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

Title:	Conference and Biological Opinion on SpaceX Starship-Super Heavy Increased Launch Cadence and Operations in the North Atlantic Ocean, Gulf of Mexico, North Pacific Ocean, South Pacific Ocean, and Indian Ocean Authorized by the Federal Aviation Administration
Action Agency:	Federal Aviation Administration, U.S. Department of Transportation
In Consultation With:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
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TABLE OF CONTENTS

List of Figures

List of Tables

1. INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 et seq.) establishes a national mandate for conserving and recovering threatened and endangered species of fish, wildlife, plants, and the habitats on which they depend. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Section 7(a)(4) of the ESA requires federal agencies to confer with the Secretary on any action that is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat. For actions that are not likely to jeopardize the continued existence of a proposed species or adversely modify critical habitat, a conference can be requested by the action agency, though it is not required. If requested by the federal action agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in 50 CFR §402.14. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated.

Section 7(b)(3) of the ESA requires that, at the conclusion of consultation, the National Marine Fisheries Service (NMFS) provide an opinion stating whether the federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify their critical habitat. Similarly, when conferring on proposed species or proposed critical habitat, NMFS also reaches a conclusion as to whether the action will satisfy 7(a)(2) for those entities as proposed. If NMFS determines that the action is likely to jeopardize ESA-listed species or destroy or adversely modify designated or proposed 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 the action (or reasonable and prudent alternative) is expected to cause incidental take without violating section 7(a)(2), section 7(b)(4), as implemented by 50 CFR §402.14(i), requires NMFS to provide an incidental take statement (ITS) that specifies the amount or extent of incidental taking. Blue whale (*Balaenoptera musculus*), false killer whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular Distinct Population Segment (DPS), fin whale (*Balaenoptera physalus*), gray whale (*Eschrichtius robustus*) – Western North Pacific DPS, humpback whale (*Megaptera novaeangliae*) – Mexico DPS and Central America DPS, North Atlantic right whale (*Eubalaena glacialis*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter microcephalus*), Rice's whale (*Balaenoptera ricei*), Guadalupe fur seal (*Arctocephalus townsendi*), and Hawaiian monk seal (*Neomonachus schauinslandi*) in this consultation are regulated under the Marine Mammal Protection Act (MMPA) and the ESA. Each statute has defined the meaning of take independently. The MMPA defines take as to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (16 U.S.C §1632(13)). Take under the ESA is 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)). Actions considered 'take' under one statute do not necessarily rise to the level of take under the other statute. The ITS includes reasonable and prudent measures, which are actions necessary or appropriate to minimize impacts of incidental taking, and terms and conditions to implement the reasonable and prudent measures.

The action agency for this consultation is the Federal Aviation Administration (FAA). The Space Exploration Technologies Corp. (SpaceX) is the applicant. The FAA proposes to modify and issue vehicle operator license(s) authorizing SpaceX to conduct up to 145 launches annually of SpaceX's Starship-Super Heavy launch vehicle, including vehicle landings in the North Atlantic Ocean, Gulf of Mexico, North Pacific Ocean, South Pacific Ocean, and Indian Ocean beginning in March 2025.

Updates to the regulations governing interagency consultation (50 CFR Part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). NMFS is applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act (89 Fed. Reg. 24268; 84 Fed. Reg. 45015). NMFS has considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C. §1536(a)(2)), associated implementing regulations (50 CFR Part 402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by the NMFS Office of Protected Resources (OPR) ESA Interagency Cooperation Division (hereafter referred to as 'we' or 'us'). We prepared this biological opinion (opinion) and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402. This document represents NMFS's opinion on the effects of these actions on blue whale, false killer whale – Main Hawaiian Islands Insular DPS, fin whale, gray whale – Western North Pacific DPS, humpback whale – Mexico DPS and Central America DPS, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, Hawaiian monk seal; green turtle (*Chelonia mydas*) – North Atlantic DPS, South Atlantic DPS, East Pacific DPS, Central North Pacific DPS, East Indian-West Pacific DPS, North Indian DPS, and Southwest Indian DPS, hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS, North Pacific Ocean DPS, South Pacific Ocean DPS, North Indian Ocean DPS, Southwest Indian Ocean DPS, and Southeast Indo-Pacific Ocean DPS, and olive ridley turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast breeding colonies and all other areas/not Mexico's Pacific Coast breeding colonies; Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS and South Atlantic DPS, giant manta ray (*Manta birostris*), Gulf sturgeon (*Acipenser oxyrinchus desotoi*), Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead shark (*Sphyrna lewini*) – Eastern Atlantic DPS, Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS, shortnose sturgeon (*Acipenser brevirostrum*), smalltooth sawfish (*Pristis pectinata*) – U.S. portion of range DPS, steelhead trout (*Oncorhynchus mykiss*) – South-Central California Coast DPS and Southern California DPS, black abalone (*Haliotis cracherodii*); and designated critical habitat of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, black abalone, and proposed critical habitat of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle and Rice's whale.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA; section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file electronically with the NMFS OPR in Silver Spring, Maryland, and available in the NOAA Library Institutional Repository https://repository.library.noaa.gov/welcome.

1.1 Background

The FAA Office of Commercial Space Transportation oversees, licenses, and regulates U.S. commercial launch and reentry activities, as well as the operation of launch and reentry sites within the United States or as carried out by U.S. citizens, as authorized by the Commercial Space Launch Act of 1984, as amended and codified at 51 U.S.C. §§ 50901–50923. Section 50903 requires the Secretary of Transportation (or FAA Administrator, as codified in 49 CFR § 1.83(b)) to encourage, facilitate, and promote commercial space launches and reentries by the private sector. The same launch vehicle operators that receive a license or permit from the FAA may also conduct operations for the Department of Defense (DoD). FAA is proposing to modify and issue vehicle operator license(s) authorizing SpaceX for Starship-Super Heavy launch and reentry operations at a rate of 145 launches per year from Starbase (Boca Chica Launch Site), Cape Canaveral Space Force Stations (CCSFS), and Kennedy Space Center (KSC).

1.2 Consultation History

- **May 24, 2024:** The FAA submitted, via email to NMFS, a Biological Assessment for SpaceX Starship-Super Heavy operations with landings in the North Atlantic Ocean, Gulf of Mexico, North Pacific Ocean, South Pacific Ocean, and Indian Ocean.
- **June 24, 2024:** NMFS requested, via email to FAA, additional information on FAA's proposed action, including the landing area GIS files, number of landings per ocean area, anticipated date by which there will be a fully reusable vehicle, how species densities were calculated, and estimated extent of ensonified areas for ESA-listed fishes.
- **October 18, 2024**: The FAA submitted, via email to NMFS, a revised Biological Assessment, which included responses to a majority of our request for additional information.
- **November 20, 2024**: NMFS submitted, via email, another request for additional information to FAA, including the portions of the June 24, 2024 request for which a complete response was not provided.
- **November 22, 2024**: NMFS met with FAA and SpaceX to discuss the proposed Starship-Super Heavy operations, NMFS's requests for additional information, and SpaceX's questions.
- **November 27, 2024:** SpaceX provided responses to our requests for additional information and requested additional clarification on potential take.

- **December 3, 2024:** NMFS determined the FAA's initiation package was complete and provided responses to SpaceX and FAA's questions via email.

1.3 Analytical Approach

This opinion includes a jeopardy analysis. Prior to 2016, the designation of critical habitat for Northwest Atlantic Ocean DPS of loggerhead turtle used the term primary constituent element (PCE), as well as physical or biological features (PBFs), and other designations also used the term essential features, or generally identified aspects of critical habitat that were essential to the conservation of the species. The 2016 critical habitat regulations (50 CFR §424.12) replaced these terms with PBFs. The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether an action agency is able to insure its proposed action is not likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify all aspects of the proposed action (as defined in 50 CFR §402.02), including activities that are a consequence of the action.
- Identify the physical, chemical, and biological modifications to land, water, and air (stressors) that result from those actions and subsequent activities.
- Establish the spatial extent of those stressors, which is the action area (50 CFR §402.02).
- Identify the listed species (as defined at 16 U.S.C. §1532(16)) and designated and proposed critical habitat (as defined at 16 U.S.C. §1532(5)) in the action area.
- Identify the species and critical habitats that are not likely to be adversely affected by the action.
- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline (as defined in 50 CFR §402.02) as it pertains to the species and critical habitat.
- Evaluate the effects of the proposed action on listed species and their designated or proposed critical habitat using a stressor-exposure-response approach. When complete, this section anticipates the amount or extent, as well as the forms (harass, harm, etc.), of take of listed species (or a surrogate) that is reasonably certain to occur as a result of the action, as well as the extent of effects to critical habitat.
- Evaluate cumulative effects (as defined at 50 CFR §402.02).
- Produce an integration and synthesis, where we add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.
- Complete a jeopardy and destruction or adverse modification analysis relying on the justification in the integration and synthesis.

- Suggest a reasonable and prudent alternative to the proposed action and assess the effects of that alternative action, if the opinion determines the action agency failed to insure its action is not likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.
- Provide an incidental take statement that specifies the impact of the take on listed species (amount or extent), reasonable and prudent measures, and the terms and conditions to implement those measures for actions that do not violate section 7(a)(2) of the ESA or for an alternative action that is identified that does not violate section 7(a)(2) of the ESA.

In each of the steps above, NMFS relies on the best scientific and commercial data available. In order to ensure we reach supportable conclusions, we used information from FAA (e.g., Biological Assessment, Revised Draft Tiered Environmental Assessment), peer-reviewed scientific literature, government reports, and commercial studies. We also relied on technical information from SpaceX on their launch vehicle and operations.

2. Proposed Federal 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 on the high seas. Examples include, but are not limited to: 1) actions intended to conserve listed species or their habitat; 2) the promulgation of regulations; 3) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants in aid; or 4) actions directly or indirectly causing modifications to the land, water, or air (50 CFR §402.02).

2.1 Description of the Action

The FAA is proposing to modify and issue vehicle operator license(s) authorizing SpaceX to conduct launch and reentry operations of their launch vehicle, Starship-Super Heavy. The FAA proposes to authorize up to 145 launches of Starship-Super Heavy per year. Launches will occur from the Boca Chica Launch Site, KSC's Launch Complex 39A (LC-39A), and CCSFS. The proposed number of launches per year for each launch site is as follows: 25 from Boca Chica, 44 from LC-39A, and 76 from CCSFS.

At the time of this consultation, the only operational launch site for Starship-Super Heavy is the Boca Chica Launch Site. Under the current license, FAA authorizes up to five Starship-Super Heavy launches annually from the Boca Chica Launch Site. Under the proposed license, FAA will authorize up to 25 launches annually from the Boca Chica Launch Site beginning March 2025. In the Revised Draft Tiered Environmental Assessment for SpaceX Starship/Super Heavy Vehicle Increased Cadence at the SpaceX Boca Chica Launch Site in Cameron County, Texas, FAA anticipates 22 daytime (7am–7pm) and three nighttime (7pm–7am) Super Heavy launches and 22 daytime (potentially back to the launch site) and three nighttime Starship landings.

FAA will also issue vehicle operator license(s) for Starship-Super Heavy launch and reentry operations out of LC-39A and CCSFS. Launch cadence at LC-39A and CCSFS are expected to ramp up over time to the annual maximum of 44 and 76 launches, respectively. Launches from

LC-39A are expected to begin no later than fall of 2025 and launches from CCSFS are expected to begin no earlier than fall of 2026.

FAA licenses are generally valid for a maximum of five years.

This consultation supersedes all previous consultations related to FAA's authorization of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, and OPR-2021-02908).

Starship-Super Heavy Launch Vehicle

Starship-Super Heavy is a two-stage vertical launch vehicle that is designed to eventually be fully reusable. While working towards reusability, Starship and/or Super Heavy will be expended (i.e., discarded) in the ocean. Starship-Super Heavy is expected to be fully reusable by October 2025 (i.e., Starship and Super Heavy will land back at the launch site or on a floating platform after October 2025, for the duration of the vehicle operator license). Between March 2025 and October 2025, Starship and/or Super Heavy may be expended in the ocean. The interstage (see below) may still be expended in the Gulf of Mexico through calendar year 2026 although Starship and Super Heavy will be reusable. Full reusability will entail both Starship and Super Heavy landing at the launch site or on an ocean-going barge or floating platform, which will be towed back to port.

