of water and release of detonation gases into the atmosphere. When a detonation occurs below the water surface after the impact crater has fully or partially closed, water can be violently ejected upward by the pressure impulse and through venting of the gas bubble formed by the detonation. With radii of up to 15 meters, the gas bubbles that would be generated by EGTTR munition detonations would be larger than the depth of detonation but much smaller than the water depth, so all munitions analyzed are considered to fully vent to the surface without forming underwater bubble expansion and contraction cycles.

When detonations occur at the water surface, a large portion of the energy and gases that would otherwise form a detonation bubble are reflected upward from the water. Likewise, when a shallow detonation occurs below the water surface but prior to the impact crater closing, considerable energy is reflected upward from the water. As a conservative assumption, no energy losses from surface effects are included.

The impulsive pressure waves generated by munition impact and warhead detonation radiate spherically and are reflected between the water surface and the sea bottom. There is generally some attenuation of the pressure waves by the sea bottom but relatively little attenuation of the pressure waves by the water surface. As a conservative assumption, the water surface is assumed to be flat (no waves) to allow for maximum reflectivity.

The net explosive weight (NEW) of a munition at impact can be directly correlated with the energy in the impulsive pressure wave generated by the warhead detonation. The NEWs of munitions addressed range from 0.1 pound (lb) for small projectiles to 945 lb for the largest bombs. The explosive materials used in these munitions also vary considerably with different formulations used to produce different intended effects. The primary detonation metrics directly considered and used for modeling analysis are the peak impulse pressure and duration of the impulse. An integration of the pressure of an impulse over the duration (time) of an impulse provides a measure of the energy in an impulse.

Some of the NEW of certain types of munitions, such as missiles, is associated with the propellant used for the flight of the munition. This propellant NEW is unrelated to the NEW of the warhead, which is the primary source of explosive energy in most munitions. The propellant of a missile fuels the flight phase and is mostly consumed prior to impact. Missile propellant typically has a lower flame speed than warhead explosives and is relatively insensitive to detonation from impacts but burns readily. A warhead detonation provides a high-pressure, high-velocity flame front that may cause burning propellant to detonate; therefore, this analysis assumes that the unconsumed residual propellant that remains at impact contributes to the detonation-induced pressure impulse in the water. The impact analysis assumes that 20 percent of the propellant remains unconsumed in missiles at impact; this assumption is based on input from user groups and is considered a reasonable estimate for the purpose of analysis. The NEW associated with this unconsumed propellant is added to the NEW of the warhead to derive the total energy released by the detonation. Absent a warhead detonation, it is assumed that continued burning or deflagration of unconsumed residual propellant does not contribute to the pressure impulse in the water; this applies to inert missiles that lack a warhead but contain propellant for flight.

In addition to the energy associated with the detonation, energy is also released by the physical impact of the munition with the water. This kinetic energy has been calculated and incorporated into the estimations of munitions energy for both live and inert munitions in this BA. The kinetic energy of the munition at impact is calculated as one half of the munition mass times the square of the munition velocity. The initial impact event contributing to the pressure impulse in water is assumed to be 1 millisecond in duration. To calculate the velocity (and kinetic energy) immediately after impact, the deceleration contributing to the pressure impulse in the water is assumed for all munitions to be 1,500 g-forces, or 48,300 feet per square second over 1 millisecond. A substantial portion of the change in kinetic energy at impact is dissipated as a pressure impulse in the water, with the remainder being dissipated through structural deformation of the munition, heat, displacement of water, and other smaller energy categories. Even with 1,500 g-forces of deceleration, the change in velocity over this short time period is small and is proportional to the impact velocity and munition mass. The impact energy is the portion of the kinetic energy at impact that is transmitted as an underwater pressure impulse, expressed in units of trinitrotoluene-equivalent (TNT_{eq}). The impact energies of the proposed live munitions were calculated and included in their total energy estimations.

The impact energies of the inert munitions proposed to be used were also calculated. To assess the potential impacts of inert munitions on marine animals, the inert munitions were categorized based on their impact energies into the following four classes of 2 lb, 1 lb, 0.5 lb, and 0.15 lb TNT_{eq}; these values correspond closely to the actual or average impact energy values of the munitions and are rounded for the purpose of analysis. The 2 lb class represents the largest inert bomb, which includes the Mark (Mk)-84 General Purpose (GP), Guided Bomb Unit (GBU)-10, and GBU-31 bombs, whereas the 1 lb class represents the largest inert missile, which is the Air-to-Ground Missile (AGM)-158 Joint Air-to-Surface Standoff Missile (JASSM). The JASSM has greater mass but lower impact energy than the GBU-31; this is because of the JASSM's lower velocity at impact and associated change in velocity over the deceleration period, which contributes to the pressure impulse. The 0.5 lb and 0.15 lb impact energy classes each represent the approximate average impact energy of multiple munitions, with the 0.5 lb class representing munitions with mid-level energies, and the 0.15 lb class representing munitions with the lowest energies.

For this analysis, the NEW associated with the physical impact of each munition and the unconsumed propellant in certain munitions is added to the NEW of the warhead to derive the NEW at impact (NEWi) for each live munition. The NEWi of each munition was then used to calculate the peak pressure and pressure decay for each munition. This results in a more accurate estimate of the actual energy released by each detonation. Extensive research since the 1940s has shown that each explosive formulation produces unique correlations to explosive performance metrics. The peak pressure and pressure decay constant depend on the NEW, explosive formulation, and distance from the detonation. The peak pressure and duration of the impulse for each munition can be calculated empirically using similitude equations, with constants used in these equations determined from experimental data (NSWC 2017).

Similitude Equations

$$\text{Pmax} = k_p \left(\frac{W^{1/3}}{3.28r}\right)^{\alpha_p}$$

$$\theta = k_\theta W^{1/3} \left(\frac{W^{1/3}}{3.28r}\right)^{\alpha_\theta}$$

where:

Pmax = shock wave peak pressure, pounds per square inch (psi)
θ = shock wave time constant, milliseconds (msec)
W = net explosive weight (NEW) or net explosive weight at impact (NEWi), lb
r = radial distance from detonation, meters
k_p = explosive-specific peak pressure similitude coefficient
α_p = explosive-specific peak pressure similitude exponent
k_θ = explosive-specific θ similitude coefficient
α_θ = explosive-specific θ similitude exponent

The explosive-specific similitude constants and munition-specific NEWi were used for calculating the peak pressure and pressure decay for each munition analyzed. It should be noted that this analysis assumes that all detonations occur in the water and none of the detonations occur above the water surface when a munition impacts a target. This exceptionally conservative assumption implies that all munition energy is imparted to the water rather than the intended targets.

1.2 Analysis Metrics

The following standard metrics are used to assess underwater pressure and impulsive noise impacts on marine animals:

- *Sound pressure level (SPL)* is the ratio of the absolute sound pressure and a reference level. In water, the units are in decibels (dB) referenced to 1 micropascal (μPa) (dB re 1 μPa). The SPL for a given munition can be explicitly calculated at a radial distance using the similitude equations.
- *Sound exposure level (SEL)* accounts for both sound intensity and duration. This metric provides a measure of cumulative exposure from multiple detonations over a 24-hour period. In water, the units are in dB referenced to 1 μPa-squared second (dB re 1 $\mu Pa^2 \cdot s$). A commercially available software package, dBSea (version 2.3), was used to calculate the SEL for each mission day.
- *Positive impulse* is the time integral of the initial positive phase of the pressure impulse. This metric provides a measure of energy in the form of time-integrated pressure. Units are typically pascal-seconds (Pa·s) or pounds per square inch (psi) per millisecond (msec) (psi·msec). The positive impulse for a given munition can be explicitly calculated at a given distance using the similitude equations and integrating the pressure over the initial positive phase of the pressure impulse.

The munition-specific peak pressure and pressure decay at various radii were used to determine the species-specific distance to effect for mortality, slight lung injury, peak pressure–induced permanent threshold shift (PTS) in hearing and peak pressure–induced temporary threshold shift (TTS) in hearing for each species. The munition-specific peak pressures and decays for all munitions in each mission-day category were used as a time-series input in the dBSea underwater acoustic model to determine the distance to effect for cumulative SEL-based (24-hour) PTS, TTS, and behavioral effects for each species for each mission day.