Starship-Super Heavy is approximately 121 meters (m) tall by 9 m in diameter: Super Heavy, the first stage (or booster), is approximately 71 m tall, and Starship, the second stage (or spacecraft), is approximately 50 m tall. Super Heavy will be equipped with 33 Raptor engines and Starship will be equipped with six Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH_4). Super Heavy can hold up to 3,400 metric tons (MT) of propellant and Starship can hold up to 1,200 MT of propellant.

During a Starship-Super Heavy launch, the launch vehicle reaches supersonic speeds, generating a sonic boom of up to 21 pounds per square foot (psf). After launch, Super Heavy's engines cut off at an altitude of approximately 64 kilometers (km) and Super Heavy separates from Starship. After Super Heavy separates from Starship, Starship engines ignite to fly Starship to its desired orbit. Super Heavy then conducts a boost-back burn prior to descending into the atmosphere and a landing burn as it returns to the launch site or lands on a floating platform, once fully reusable. Sarship conducts an in-space coast phase before beginning its descent.

The subsections below describe the ways that each vehicle may be expended during operations to full reusability.

Super Heavy Operations

Super Heavy may be expended in the Gulf of Mexico (Gulf of Mexico portion of the action area; Figure 1) or the Northwest Atlantic Ocean (Atlantic Ocean portion of the action area; Figure 2), at least five nautical miles (NM) from shore. In the Gulf of Mexico portion of the action area, Super Heavy will be expended at least 37 NM from the Flower Garden Banks National Marine

Sanctuary. During descent, when Super Heavy is supersonic, a sonic boom of up to 21 psf will be generated. A landing on an ocean-going barge or floating platform would produce a sonic boom of up to 8 psf. After the boost back burn, Super Heavy will have approximately 74 MT of residual propellant. If a landing burn is conducted, Super Heavy will have approximately 8 MT of residual propellant. Until full reusability is achieved, Super Heavy may be expended under the following conditions:

1. In-flight breakup: Super Heavy breaking up during reentry, resulting in debris falling into the Gulf of Mexico and/or Atlantic Ocean portions of the action area.
2. Hard landing with explosion: Super Heavy lands in the ocean at terminal velocity, breaking up upon impact with debris contained within approximately 1 km of the landing point, and resulting in an explosive event at the surface of the water.
3. Soft landing with explosion: Super Heavy conducts a soft water landing (i.e., descending under controlled thrust) and tips over and an explosive event occurs.
4. Soft landing and sink: Super Heavy conducts a soft water landing, tips over, and sinks to the bottom of the ocean.

Between March 2025 and October 2025, there will be no more than 25 in-flight Super Heavy breakups and no more than 20 Super Heavy explosive events. Currently, FAA and SpaceX do not have estimates on the number of Super Heavy landings in each portion of the action area, or Super Heavy landing locations within each portion of the action area.

SpaceX provided the best available information on how a Super Heavy explosion will occur, based on previous launches and tests of similar vehicles. A Super Heavy explosion is the result of a breakdown of the fuel transfer tube and subsequent mixing and igniting of residual propellant, which will be located 3 m from the ocean's surface due to the vertical orientation of Super Heavy. SpaceX calculated an explosive weight of 6,660 kilograms (kg) based on a 9% explosive yield and 74 MT of residual propellant (no landing burn).

The Starship-Super Heavy interstage (forward heat shield) will continue to be expended in the Gulf of Mexico portion of the action area (see OPR-2024-02422), 1–400 km from shore directly off of the Boca Chica Launch Site and 30–400 km from shore in the western Gulf of Mexico (Figure 3). The interstage landing area is at least 37 km from the Flower Garden Banks National Marine Sanctuary. The interstage is comprised of stainless steel and is approximately 9.1 m in diameter, 1.8 m long, and 9,072 kg. It provides thermal protection against heat produced from Starship engines when the two stages separate. During Super Heavy landings in the Gulf of Mexico or back at the Boca Chica Launch Site, the interstage will be released from Super Heavy. After release, the interstage gradually drifts away from Super Heavy and is expected to land 3–4 km downrange of where Super Heavy lands. Upon impact with the water at terminal velocity, the interstage will break up resulting in debris. The interstage will be expended in the Gulf of Mexico portion of the action area up to five times a year through calendar year 2026, at which time the interstage will be a permanent fixture on Super Heavy and will no longer be expended.

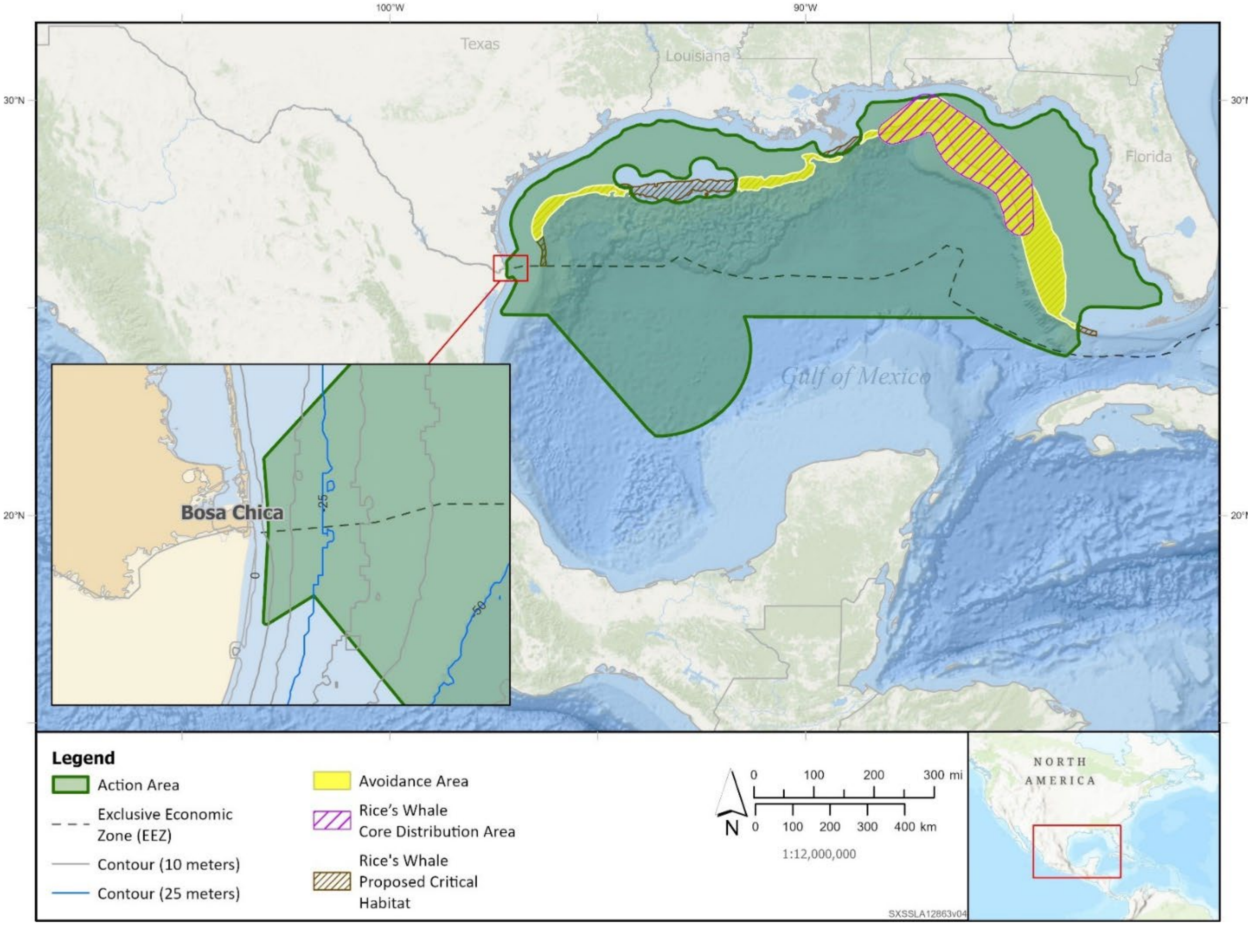

Figure 1. Map of the Gulf of Mexico portion of the action area. Super Heavy will be expended at least five NM from shore.[1]

[1] The area less than five NM from shore off Boca Chica represents the interstage landing area, also illustrated in Figure 3.

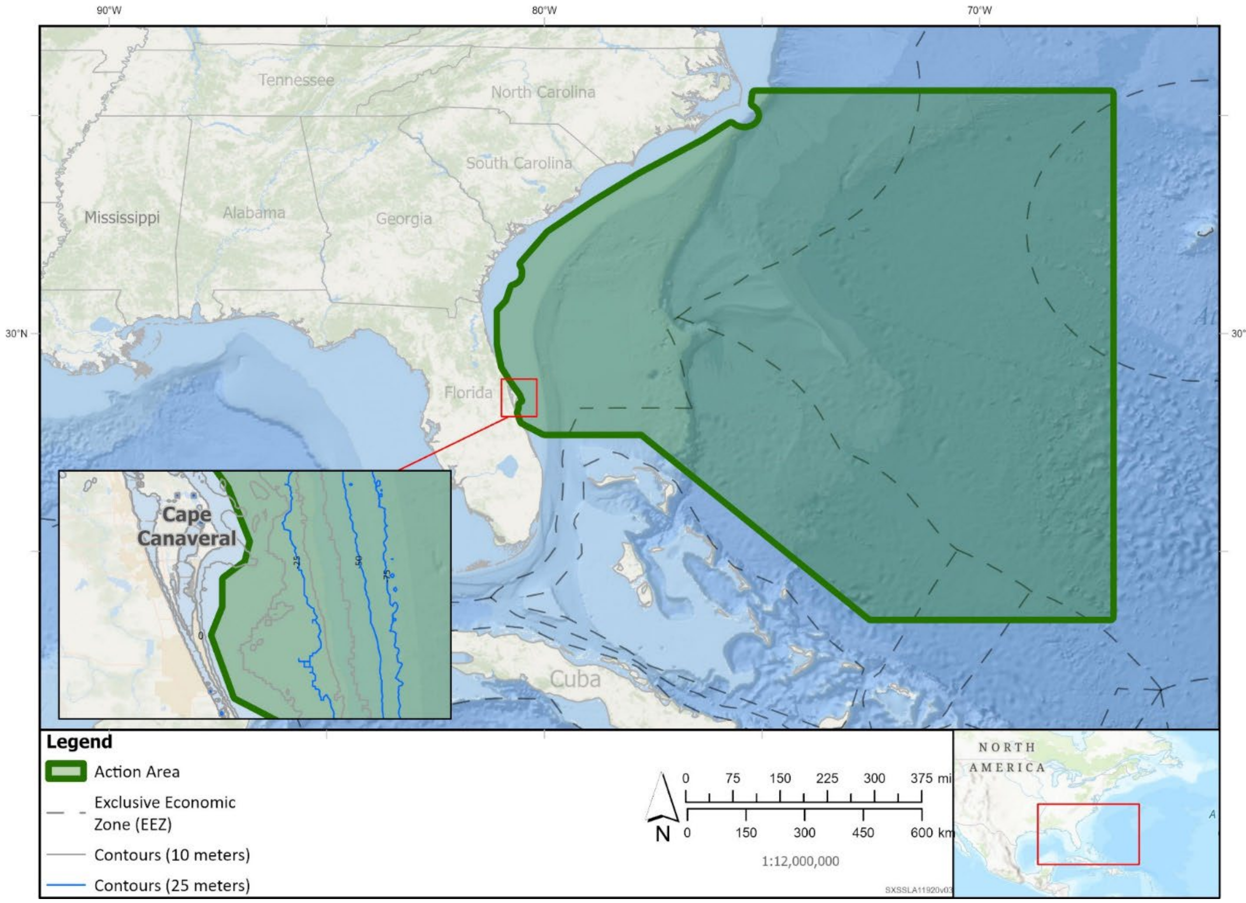

Figure 2. Map of the Atlantic Ocean portion of the action area (non-Gulf of Mexico). Super Heavy will be expended at least five NM from shore.

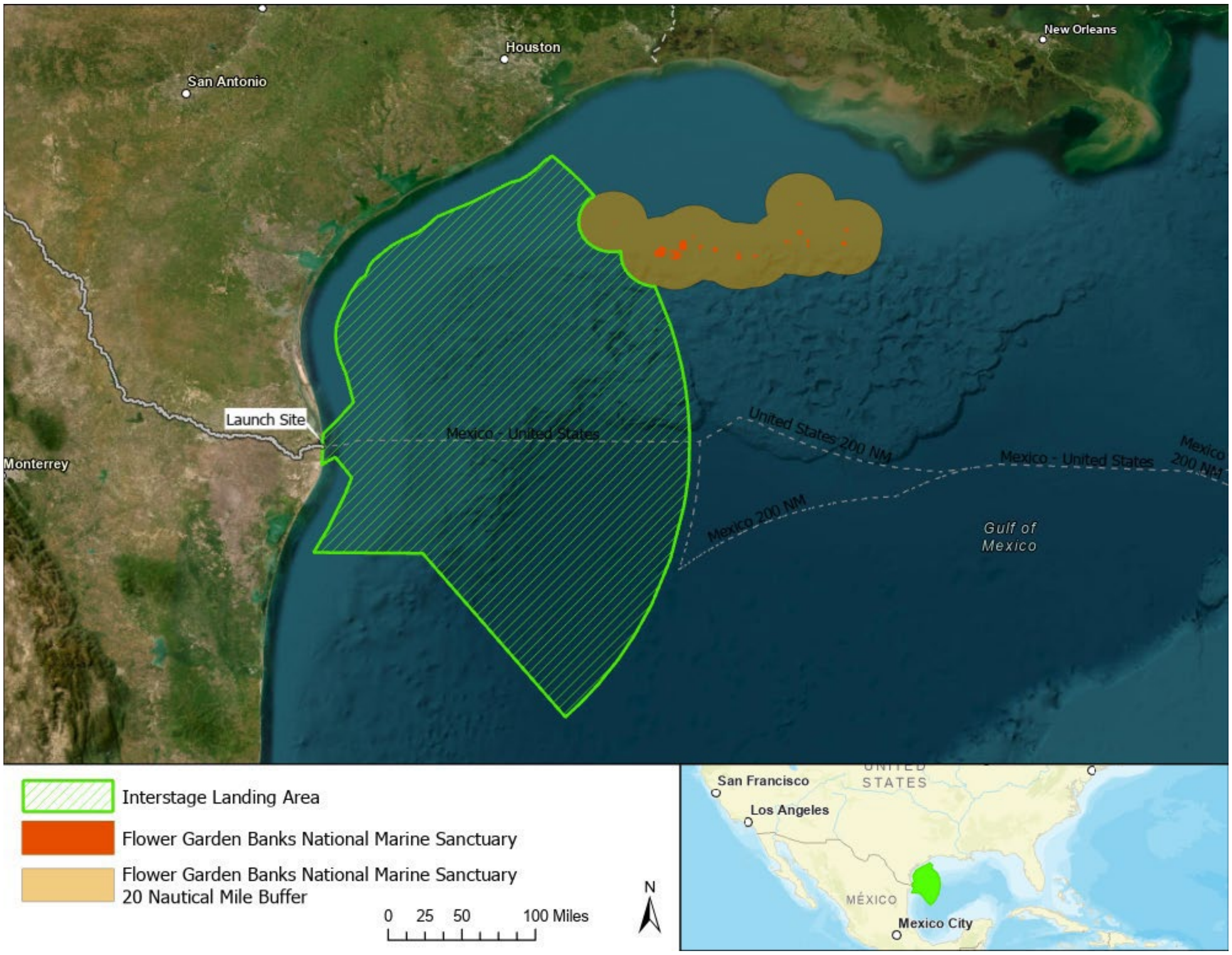

Figure 3. Map of the interstage landing area within the Gulf of Mexico portion of the action area. The interstage landing area encompasses waters 1–400 km from shore directly off the Boca Chica Launch Site and 30–400 km from shore in other areas of the landing area.

Starship Operations

Starship may be expended in the Indian Ocean (Indian Ocean portion of the action area; Figure 4), North Pacific Ocean (Hawai'i and Central North Pacific portion of the action area and Northeast and Tropical Pacific portion of the action area; Figure 5), or Southeast Pacific (South Pacific portion of the action area; Figure 6). Starship will be expended in the Indian Ocean portion of the portion of the action area at least 200 NM from any land area. During descent, when Starship is supersonic, a sonic boom of up to 2 psf will be generated. After its descent through the atmosphere, Starship will have approximately 101 MT of residual propellant (31 MT in the header tanks and 70 MT in the main tanks). If a landing burn is conducted, Starship will have 8 MT of residual propellant. Until full reusability is achieved, Starship may be expended under the following conditions:

1. In-flight breakup: Starship breaking up during reentry, resulting in debris falling into the Indian Ocean, Hawai'i and Central North Pacific, Northeast and Tropical Pacific, and/or South Pacific portions of the action area.

2. Hard landing with explosion: Starship lands in the ocean at terminal velocity, breaking up upon impact with debris contained within approximately 1 km of the landing point, and resulting in an explosive event at the surface of the water.
3. Soft landing with explosion: Starship conducts a soft water landing (i.e., descending under controlled thrust) and tips over and an explosive event occurs.
4. Soft landing and sink: Starship conducts a soft water landing, tips over, and sinks to the bottom of the ocean.

Between March 2025 and October 2025, FAA and SpaceX estimate there will be no more than 25 in-flight breakups and no more than 20 explosive events. Currently, FAA and SpaceX do not have estimates on the number of Starship landings in each portion of the action area, or Starship landing locations within each portion of the action area.

SpaceX provided the best available information on how a Starship explosion will occur, based on previous launches and tests of similar vehicles. A Starship explosion is a result of a breakdown of the fuel transfer tube and subsequent mixing and igniting of residual propellant, which will be located, at minimum, 4.5 m from the ocean's surface due to the horizontal orientation of Starship. SpaceX calculated an explosive weight of approximately 9,947 kg based on a 9% explosive yield for the main tanks, 11.9% yield for the header tanks, and approximately 101 MT of residual propellant (no landing burn).

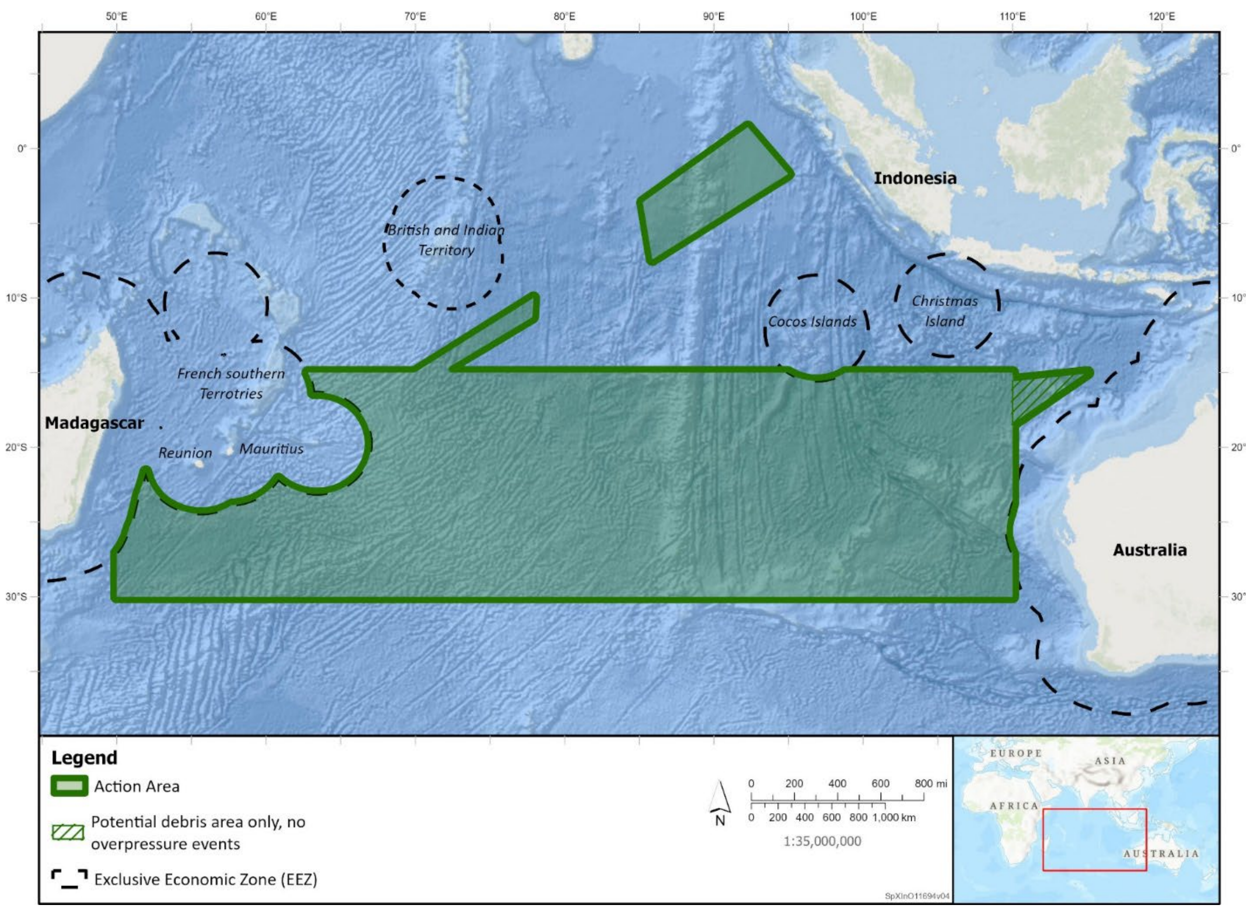

Figure 4. Map of the Indian Ocean portion of the action area. Starship will be expended at least 200 NM from shore.