1.3 Analysis Methodology

The zone of influence (ZOI) is the area or volume of ocean in which marine animals could be exposed to various pressure and impulsive noise levels generated by a surface or subsurface detonation. For this BA, the ZOIs for the detonations under the Proposed Action were estimated using Version 2.3 of the dBSea model for cumulative SEL and using explicit similitude equations for SPL and positive impulse. The dBSea model is a commercially available model for evaluating underwater acoustic transmission. The characteristics of the impulse noise at the source were calculated based on munition-specific data including munition mass at impact, munition velocity at impact, NEW of warheads, explosive-specific similitude data, and propellant data for missiles. Table A-1 presents the source-level SPLs (at *r* = 1 meter) calculated for the munitions addressed in this BA.

Table A-1. Calculated Source SPLs for Munitions

				Peak Pressure and Decay Values		
Type	Warhead NEW (lbm)	Modeled Explosive	Model NEWi (lbm)	Pmax @ 1 m (psi)	SPL @ 1 m dB re 1 mPa	θ msec
AGM-158 JASSM All Variants	240.26	Tritonal	241.36	45961.4858	290.0	0.320
GBU-54 KMU-572C/B, B/B	192	Tritonal	192.3	42101.8577	289.3	0.302
AGM-65 (all variants)	85	Comp B	98.3	37835.4932	288.3	0.200
AIM-120C3	15	PBXN-110	36.18	24704.864	284.6	0.167
AIM-9X Blk I	7.7	PBXN-110	20	19617.2833	282.6	0.143
AGM-114 (All ex R2 with TM(R10))	9	PBXN-110	13.08	16630.2435	281.2	0.128
AGM-179 JAGM	9	PBXN-110	13.08	16630.2435	281.2	0.128
AGM-114 R2 with TM (R10)	8	PBXN-9	13.08	17240.2131	281.5	0.124
AGR-20 (APKWS)	2.3	Comp B	3.8	10187.8419	276.9	0.090
PGU-43 (105 mm)	4.7	Comp B	4.72	11118.8384	277.7	0.095
GBU-69	36	Tritonal	36.1	22074.1015	283.7	0.198
GBU-70	36	Tritonal	36.1	22074.1015	283.7	0.198
GBU-39 SDB (GTV)	0.39	PBXN-9	0.49	4757.6146	270.3	0.054
GBU-53/B (GTV)	0.34	PBXN-9	0.44	4561.06062	270.0	0.053
GBU-12	192	Tritonal	192.3	42101.8577	289.3	0.302
Mk-81 (GP 250 lb)	100	H-6	100	38017.3815	288.4	0.237

105 mm HE (FU)	4.7	Comp B	4.7	11099.8118	277.7	0.095
30 mm HE	0.1	Comp B	0.1	2349.10708	264.2	0.037
105 mm HE (TR)	0.35	Comp B	0.37	3981.78228	268.8	0.051
GBU-10, GBU-24, or GBU-31	945	Tritonal	946.8	77897.0371	294.6	0.452
HACM	n/a	TNT	350	54468.3436	291.5	0.306
GBU-39 (SDB I)	36	Tritonal	36.1	22074.1015	283.7	0.198
Spike NLOS	34.08	PBXN-9	40	26720.2127	285.3	0.164
GBU-53 (SDB II)	22.84	PBXN-109	22.94	19365.0753	282.5	0.154
Inert GBU-39 (LSDB) with live fuze	0.39	PBXN-9	0.49	4757.6146	270.3	0.054
Inert GBU-53 (SDB II) with live fuze	0.34	PBXN-9	0.44	4561.06062	270.0	0.053
Underwater Mine Charge	20	C-4	20	20527.4244	283.0	0.140
Floating Mine Charge	5	C-4	5	11811.7218	278.2	0.100

θ = shock wave time constant; AGM = Air-to-Ground Missile; AIM = Air Intercept Missile; APKWS = Advanced Precision Kill Weapon System; dB re 1 µPa = decibel(s) referenced to 1 micropascal; FU = Full Up; GBU = Guided Bomb Unit; GP = General Purpose; GTV = Guided Test Vehicle; HACM = Hypersonic Attack Cruise Missile; HE = High Explosive; JASSM = Joint Air-to-Surface Standoff Missile; lb = pound(s); lbm = pound-mass; LSDB = Laser Small-Diameter Bomb; m = meter(s); Mk = Mark; mm = millimeter(s); msec = millisecond(s); NEW = net explosive weight; NEWi = net explosive weight at impact; NLOS = Non-Line-of-Sight; PGU = Projectile Gun Unit; Pmax = shock wave peak pressure; psi = pound(s) per square inch; SDB = Small-Diameter Bomb; SPL = sound pressure level; TM = telemetry