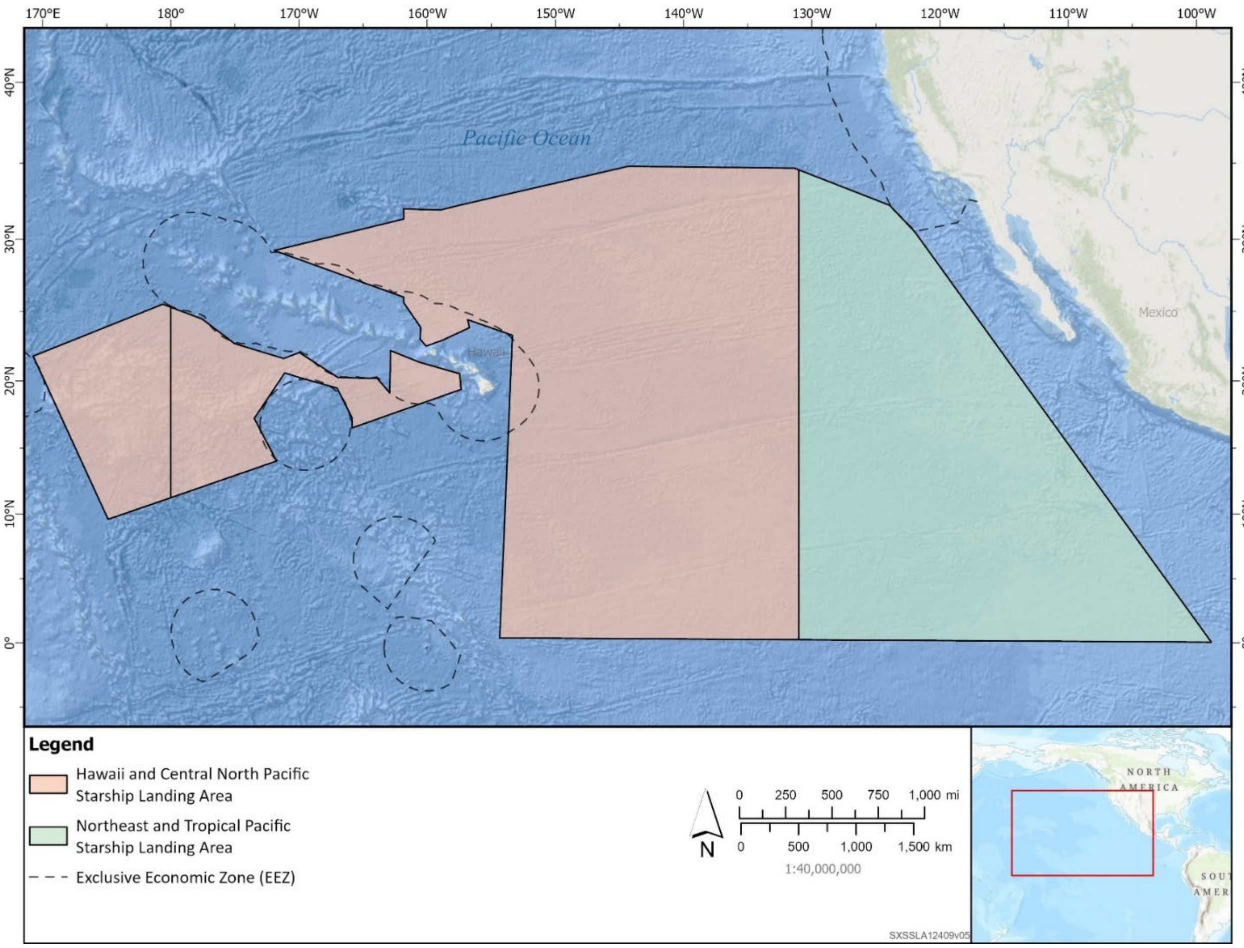

Figure 5. Map of the Hawai'i and Central North Pacific portion of the action area (pink area) and Northeast and Tropical Pacific portion of the action area (green area).

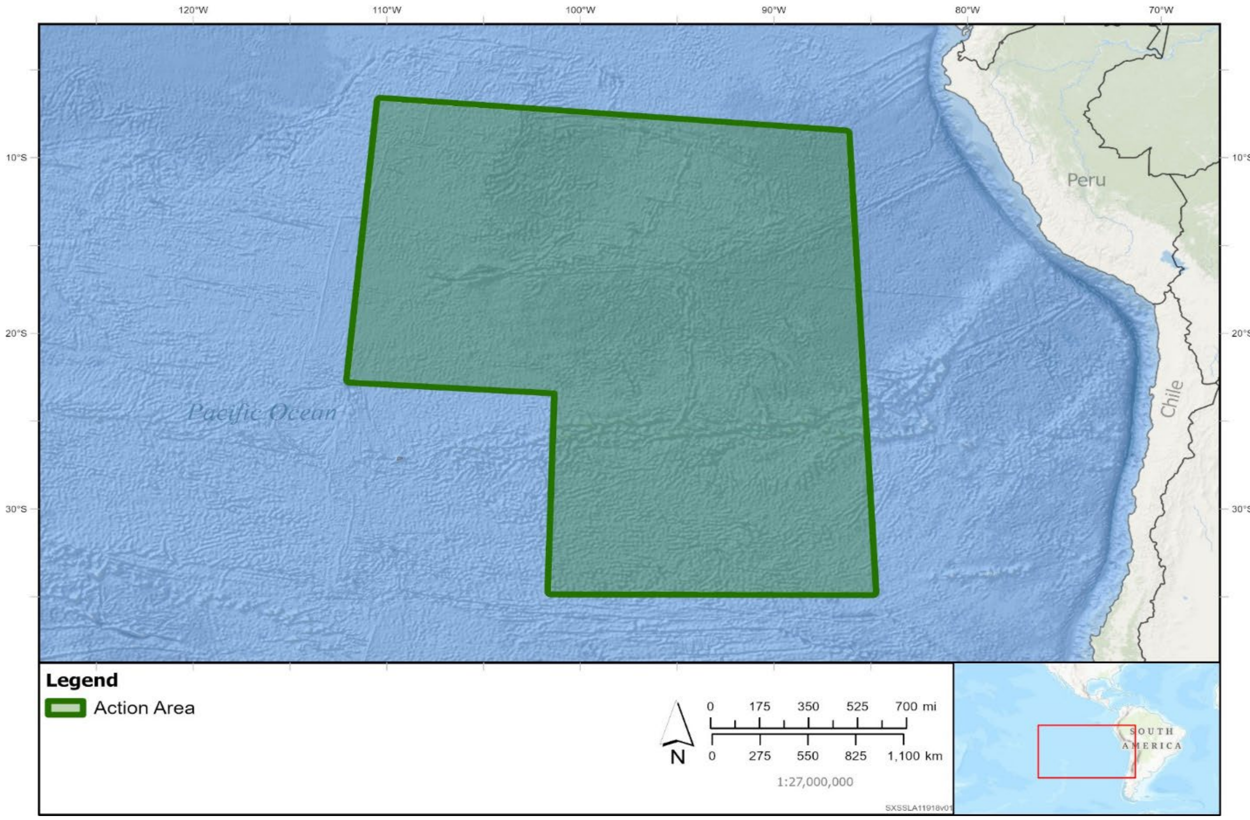

Figure 6. Map of the South Pacific portion of the action area.

Pre- and Post-Launch Activities

Prior to launch, weather balloons will be deployed to measure weather data. Between five and 15 weather balloons are used for each launch. The data, including wind speeds, are necessary to determine if it is safe to launch and land the vehicle. The weather balloons are made of latex with radiosondes attached to each balloon. A radiosonde, typically the size of a half-gallon milk carton, is attached to the weather balloon to measure and transmit atmospheric data to the launch operator. The latex balloon attached to each weather balloon typically has a diameter at launch of approximately 1.2 m. When a balloon is deployed, it rises approximately 19–29 km into the air and then bursts. The radiosonde and shredded balloon pieces fall back to Earth and are not recovered. The radiosonde does not have a parachute and is expected to sink to the ocean floor when it lands over water.

A number of spotter aircraft, including drones, and surveillance vessels (or boats) are used during launch activities to ensure that designated hazard areas are clear of non-participating crafts. Combinations of radar, visual spotter aircraft, surface surveillance, and law enforcement vessels, may be deployed prior to launch. Most fixed wing aircraft operate at altitudes of 4,572 m but may drop to 457 m to visually obtain a call sign from a non-participating vessel.

2.2 Conservation Measures

The FAA will implement conservation measures in order for their action to result in the least practicable adverse impact to ESA-listed species in the different portions of the action area. Conservation measures include mitigation, which include measures that avoid or reduce the severity of the effects of the action on ESA-listed species and their critical habitats, and monitoring, which is used to observe or check the progress of the mitigation over time and to ensure that any measures implemented to reduce or avoid adverse effects on ESA-listed species and their critical habitats are successful. This consultation supersedes all previous consultations related to FAA's authorization of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, and OPR-2021-02908). Conservation measures from previous consultations are applied to this consultation and are described below. Conservation measures are listed first by general measures applicable to all portions of the action area, then by specific portions of the action area.

General conservation measures:

1. Launch and reentry activities, including vehicle landing locations and breakups, will occur at least 5 NM from the coast of the United States or islands. The only activities that will occur within 5 NM from the coast will be interstage landings in the Gulf of Mexico (as described in Section 2.1) and vessel transits to and from a port for surveillance or when recovering launch vehicle components.
2. No vehicle landings or breakups will occur in coral reef areas.
3. No activities will occur in or affect a National Marine Sanctuary unless the appropriate authorization has been obtained from the Sanctuary.
4. If safe and feasible to do so, conduct surveillance via vessel, aircraft (including unmanned aircraft systems/vehicles), or remote camera 30 minutes prior to either vehicle's landing to document any protected species present in the vicinity of the landing area. After the vehicle lands and once safe to do so, conduct surveillance via vessel, aircraft (including unmanned aircraft systems/vehicles), or remote camera to document any potential impacts to protected species (presence, distribution, abundance, and behavior). This documentation will be included in the annual reporting requirement to NMFS.

Education and Observation

5. A dedicated observer(s) (e.g., biologist or person other than the vessel operator that can recognize ESA-listed and MMPA-protected species) will be provided by the launch operator to monitor for ESA-listed and MMPA-protected species with the aid of binoculars during all in-water activities, including transit for surveillance or to retrieve launch vehicle stages and components, other launch and reentry-related equipment, or debris.
   a. When an ESA-listed or MMPA-protected species is sighted, the observer will alert vessel operators to implement the appropriate measures (see below).
   b. Dedicated observers will record the date, time, location, species, number of animals, distance and bearing from the vessel, direction of travel, and other relevant information such as behavior, for all sightings of ESA-listed or MMPA-protected species.

   c. Dedicated observers will survey the landing/recovery area for any injured or killed ESA-listed or MMPA-protected species and any discoveries will be reported as noted below.
6. The launch operator will instruct all personnel associated with launch and reentry operations about ESA-listed species and critical habitat, and species protected under the MMPA, that may be present in the operations areas. The launch operator will advise personnel of the civil and criminal penalties for harming, harassing, or killing ESA-listed or MMPA-protected species.

Vessel Operations

All vessel operators will be on the lookout for and attempt to avoid collision with ESA-listed and MMPA-protected species. A collision with an ESA-listed species will require reinitiation of consultation. Vessel operators will ensure the vessel strike avoidance measures and reporting are implemented, and will maintain a safe distance by following these measures:

7. All vessels will be in compliance with all area restrictions.
8. All vessels will slow to 10 knots or less when mother/calf pairs or groups of marine mammals are observed.
9. All vessels will maintain, at minimum, a distance of 91.4 m from all ESA-listed marine mammals and MMPA-protected species (except for greater distances specified below), and 45.7 m from sea turtles. If this distance becomes less than 91.4 m or 45.7 m, the vessel will slow down and shift the engine to neutral until the animal(s) have left the area.
10. All vessels will attempt to remain parallel or transit away to an ESA-listed species' course when sighted while the vessel is in transit (e.g., bow-riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.

Reporting Stranded, Injured, or Dead Animals

11. Any ESA-listed species collision(s), injuries, mortalities, or strandings observed will be reported immediately to the appropriate NMFS regional contact listed below (see also also (https://www.fisheries.noaa.gov/report), to Tanya Dobrzynski, Chief, ESA Interagency Cooperation Division, by email at Tanya.Dobrzynski@noaa.gov, and to nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2024-01147 FAA Starship-Super Heavy Increased Launch Cadence – Collision, Injury, or Mortality Report."
    a. For operations in the Gulf of Mexico and Atlantic Ocean: for marine mammals (877) WHALE-HELP (877-942-5343) and for sea turtles (844) SEA-TRTL (844-732-8785)
    b. For operations in the North Pacific Ocean: (866) 767-6114 (West Coast) or (888) 256-9840 (Hawai'i)
    c. In the Gulf of Mexico and Atlantic Ocean near Florida, report any smalltooth sawfish sightings to (844) 4SAWFISH or (844) 472-9347 or via email sawfish@fwc.com
    d. Report any giant manta ray sightings to (727) 824-5312 or via email to manta.ray@noaa.gov
    e. Report any injured, dead, or entangled North Atlantic right whales to (877) WHALE-HELP (877) 942-5343 and the U.S. Coast Guard via VHF Channel 16

Aircraft Procedures
Aircraft will maintain a minimum of 304.8 m over ESA-listed or MMPA-protected species and 457.2 m above North Atlantic right whales. Aircraft will avoid flying in circles if marine mammals or sea turtles are spotted and avoid any type of harassing behavior.

Hazardous Materials Emergency Response
In the event of a failed launch operation, launch operators will follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan (or similar plan). Procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts.

Gulf of Mexico portion of the action area conservation measures:

1. Reentry trajectories will be planned to avoid Super Heavy landings, explosions, and breakups within Rice's whale core distribution area and proposed critical habitat. Super Heavy may land in only a small portion of Rice's whale proposed critical habitat (see Figure 1) off Boca Chica, Texas.
2. All vessels will slow to 10 knots or less when Rice's whales are observed and maintain a minimum distance of 457.2 m from Rice's whales. If a whale is observed but cannot be confirmed as a species other than a Rice's whale, the vessel operator must assume that it is a Rice's whale and take appropriate action.
3. Avoid vessel transit in the Rice's whale core distribution area and proposed critical habitat. No vessel transit will occur at night in Rice's whale core distribution area or proposed critical habitat. If transit in the core distribution area or proposed critical habitat is required, avoid areas where water depth is 100–425 m (where Rice's whale has been observed; Rosel et al. 2021) and transit as slowly as practicable, limiting speeds to 10 knots or less.

Atlantic Ocean portion of the action area (non-Gulf of Mexico) conservation measures:

1. All vessels will slow to 10 knots or less when North Atlantic right whales are observed and maintain a minimum distance of 457.2 m from North Atlantic right whales. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action.
2. All vessels will comply with applicable North Atlantic right whale speed rules, including Seasonal Management Areas, Slow Zones, and Dynamic Management Areas. Information on Seasonal Management Areas, Slow Zones, Dynamic Management Areas, and how to sign up for alerts is available at NMFS's Reducing Vessel Strikes to North Atlantic Right Whales website.
3. No Super Heavy landings, explosions, or breakups will occur within North Atlantic right whale critical habitat, and Seasonal Management Areas from November 1 through April 30.
4. No Super Heavy landings, explosions, or breakups will occur within designated North Atlantic right whale Slow Zones or Dynamic Management Areas, if the Slow Zone or Dynamic Management Area is established prior to launch.

5. No vessel transit will occur at night in North Atlantic right whale critical habitat or Seasonal Management Areas from November 1 through April 30, and no transit will occur at night in any designated Slow Zones or Dynamic Management Areas.

Indian Ocean portion of the action area conservation measures:

1. To the maximum extent practicable, Starship landings will avoid Important Marine Mammal Areas[2] and Ecologically or Biologically Significant Areas[3].
2. If possible, Starship landings will also avoid other physiographic features, such as seamounts, that may provide conservation benefits to listed species.

Hawai'i and Central North Pacific portion of the action area conservation measures:

1. Although unlikely, to prevent debris from a Starship explosive event or in-flight breakup from entering the Papahānaumokuākea Marine National Sanctuary, SpaceX will have a vessel in the area of highest likelihood of debris that will identify large debris for salvage. SpaceX will use the vessel to survey for debris for approximately 24 to 48 hours (using visual survey in the daytime and onboard vessel radar at night) depending on the outcome of the breakup. If there is floating debris detected by the vessel during the debris survey, SpaceX will sink or recover any debris before it can drift into the Papahānaumokuākea Marine National Sanctuary by removing the item using a net or boat hook, or puncturing the item using a firearm to cause it to sink. If debris is still identified after the 24–48 hour survey, SpaceX will use an aerial asset, additional vessel, or satellite imaging, to confirm and characterize any debris to verify that debris sinks within 10 days.

Reporting to NMFS

This consultation supersedes all previous consultations related to FAA's authorization of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, and OPR-2021-02908). Reporting requirements from previous consultations are applied to this consultation and are described below.

Prior to full reusability of the launch vehicle, FAA, in coordination with SpaceX, will provide a report after each Starship-Super Heavy flight. Reports after each flight, prior to achieving full reusability, should be submitted no more than 30 days after the flight. The reports should be submitted electronically to nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2024-01147 FAA Starship-Super Heavy Increased Launch Cadence – [Flight #] Fate Report."

After each Starship-Super Heavy flight prior to achieving full reusability, FAA will provide information to NMFS detailing the results of launches and landings, based on available telemetry data received from the vehicles, including:

[2] Important Marine Mammal Areas (IMMAs) are "discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation." For more information, see https://www.marinemammalhabitat.org/immas/ and https://www.marinemammalhabitat.org/imma-eatlas/

[3] Ecologically or Biologically Significant Areas (EBSAs) under the Convention on Biological Diversity are marine areas that are functionally important in supporting healthy oceans and ocean services. For more information, see https://www.cbd.int/ebsa/.

1. Whether Starship and Super Heavy resulted in an anomaly or nominal (i.e., all operations occurred as expected) landing, and where (expressed in the last known GPS location) the anomaly or landing occurred.
2. The debris catalog generation, approximate location, and any other information that can corroborate assumptions about the debris and/or debris field from an in-flight breakup or explosive event of each vehicle.
3. Whether Starship and Super Heavy landings occurred in the expected manner. For landings resulting in explosion, information reported to NMFS shall include the amount of fuel/propellant remaining in main and header tanks, vehicle orientation upon landing and height of the explosive event above the surface of the water, debris catalog generation, and any other data that can corroborate whether the assumptions about the explosion and area of impact (physically and acoustically) were appropriate.
4. Any documentation of ESA-listed species pre- and post-landing, per items 4 and 5 under General Conservation Measures.

Once the vehicle has achieved full reusability, FAA, in coordination with SpaceX, will provide annual reports to NMFS by November 1 of each year beginning the calendar year after this consultation is completed (2026) and each year activities covered under this consultation occur. Annual reports will include the following:

1. The dates and locations of all launches, including launch site, and any relevant license or permit that authorized the activities.
2. Details of launch and reentry operations that may affect the marine environment, such as interstage landings and debris, heat plumes, deluge system discharges, and any other operations that involve entry of materials into the marine environment.
3. Dates of reentry, if different from launch date.
4. Approximate locations with GPS coordinates when available of all landing and debris areas (e.g., interstage debris). Information should also be provided regarding support vessels used during operations, such as for pre-launch surveillance, and transit routes, as well as aircraft activity associated with operations.
5. Any information regarding effects to ESA-listed species due to the activities (e.g., from dedicated observers or via those described in item 4 under General Conservation Measures).
6. Sighting logs with observations of ESA-listed species with date, time, location, species (if possible to identify), number of animals, distance and bearing from the vessel, direction of travel, and other relevant information such as, but not limited to, behavior.

The annual report should be submitted electronically to nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2024-01147 FAA Starship-Super Heavy Increased Launch Cadence – [Year] Annual Report."

2.3 Activities Caused by the Action

Because the Starship-Super Heavy launch vehicle is designed to be a reusable transportation system, which is capable of carrying reusable payloads of up to 150 MT and expendable payloads of up to 250 MT, there are various activities that will occur as a result of FAA's licensing of Starship-Super Heavy launch and reentry operations. These activities include, but are not necessarily limited to, launching satellites and capsules (or other payloads, and subsequent reentry of those satellites, capsules, and payloads at a later date) and DoD projects (e.g., using Starship to explore rapid global mobility). Activities that use Starship-Super Heavy capabilities are more than likely to occur once the launch vehicle is fully reusable (after October 2025). Exact projects, missions, and payloads that may affect ESA-listed or proposed species and their designated or proposed critical habitat are currently unknown and may require separate consultation.

2.4 Stressors Resulting from the Components of the Proposed Action

In this section, the direct or indirect modifications to the land, water, or air caused by an action are identified as stressors. This section identifies all of the resulting from the proposed action, as well as the sources of those stressors. Some stressors may have multiple sources. Likewise, multiple sources may combine to create a stressor that would not exist if only one of the sources were present. The following is a summarization of stressors that are reasonably certain to be caused by this action:

1. Sonic booms and impulse noise generated during stage landings in the ocean;
2. Direct impact by fallen objects (radiosonde, Super Heavy, Starship, debris);
3. Impacts from pollution (unrecovered debris, emissions, propellant);
4. Vessel strike and vessel noise;
5. Aircraft overflight; and
6. Acoustic effects (in-air and underwater) from explosive events.

3. Action Area

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" (50 CFR §402.02). The action area is defined by the extent of the environmental changes the stressors cause on the physical environment (e.g., land, air or water, detailed in the previous section). The action area includes portions of the Gulf of Mexico and another area in the Atlantic Ocean, Indian Ocean, Hawai'i and Central North Pacific, Northeast and Tropical Pacific, and South Pacific (see Figures 1–6) where Super Heavy or Starship will be expended until full reusability or land on an ocean-going barge or floating platform. The action area also includes waters between the Super Heavy and Starship landing areas and shore (except for in the Indian Ocean), where vessels are expected to transit between ports and landing locations for surveillance or recovery of launch vehicle components. These waters are off the Hawaiian archipelago, Southern California (south of the Santa Maria River), Mexico, Central America, Peru, Chile, Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina.

4. Species and Critical Habitat that May be Affected by the Proposed Action

The ESA allows for three general determinations for listed species and critical habitat: 1) no effect, 2) may affect, not likely to adversely affect (NLAA), and 3) may affect, likely to adversely affect (LAA). Action agencies, prior to requesting ESA consultation, determine whether their proposed action may affect ESA-listed species or their designated or proposed critical habitat. Generally, a "no effect" determination means there is no plausible exposure or response to stressors generated by the proposed action for any ESA-listed species or designated or proposed critical habitat. A "no effect" determination does not require consultation. Any scenario where there is a plausible exposure to stressors generated by the action, no matter how unlikely, is considered "may affect." For any action that "may affect" an ESA-listed species or its designated critical habitat, the action agency shall consult with the Services under section 7(a)(2) of the ESA. An action agency is also required to confer with the Services on any effects to proposed species or proposed critical habitat if those effects are likely to jeopardize the continued existence of the species or destroy or adversely modify the proposed critical habitat. However, action agencies may voluntarily confer with the Services for all proposed species or proposed critical habitat in the action area when the action may affect those proposed entities without rising to a level requiring us to confer.

Table 1. Species and critical habitat present in the action area

Species	ESA Status	Critical Habitat	Recovery Plan
Blue Whale (*Balaenoptera musculus)*	E – 35 Fed. Reg. 18319	-- --	07/1998 11/2020
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 Fed. Reg. 70915	83 Fed. Reg. 35062	86 Fed. Reg. 60615 10/2021
Fin Whale (*Balaenoptera physalus)*	E – 35 Fed. Reg. 18319	-- --	75 Fed. Reg. 47538 07/2010
Gray Whale (*Eschrichtius robustus*) – Western North Pacific DPS	E – 35 Fed. Reg. 18319	-- --	-- --
Humpback Whale (*Megaptera novaeangliae*) – Central America DPS	E – 81 Fed. Reg. 62259	86 Fed. Reg. 21082	11/1991 06/2022 (Outline)
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS	T – 81 Fed. Reg. 62259	86 Fed. Reg. 21082	11/1991 06/2022 (Outline)
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 Fed. Reg. 12024	81 Fed. Reg. 4837*	70 Fed. Reg. 32293 08/2004
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 Fed. Reg. 12024	73 Fed. Reg. 19000**	78 Fed. Reg. 34347 06/2013

Species	ESA Status	Critical Habitat	Recovery Plan
Sei Whale (*Balaenoptera borealis*)	E – 35 Fed. Reg. 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 Fed. Reg. 18319	-- --	75 Fed. Reg. 81584 12/2010
Rice's Whale (*Balaenoptera ricei*)	E – 84 Fed. Reg. 15446 and 86 Fed. Reg. 47022	88 Fed. Reg. 47453 (Proposed)	09/2020 (Outline)
Guadalupe Fur Seal (*Arctocephalus townsendi*)	T – 50 Fed. Reg. 51252	-- --	-- --
Hawaiian Monk Seal (*Neomonachus schauinslandi*)	E – 41 Fed. Reg. 51611	80 Fed. Reg. 50925	72 Fed. Reg. 46966 2007
Green Turtle (*Chelonia mydas*) – Central North Pacific DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572 (Proposed)	63 Fed. Reg. 28359 01/1998
Green Turtle (*Chelonia mydas*) – East Indian-West Pacific DPS	T – 81 Fed. Reg. 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572 (Proposed)	63 Fed. Reg. 28359 01/1998
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 Fed. Reg. 20057	63 Fed. Reg. 46693** 88 Fed. Reg. 46572 (Proposed)	10/1991 – U.S. Atlantic
Green Turtle (*Chelonia mydas*) – North Indian DPS	T – 81 Fed. Reg. 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – South Atlantic DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572** (Proposed)	10/1991 – U.S. Atlantic
Green Turtle (*Chelonia mydas*) – Southwest Indian DPS	T – 81 Fed. Reg. 20057	-- --	-- --
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 Fed. Reg. 8491	63 Fed. Reg. 46693**	57 Fed. Reg. 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico

Species	ESA Status	Critical Habitat	Recovery Plan
			63 Fed. Reg. 28359 05/1998 – U.S. Pacific
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 Fed. Reg. 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 Fed. Reg. 8491	44 Fed. Reg. 17710 77 Fed. Reg. 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 Fed. Reg. 28359 05/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – North Indian Ocean DPS	E – 76 Fed. Reg. 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 Fed. Reg. 58868	-- --	63 Fed. Reg. 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 Fed. Reg. 58868	79 Fed. Reg. 39855	74 Fed. Reg. 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific 01/2009 – Northwest Atlantic
Loggerhead Turtle (*Caretta caretta*) – South Pacific Ocean DPS	E – 76 Fed. Reg. 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – Southeast Indo-Pacific Ocean DPS	T – 76 Fed. Reg. 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – Southwest Indian Ocean DPS	T – 76 Fed. Reg. 58868	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Olive Ridley Turtle (*Lepidochelys olivacea*) – All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	T – 43 Fed. Reg. 32800	-- --	-- --
Olive Ridley Turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast Breeding Colonies	E – 43 Fed. Reg. 32800	-- --	63 Fed. Reg. 28359
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 Fed. Reg. 5913	82 Fed. Reg. 39160**	02/2012 (Outline)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 Fed. Reg. 5913	82 Fed. Reg. 39160**	02/2012 (Outline)
Giant Manta Ray (*Manta birostris*)	T – 83 Fed. Reg. 2916	-- --	12/2019 (Outline)
Green Sturgeon (*Acipenser medirostris*) – Southern DPS	T – 71 Fed. Reg. 17757	74 Fed. Reg. 52300**	8/2018
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 Fed. Reg. 49653	68 Fed. Reg. 13370	09/1995
Nassau Grouper (*Epinephelus striatus*)	T – 81 Fed. Reg. 42268	89 Fed. Reg. 126**	8/2018 (Outline)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 Fed. Reg. 4153	-- --	89 Fed. Reg. 56865 7/2024
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Central and Southwest Atlantic DPS	T – 79 Fed. Reg. 38213	-- --	-- --
Scalloped Hammerhead Shark	E – 79 Fed. Reg. 38213	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
(*Sphyrna lewini*) – Eastern Atlantic DPS			
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Eastern Pacific DPS	E – 79 Fed. Reg. 38213	-- --	-- --
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Indo-West Pacific DPS	T – 79 Fed. Reg. 38213	-- --	-- --
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 Fed. Reg. 4001	-- --	63 Fed. Reg. 69613 12/1998
Smalltooth Sawfish (*Pristis pectinata*) – U.S. portion of range DPS	E – 68 Fed. Reg. 15674	74 Fed. Reg. 45353*	74 Fed. Reg. 3566 01/2009
Steelhead Trout (*Oncorhynchus mykiss*) – South-Central California Coast DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52487**	78 Fed. Reg. 77430
Steelhead Trout (*Oncorhynchus mykiss*) – Southern California DPS	E – 71 Fed. Reg. 834	70 Fed. Reg. 52487**	77 Fed. Reg. 1669
Black Abalone (*Haliotis cracherodii*)	E – 74 Fed. Reg. 1937	76 Fed. Reg. 66805	85 Fed. Reg. 5396

Fed. Reg. = *Federal Register*; E = Endangered; T = Threatened; DPS = Distinct Population Segment
* Designated critical habitat overlaps with the action area but the action will have no effect on any PBFs
** Designated critical habitat does not overlap with the action area

Table 2. Physical or Biological Features (PBFs) of designated or proposed critical habitat (CH) present in the action area and that may be affected by the proposed action

Designated or Proposed Critical Habitat	PBFs
False Killer Whale – Main Hawaiian Islands Insular DPS	Currently designated CH: Main Hawaiian Islands – waters 45 m to 3,200 m depth Designated CH PBFs: 1. Adequate space for movement and use within shelf and slope habitat

Designated or Proposed Critical Habitat	PBFs
	2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth 3. Waters free of pollutants of a type and amount harmful to Main Hawaiian Islands insular false killer whales 4. Sound levels that would not significantly impair false killer whales' use or occupancy
Humpback Whale – Central America DPS	Currently Designated CH: California – marine habitat within portions of the California Coastal Ecosystem Designated CH PBFs: 1. Prey species, primarily euphausiids (*Thysanoessa, Euphausia, Nyctiphanes,* and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), and Pacific herring (*Clupea pallasii*), of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth
Humpback Whale – Mexico DPS	Currently Designated CH: California – marine habitat within portions of the California Coastal Ecosystem Designated CH PBFs: 1. Prey species, primarily euphausiids (*Thysanoessa, Euphausia, Nyctiphanes,* and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasii*), capelin (*Mallotus villosus*), juvenile walleye pollock (*Gadus chalcogrammus*), and Pacific sand lance (*Ammodytes personatus*) of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth
Hawaiian Monk Seal	Currently Designated CH: Northwestern Hawaiian Islands – all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and including marine habitat through the water's edge, including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, out to the 200-m depth contour line around the following 10 areas: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island

Designated or Proposed Critical Habitat	PBFs
	Main Hawaiian Islands – marine habitat from the 200-m depth contour line, including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, through the water's edge 5 m into the terrestrial environment from the shoreline between identified boundary points on the islands of: Kaula, Niihau, Kauai, Oahu, Maui Nui (including Kahoolawe, Lanai, Maui, and Molokai), and Hawai'i Designated CH PBFs: 1. Marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk sea foraging
Leatherback Turtle	Currently Designated CH: California coast – Point Arena to Point Arguello east of the 3,000-m depth contour Designated CH PBFs: 1. Occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., *Chrysaora, Aurelia, Phacellophora,* and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks
Loggerhead Turtle – Northwest Atlantic Ocean DPS	Currently Designated CH: Northwest Atlantic Ocean DPS range – neritic (nearshore reproductive, foraging, winter, breeding, and migratory) and *Sargassum* habitat Designated CH PBFs: 1. Nearshore Reproductive Habitat – (1) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water 2. Foraging Habitat – (1) Sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit, blue, horseshoe), mollusks, echinoderms and sea pens 3. Winter Habitat -- 4. Constricted Migratory Habitat – (1) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas 5. *Sargassum* Habitat – (1) *Sargassum* in concentrations that support adequate prey abundance and cover; and (2) Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and

Designated or Proposed Critical Habitat	PBFs
	animals native to the *Sargassum* community such as hydroids and copepods
Gulf Sturgeon	Currently Designated CH: Gulf of Mexico – estuarine and marine habitat Designated CH PBFs: 1. Abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages 2. Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages 3. Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage)
Black Abalone	Currently Designated CH: California – rocky intertidal and subtidal habitat from the Mean Higher High Water (MHHW) line to a depth of 6 m relative to the Mean Lower Low Water (MLLW) line, and coastal marine waters encompassed by these areas from Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, as well as on the Farallon Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island Designated CH PBFs: 1. Food resources; abundant food resources including bacterial and diatom films, crustose coralline algae, and a source of detrital macroalgae, area required for growth and survival of all stages of black abalone 2. Juvenile settlement habitat; rocky intertidal and subtidal habitat containing crustose coralline algae and crevices or cryptic biogenic structures important for successful larval recruitment and juvenile growth and survival 3. Suitable water quality including temperature, salinity, pH, and other chemical characteristics necessary for normal settlement, growth, behavior, and viability

Designated or Proposed Critical Habitat	PBFs
Green Turtle – Central North Pacific DPS	Currently Proposed CH: Hawaiian Archipelago – all nearshore waters from the Mean High Water line to 20 m depth of Hawai`i, Maui, Kaho`olawe, Lana`i, Moloka`i, O`ahu, Kaua`i, Lalo/French Frigate Shoals, Kamole/Laysan Island, Kapou/Lisianski Island, Manawai/Pearl and Hermes Atoll, Kuaihelani/Midway Atoll, and Hōlanikū/Kure Atoll. These areas contain reproductive and benthic foraging/resting essential features Proposed CH PBFs: 1. Reproductive feature: sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches proposed as critical habitat by the U.S. Fish and Wildlife Service, to allow for the transit, mating, and interesting of reproductive individuals, and the transit of post-hatchlings 2. Benthic foraging/resting feature: from the Mean High Water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction
Green Turtle – East Pacific DPS	Currently Proposed CH: California – from the Mexico border to and including North San Diego Bay, all nearshore areas from the Mean High Water line to 10 km offshore. These areas contain the migratory essential feature California – all nearshore areas from the Mean High Water line to 20 m depth, from and including San Diego Bay to and including Santa Monica Bay (except for the area between Oceanside and San Onofre) and surrounding Catalina Island. These areas contain benthic foraging/resting essential features Proposed CH PBFs: 1. Migratory feature: from the Mean High Water line to 10 km offshore, sufficiently unobstructed waters that allow for unrestricted transit of reproductive individuals between benthic foraging/resting and reproductive areas 2. Benthic foraging/resting feature: from the Mean High Water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity,

Designated or Proposed Critical Habitat	PBFs
	abundance, and density necessary to support survival, development, growth, and/or reproduction
Green Turtle – North Atlantic DPS	Currently Proposed CH: Florida – all nearshore areas from the Mean High Water line to 20 m depth. These areas contain reproductive, migratory, and benthic foraging/resting essential features Texas – from the Mexico border to and including Galveston Bay, all nearshore areas from the Mean High Water line to 20 m depth. These areas contain benthic foraging/resting essential features North Carolina – from the South Carolina border to but not including Albemarle and Currituck Sounds, all nearshore areas from the Mean High Water line to 20 m depth. These areas contain benthic foraging/resting essential features Gulf of Mexico and Atlantic Ocean – in the Gulf of Mexico, surface-pelagic areas from 10 m depth to the outer boundary of the U.S. Exclusive Economic Zone (EEZ). In the Atlantic Ocean, surface-pelagic areas from 10 m depth to the outer boundary of the U.S. EEZ, with the exception of areas north of Cape Canaveral, where the nearshore boundary follows the edge of the Gulf Stream. These areas contain surface-pelagic foraging/resting essential features Proposed CH PBFs: 1. Reproductive feature: sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches proposed as critical habitat by the U.S. Fish and Wildlife Service, to allow for the transit, mating, and interesting of reproductive individuals, and the transit of post-hatchlings 2. Migratory feature: from the Mean High Water line to 20 m depth, sufficiently unobstructed waters that allow for unrestricted transit of reproductive individuals between benthic foraging/resting and reproductive areas 3. Benthic foraging/resting feature: from the Mean High Water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction 4. Surface pelagic foraging/resting feature: convergence zones, frontal zones, surface-water downwelling areas, the margins of major boundary currents, and other areas that result in concentrated components of the *Sargassum*-dominated drift community, as well as the currents which carry turtles to

Designated or Proposed Critical Habitat	PBFs
	Sargassum-dominated drift communities, which provide sufficient food resources and refugia to support the survival, growth, and development of post-hatchlings and surface-pelagic juveniles, and which are located in sufficient water depth (at least 10 m) to ensure offshore transport via ocean currents to areas which meet forage and refugia requirements
Rice's Whale	Currently Proposed CH: Gulf of Mexico – continental shelf and slope associated waters between the 100-m isobaths to the 400-m isobath Proposed CH PBFs: 1. Sufficient density, quality, abundance, and accessibility of small demersal and vertically migrating prey species, including scombriformes, stomiiformes, myctophiformes, and myopsida 2. Marine water with (i) elevated productivity, (ii) bottom temperatures of 10–19°C, and (iii) levels of pollutants that do not preclude or inhibit any demographic function 3. Sufficiently quiet conditions for normal use and occupancy, including intraspecific communication, navigation, and detection or prey, predators, and other threats

4.1 May Affect, Not Likely to Adversely Affect

Once we have determined the action may affect ESA-listed species or their designated or proposed critical habitat, the next step is differentiating between stressors that are NLAA and LAA for each listed species and critical habitat in the action area. An action warrants a NLAA finding when its effects are completely beneficial, discountable, or insignificant. Completely beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Completely beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected, albeit positively. Discountable effects are those that could occur while an ESA-listed species is in the action area but, because of the intensity, magnitude, frequency, duration, or timing of the stressor, exposure to the stressor is extremely unlikely to occur. Insignificant effects relate to the response of exposed individuals where the response, in terms of an individual's growth, survival, or reproduction, would be immeasurable or undetectable, or an impact to the conservation value of a PBF would be immeasurable or undetectable. For stressors that meet these criteria for completely beneficial, discountable, or insignificant, the appropriate conclusion is NLAA.