For SEL analysis, the dBSea model was used with the ray-tracing option for calculating the underwater transmission of impulsive noise sources represented in a time series (1,000,000 samples per second) as calculated using similitude equations (*r* = 1 meter) for each munition for each mission day. All surface detonations are assumed to occur at a depth of 1 meter, and all subsurface detonations, which would include the GBU-10, GBU-24, GBU-31, and subsurface mines, are assumed to occur at a depth of 3 meters. The model used bathymetry for the Live Impact Area (LIA) with detonations occurring at the center of the LIA with a water depth of 70 meters. The seafloor of the LIA is generally sandy, so sandy bottom characteristics for reflectivity and attenuation were used in the dBSea model. The model was used to calculate impulsive acoustic noise transmission on one-third octaves from 31.5 hertz to 32 kilohertz. Maximum SELs from all depths projected to the surface were used for the analyses.

The cumulative SEL is based on multiple parameters including the acoustic characteristics of the detonation and sound propagation loss in the marine environment, which is influenced by a number of environmental factors including water depth and seafloor properties. Based on integration of these parameters, the dBSea model predicts the distances at which each marine animal species is estimated to experience SELs associated with the onset of PTS, TTS, and behavioral disturbance. The thresholds for the onset of TTS and PTS used in the model and pressure calculations are based on those presented in *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (DoN 2017) for cetaceans with mid- to high-frequency hearing (dolphins) and low-frequency hearing (Rice's whale). Behavioral thresholds are set 5 dB below the SEL-based TTS threshold, as recommended by Finneran and Jenkins (2012).

1.4 Number of Events

Following issuance of the 2017 Programmatic Biological Opinion, the National Marine Fisheries Service requested that the acoustic impact analysis be based on the total number of detonations conducted during a given mission instead of each individual detonation to account for the accumulated energy from multiple detonations over a 24-hour period. In accordance with this approach, mission-day categories for each user group were developed (Table 4-2) and used for modeling and analysis in this BA. Each mission-day category represents one or more events that includes the munitions assigned to the category. Munitions were categorized to provide mission-day scenarios of varying intensities with respect to total energy released. The number of mission days assigned to each category was based on historical numbers and projections provided by certain user groups. Although the mission-day categories developed for this BA may not represent the exact manner in which munitions would be used, they provide a conservative range of mission scenarios to account for accumulated energy from multiple detonations. It is important to note that only acoustic energy metrics (SEL) are affected by the accumulation of energy over a 24-hour period. Pressure metrics (e.g., peak SPL and positive impulse) do not accumulate and are based on the highest impulse pressure value within the 24-hour period. As indicated in Table 4-2, a total of 19 mission-day categories (A through S) were developed for this BA. Table A-2 presents the source-level SPL and SEL (at *r* = 1 meter) for each mission-day category. Based on the categories developed, the total NEWi per mission day would range from 2,413.6 to 30.4 lb. The highest detonation energy of any single munition used under the Proposed Action would be 945 lb NEW; the munitions having this NEW include the GBU-10, GBU-24, and GBU-31. This was also the highest NEW for a single munition in the previous BA.

Table A-2. Calculated Source SPLs and SELs for Mission-Day Categories

Mission Day	Total Warhead NEW, lbm	Modeled NEWi, lbm	Source Cumulative SEL, dB	Source Peak SPL, dB
A	2402.6	2413.6	262.1	290
B	1961	2029.9	261.4	289.3
C	1145	1376.2	259.8	288.3
D	562	836.22	257.6	288.3
E	817.88	997.62	257.1	281.5
F	584	584.6	256.2	289.3
G	191	191.6	250.4	277.7
H	60.5	61.1	245.2	268.8
I	18.4	30.4	242.5	276.9
J	945	946.8	258.1	294.6
K	Not available	350	253.4	291.5
L	624.52	627.12	256.2	290
M	324	324.9	253.2	283.6
N	219.92	238.08	252	285.3
O	72	104.64	248.3	281.2

P	90	130.8	249.3	281.2
Q	94	94.4	247.5	277.7
R	35.12	35.82	241.7	270.3
S	130	130	249.4	283

lbm = pound-mass; NEW = net explosive weight; NEWi = net explosive weight at impact; SEL = sound exposure level; SPL = sound pressure level