To assist in reaching a determination, we perform a two-step assessment that considers all of the stressors identified in Section 2.4 of this opinion and all of the species and critical habitats identified in Table 1 to understand the likelihood of the stressors having an effect on the ESA-listed species or their designated or proposed critical habitat. First, we consider whether it is likely that a listed species or critical habitat is exposed to a stressor or there is a reasonable expectation of the stressor and an individual or habitat co-occurring. If we conclude that exposure of a species or critical habitat to a stressor caused by the proposed action or activity is discountable, we must also conclude it is NLAA. However, if exposure is probable, the second step is to evaluate the probability of a response to the stressor. When all stressors of an action are found to be NLAA for a listed species or a critical habitat, we conclude informal consultation for that species or critical habitat. Likewise, if a stressor associated with this action is found to be NLAA for all listed species and all critical habitats, there is no need to continue analyzing the consequences of that stressor in the Analysis of Effects. Where the negative effects to any species or critical habitat or from any stressor to those species or critical habitat are found to exceed the standards of insignificant or discountable, we must analyze those consequences in the Analysis of Effects.

4.1.1 Stressors Not Likely to Adversely Affect Species or Critical Habitat

This section identifies the stressors that are NLAA for every ESA-listed species and their designated or proposed critical habitat in the action area and will not be analyzed further in this opinion.

4.1.1.1 Sonic Booms and Impulse Noise

Sonic booms generated by Super Heavy and Starship are expected to be a maximum of 21 and 2 psf, respectively. A recent study also recorded a sonic boom of less than 1 psf from the interstage landing (Gee et al. 2024). An overpressure of 1 psf is similar to a thunderclap. Boom intensity, in terms of psf, is greatest under the flight path and progressively weakens with horizontal distance away from the flight path. Acoustic energy in the air does not effectively cross the air-water boundary and most of the sound energy is reflected off the water's surface (Richardson et al. 1995). Previous research conducted by the U.S. Air Force determined that a peak pressure of 12 pounds per square inch (psi) in the water would be needed to meet the threshold for harassment of marine mammals and sea turtles from impulsive sound. Rather than responding primarily to sound pressure, invertebrates are mainly detect particle motion and can sense local water movements (Solé et al. 2023). This detection is limited, as particle motion diminishes rapidly with distance from the sound source, making the impact of noise on invertebrates likely less than the impact on marine mammals and sea turtles. ESA-listed fishes have a slightly lower threshold for harassment than marine mammals and sea turtles; however, to produce even 12 psi in water, a surface (in-air) pressure of approximately 900 psf is needed. The researchers also note that a sonic boom of 50 psf at the ocean surface is rare (U.S. Air Force Research Laboratory 2000). Thus, it would take a much greater sonic boom than would be generated by either Super Heavy or Starship to create an acoustic impact underwater that could cause a measurable response in ESA-listed species exposed to the noise. Therefore, any effect from the sonic booms or impulse noise on ESA-listed species while underwater would be insignificant.

ESA-listed marine mammals and sea turtles in the action area could be exposed to the overpressures from sonic booms and impulse noise in the air when they are surfacing to breathe. However, the chance of both events happening at the same time (i.e., an animal surfacing and a sonic boom/impulse noise occurring) is extremely low, considering the duration of the sonic boom or impulse noise is less than 1 second (less than 300 milliseconds). Therefore, any effect from the sonic booms or impulse noise on ESA-listed marine mammals and sea turtles at the surface of the water would be discountable because exposure of these animals to the stressor is extremely unlikely to occur.

Given the low overpressures and short duration of the sonic booms or impulse noise described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2, will be so small as to be immeasurable and are therefore insignificant.

In summary, the potential effects to ESA-listed species from sonic booms and impulse noise are discountable or insignificant. The potential effects to designated and proposed critical habitat from sonic booms and impulse noise are insignificant. We conclude that impacts from sonic booms and impulse noise to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species or their designated or proposed critical habitat.

4.1.1.2 Direct Impact by Fallen Objects

Radiosondes, Super Heavy, Starship, and associated debris (with a Super Heavy or Starship in-flight breakup or impact breakup) falling and landing in the Gulf of Mexico, Atlantic Ocean, Indian Ocean, Hawai'i and Central North Pacific, Northeast and Tropical Pacific, and South Pacific portions of the action area have the potential to affect ESA-listed species. The primary concern is direct impact from these objects striking an ESA-listed species. An object striking an ESA-listed species may result in injury or mortality to the individuals that are struck.

Super Heavy and Starship are extremely small relative to the area in which either vehicle could land (see Figures 1–6) and relative to the area over which species can be distributed in the Gulf of Mexico, Atlantic, Indian, North Pacific, and South Pacific oceans. Stage and debris landings in the ocean will only occur a maximum of 25 times[4] before the launch vehicle is fully reusable in October 2025, making the likelihood of striking an ESA-listed species unlikely. Additionally, both Super Heavy and Starship will be expended at least 5 NM from shore, and will not be expended in certain areas where ESA-listed species are expected to occur in higher numbers (e.g., critical habitat, see conservation measures for specific areas in Section 2.2). Thus, the likelihood that an ESA-listed species will be in the exact location at the exact same time that Super Heavy or Starship lands, is extremely unlikely, and thus, discountable. Debris pieces from an in-flight breakup or an impact breakup (for which debris is expected to be contained within 1 km of the landing location) of either stage will be smaller than the stage itself. Radiosondes are also much smaller than either stage. Thus, the likelihood of debris or a radiosonde striking an ESA-listed species will be even smaller than that of Super Heavy or Starship striking an ESA-listed species.

[4] Before the launch vehicle is fully reusable (October 2025), 25 launches per year from the Boca Chica Launch Site will be authorized by FAA's issuance of or modification of a license. Across the same time period, there could be a maximum of 20 explosive events of each vehicle and 25 in-flight breakups of each vehicle.

The likelihood of the interstage striking an ESA-listed species is the same as what was considered in OPR-2024-02422 (pages 14–16) because there are no proposed changes to interstage activities considered in that consultation. OPR-2024-02422 determined that it is extremely unlikely an ESA-listed species will be directly struck by the interstage as it falls to the sea surface or by debris from its impact with the sea surface based on the interstage landing location, number of interstage landings, and species densities.

Falling objects may affect designated or proposed habitat that occurs in areas where falling objects may occur (Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, North Atlantic DPS of green turtle, and Rice's whale). Falling objects may affect PBFs related to waters/passage free of obstructions and prey/cover availability: Northwest Atlantic Ocean DPS of loggerhead turtle foraging habitat, constricted migratory habitat, *Sargassum* habitat; Gulf sturgeon, North Atlantic DPS of green turtle, and Rice's whale (prey-related PBF only; Table 2). Falling objects could create obstructions to waterways or access to refugia if they land in shallow enough areas or on top of underwater refugia, which is extremely unlikely given Starship and Super Heavy will be expended at least 5 NM from shore, the limited number of times either vehicle will be expended, the small area of critical habitat relative to the action area, and the small size of Super Heavy and Starship (71x9 m and 50x9 m, respectively) and debris relative to critical habitat (generally a couple thousand to hundreds of thousands of square kilometers except for one unit of Gulf sturgeon critical habitat off Florida which is approximately 500 square kilometers [km^2]). Falling objects may also temporarily displace prey species as it sinks through the water column; however, this is not expected to affect the density, abundance, availability, or accessibility of prey in a manner that would measurably affect prey populations. Thus, the effect from falling objects on critical habitat would be discountable or insignificant.

In summary, the potential effects to ESA-listed species from a direct impact by falling objects are discountable. The potential effects to designated and proposed critical habitat from falling objects are discountable or insignificant. We conclude that direct impacts from falling objects to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species and designated or proposed critical habitat.

4.1.1.3 Impacts from Pollution

Pollution such as unrecovered debris (from Super Heavy, Starship, weather balloons, radiosondes), vessel pollutants, and the launch vehicle propellant and emissions may affect ESA-listed species and their designated or proposed critical habitat.

Unrecovered debris may be ingested by ESA-listed species foraging in the action areas. ESA-listed marine mammals, sea turtles, and fishes can ingest marine debris while foraging and nearly all ingested debris is plastic (Alzugaray et al. 2020; de Carvalho et al. 2015; Im et al. 2020; Jacobsen et al. 2010; Rodríguez et al. 2022; Rosel et al. 2021; Schuyler et al. 2014b; Werth et al. 2024; Wilcox et al. 2018). In a recent global review on ingested marine debris, a majority of mortalities in marine mammals were caused by ingestion of film-like plastic (e.g. plastic bags), plastic fragments (hardness not specified), rope/nets, and fishing debris (Roman et al. 2021). For sea turtles, a majority of mortalities were caused by ingestion of hard plastic, film-like plastic, and fishing debris (Roman et al. 2021). Plastics are also the main type of debris ingested by fishes (Cliff et al. 2002; Germanov et al. 2018). It is extremely unlikely, and, therefore, discountable, that radiosondes, Super Heavy, Starship, and interstage debris, the majority of which are heavy-weight metals or composite materials like carbon fiber that will sink immediately due to their weight, would be ingested by ESA-listed species.

Latex weather balloons undergo "brittle fracture" at altitude, where the rubber actually shatters along grain boundaries of crystallized segments and the balloon bursts. The resultant pieces of rubber are small strands comparable to the size of a quarter (Burchette 1989; Cullis et al. 2017). As these small strands descend through the air and back to the ocean, their distribution is influenced by changes in atmospheric pressure and wind, which disperses the strands before they land on the surface of the ocean where they are further dispersed due to surface currents and wind. These latex fragments will float on the surface of the water and start to degrade, eventually sinking due to the weight from biofouling (Burchette 1989; Foley 1990; Thompson et al. 2004). Out of 12 categories of ingested marine debris, balloons/latex were one of the least common types of ingested debris, and were recorded in fewer than ten sea turtles compared to the largest category, film-like plastic, which was recorded in over 300 sea turtles (Roman et al. 2021). Given the small balloon shreds are likely to be scattered and not concentrated, and they should only be available in the upper portions of the water column on the order of weeks, the potential for exposure of ESA-listed species to these shreds is extremely low and therefore discountable.

Pollutants emitted by vessels used during Starship-Super Heavy operations can include exhaust (carbon dioxide, nitrogen oxides, and sulfur oxides), and fuel or oil spills or leaks. These pollutants may affect air-breathing ESA-listed species such as marine mammals and sea turtles. Although vessels may transit through areas where ESA-listed species are expected to occur in higher numbers or densities (e.g., close to shore, critical habitat), it is unlikely that pollutants in the air would have a measurable impact on ESA-listed marine mammals or sea turtles given the relatively short duration of vessel operations (approximately five days for each launch with a recovery), dispersion of pollutants in the air, and the brief amount of time that marine mammals and sea turtles spend at the water's surface. Thus, the effects of pollutants in the water on ESA-listed species due to the proposed action will be so small as to be immeasurable. Therefore, the potential exposure of ESA-listed species to pollutants from vessel activities is insignificant.

Emissions from launching and landing each stage include nitrogen oxides, carbon monoxide, and other greenhouse gases (FAA 2024). Stages and payloads (such as satellites that can be launched via Starship) that burn up upon reentry also release vaporized metal particles. Recently, researchers have studied how these emissions and particles associated with rocket launches and reentries can lead to ozone depletion and cause detrimental effects to climate and ecosystems (Dallas et al. 2020; Ferreira et al. 2024; Kokkinakis and Drikakis 2022; Maloney et al. 2022; Murphy et al. 2023; Ross et al. 2004; Ryan et al. 2022). This may affect ESA-listed species as climate can drive range and distribution shifts in ESA-listed species and their prey (e.g., Record et al. 2019a). For a given 25 Starship-Super Heavy launches (and associated operations) from the Boca Chica Launch Site, an estimated 97,342 MT of carbon dioxide equivalent is expected per year (FAA 2024). This amount, is approximately one-sixth of the total increase in Starship-Super Heavy annual launches proposed, and is approximately less than two hundred-thousandths (0.00002) of the annual carbon dioxide equivalent emission rate of the United States (FAA

2024). We currently do not have sufficient information on the magnitude of activities that will be caused by the action (e.g., satellites reentering and burning up in the atmosphere; see Section 2.3) to determine whether effects to ESA-listed species will be more than insignificant. At present, the effects to ESA-listed species from launch and reentry activities of Starship-Super Heavy are immeasurable and thus insignificant, as well as being extremely small compared to the global level of greenhouse gas emissions.

Residual propellant (LOX and LCH_4) may remain on Super Heavy and Starship (74 MT and 101 MT, respectively). During Starship-Super Heavy Flight #3 and Flight #4, SpaceX verified the amount of residual propellant in each vehicle: Flight #3 Super Heavy contained 94 MT of residual propellant and Starship contained 56 MT of residual propellant; and Flight #4 Super Heavy contained 44 MT of residual propellant and Starship contained 12 MT of residual propellant (K. Condell, SpaceX, pers. comm. to E. Chou, NOAA Fisheries Office of Protected Resources, October 18, 2024). SpaceX noted that both Super Heavy and Starship did not complete the planned flights during Flight #3, and, therefore, had higher estimated residual propellant than if the flights were completed (such as during Flight #4); thus, the estimated residual propellant is a conservative estimate. LOX and LCH_4 are not hazardous and will be vented to the atmosphere following landing of either vehicle (FAA 2024). ESA-listed species that surface to breathe (marine mammals and sea turtles) could be exposed to the vented residual propellant. Given the limited number of times either stage will be expended (and residual propellant would be vented), dispersion of vented propellant due to weather conditions such as wind, and limited amount of time ESA-listed spend at the surface to breathe, ESA-listed species are extremely unlikely to be exposed to residual propellant in the air, meaning the effects of this stressor are discountable.

In the event that Super Heavy or Starship residual propellant ends up in the ocean, residual propellant is expected to evaporate or be diluted relatively quickly due to surface currents and ocean mixing. It is unlikely that residual propellant from either vehicle measurably contributes to the overall pollutant levels in the action area given the limited number of times either stage will be expended (and residual propellant would reach the ocean), and the large action area. The effects of residual propellant in the ocean on ESA-listed species is immeasurable and, thus, insignificant.

Hypergolic propellants, which have not been used on Starship in previous consultations on Starship-Super Heavy launch and reentry operations, may be on Starship during landing. Hypergolic fuels that could be used include monomethyl hydrazine (MMH), a derivative of hydrazine, and dinitrogen tetroxide (NTO, the oxidizer). MMH and NTO are extremely toxic and highly corrosive (Nufer 2010). MMH is classified as a potential carcinogen by the National Institute for Occupational Safety and Health (https://www.osha.gov/chemicaldata/439), can cause chemical burns in humans, and is highly flammable and can react exothermically even without an oxidizer. Water is usually used to dilute MMH to a concentration at which MMH will no longer ignite in an open air environment (approximately 58% water and 42% MMH by weight) because MMH is hygroscopic (Nufer 2010). NTO can destroy human tissue, causing burns, damage to the respiratory system (e.g., pulmonary edema), and even death if inhaled at high concentrations (Nufer 2010). NTO vapors are heavier than air and liquid NTO evaporates faster than water at room temperature (Nufer 2010). Starship's propellant storage is designed to retain residual propellant, so any hypergolic propellant remaining in Starship is not expected to be released into the ocean. In the event the hypergolic propellant tank ruptures on impact with the ocean surface, or is released into the air during an in-flight breakup, it is likely that the propellant would evaporate or be diluted quickly by surface currents and ocean mixing to a negligible concentration. Therefore, its effects to ESA-listed species would be too small to measure, and, thus, insignificant. In the event of a failed launch, a portion of propellant will be consumed by the failure (i.e., explosion) and remaining propellant will either evaporate, be diluted in the ocean, degrade in hours to days, or be contained and cleaned up according to the launch operator's (SpaceX) Hazardous Material Emergency Response Plan. To date, Starship has not had a failed launch and SpaceX has a 93% success rate for their previous rocket boosters, Falcon and Falcon Heavy (K. Condell, SpaceX, pers. comm. to E. Chou, NOAA Fisheries Office of Protected Resources, November 22, 2024). Additionally, given the limited number of times Starship will be expended, and the large areas over which species may be distributed across the Starship action area, it is extremely unlikely that ESA-listed species would be exposed to hypergolic propellant due to launch failure, meaning, its effects to ESA-listed species are discountable.

Pollution may also affect designated or proposed critical habitats that have PBFs related to prey and water quality. Prey-related PBFs include the designated critical habitats of the Main Hawaiian Islands insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle (foraging habitat and *Sargassum* habitat), Gulf sturgeon, black abalone, and the proposed critical habitats of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle (benthic foraging/resting feature and surface pelagic foraging/resting feature), and Rice's whale (Table 2). Hawkins et al. (1984) observed mortality in estuarine fish located in proximity to NASA's space shuttle launch site due to a substantial decrease in the pH of the water, which was a result of large depositions of hydrochloric acid from the solid rocket motor exhaust (Dreschel and Hinkle 1984). Hydrochloric acid is not an expected emission from the combustion of propellants used in Starship and Super Heavy. Given the limited number of times Starship and Super Heavy will be expended in a manner that facilitates pollutants entering the ocean, and the large areas over which prey species may be distributed across the action area, pollution is not expected to affect the density, abundance, availability, or accessibility of prey in a manner that would measurably affect prey populations. Thus, the effects of pollution on prey-related PBFs of designated or proposed critical habitat is insignificant.

Water quality-related PBFs include the designated critical habitats of the Main Hawaiian Islands insular DPS of false killer whale, Gulf sturgeon, black abalone, and Rice's whale (Table 2). As previously discussed, pollutants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the limited number of times either vehicle can be expended in the ocean, unlikely scenario of a launch failure, and brief exposure of residual propellants, it is highly unlikely that the water quality PBFs would become degraded to the extent that the conservation value of these critical habitats is impacted. Thus, the effects of pollution on water quality-related PBFs of designated or proposed critical habitat is insignificant.

In summary, the potential effects to ESA-listed species from pollution are discountable or insignificant. The potential effects to designated and proposed critical habitat from pollution are insignificant. We conclude that impacts from pollution to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species and their designated or proposed critical habitat.

4.1.1.4 Vessel Strike and Vessel Noise

ESA-listed species may be affected by vessel transit and operations in all portions of the action area (except the Indian Ocean) during the proposed action. The potential for a vessel striking an ESA-listed species is unlikely because the proposed action consists of relatively little vessel use. The duration of vessel operations lasts approximately five days for each launch with a recovery. Vessel operations are also only used for pre-launch surveillance and post-launch recovery (i.e., vessels are not active the entire day). Furthermore, ESA-listed marine mammals, sea turtles, and fish may spend time at or near the ocean surface but generally spend most of their time underwater where they would not be exposed to vessel strikes.

Implementation of the conservation measures listed in Section 2.2 further reduce the potential for vessel strike. Given vessel strike avoidance measures, vessel speed restrictions when the vessel is in proximity to certain ESA-listed species, presence of dedicated observers monitoring for ESA-listed species, and additional measures such as avoiding nighttime transit and compliance with vessel speed rules for critically endangered species (North Atlantic right whale and Rice's whale, see Section 2.2), vessel strikes are considered extremely unlikely to occur. Therefore, the potential effects to ESA-listed species from vessel strike are discountable.

Noise from surveillance vessels may produce an acoustic disturbance or otherwise affect ESA-listed species that spend time near the surface, such as marine mammals, sea turtles, and pelagic fishes, which may generally disrupt their behavior. Studies have shown that vessel operation can result in changes in the behavior of marine mammals, sea turtles, and fishes (Hazel et al. 2007b; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002a; Richter et al. 2003b; Smultea et al. 2008a). However, vessel noise will not exceed that of larger commercial shipping vessels and will only be temporary (approximately five days for each launch with a recovery, and only used for pre-launch surveillance and post-launch recovery) compared to the constant presence of commercial vessels. Additionally, while not specifically designed to do so, several aspects of the conservation measures will minimize effects associated with vessel acoustic disturbance to ESA-listed species (e.g., requiring dedicated observers, maintaining distance from protected species, slowing to 10 knots or less around certain species and in specific areas; see Section 2.2). Given the conservation measures and the relatively small contribution of the vessels associated with the proposed action to the overall soundscape, effects from vessel noise are expected to be so minor that they cannot be meaningfully evaluated and are thus insignificant.

Given the temporary use and low sound levels of vessel operations described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2) will be so small as to be immeasurable and are therefore insignificant.

In summary, the potential effects to ESA-listed species from vessel strike and vessel noise are discountable or insignificant. The potential effects to designated and proposed critical habitat from vessel noise are insignificant. We conclude that impacts from vessel strike and vessel noise to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species and their designated or proposed critical habitat.

4.1.1.5 Aircraft Overflight

Noise from aircraft overflight may enter the water, but, as stated in relation to sonic booms and impulse noise, very little of that sound is transmitted into water. Sound intensity produced at high altitudes is reduced when it reaches the water's surface. At lower altitudes, the perceived noise will be louder, but it will decrease rapidly as the aircraft moves away. ESA-listed species that occur at or very near the surface (e.g., marine mammals, sea turtles, fish) at the time of an overflight could be exposed to some level of elevated sound. There could also be a visual stimulus from the overflight that could potentially lead to behavioral response. Both noise and visual stimulus impacts would be temporary and only occur if an individual is surfacing or very close to the surface at the same time an aircraft is flying over.

Studies have shown minor behavioral effects (e.g., longer time to first vocalization, abrupt dives, shorter surfacing periods, breaching, tail slaps) in marine mammals exposed to repeated fixed wing aircraft overflights (Patenaude et al. 2002b; Richter et al. 2003a; Smultea et al. 2008b; Würsig et al. 1998). However, most of these responses occurred when the aircraft was below altitudes of approximately 250 m, which is lower than the altitude to be flown by aircraft during surveillance for the activities considered in this consultation. Species-specific studies on the reaction of sea turtles to fixed wing aircraft overflight are lacking. Based on sea turtle sensory biology (Bartol and Musick 2002), sound from low-flying aircraft could likely be heard by a sea turtle at or near the ocean surface. Sea turtles might be able to detect low-flying aircraft via visual cues such as the aircraft's shadow, similar to the findings of Hazel et al. (2007a) regarding watercraft, potentially eliciting a brief reaction such as a dive or lateral movement. However, considering that sea turtles spend a significant portion of their time underwater and the low frequency and short duration of surveillance flights, the probability of exposing an individual to an acoustically or visually-induced stressor from aircraft momentarily flying overhead would be very low. The same is relevant for ESA-listed fishes in the action area, considering their limited time near the surface and brief aircraft overflight.

Given the temporary use and limited amount of acoustic energy that enters the water from aircraft activities described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2) will be so small as to be immeasurable and are therefore insignificant.

Given the limited and temporary behavioral responses documented in available research, the potential effects to ESA-listed species from aircraft overflight are insignificant. The potential effects to designated and proposed critical habitat from aircraft overflight are insignificant. We conclude that impacts from aircraft overflight to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species and their designated or proposed critical habitat.

4.1.1.6 In-Air Acoustic Effects from Explosive Events

ESA-listed species that surface to breathe (marine mammals and sea turtles) may be exposed to the in-air acoustic effects from a Starship or Super Heavy explosive event. To be exposed to this stressor, ESA-listed marine mammals and sea turtles would have to be in the exact same place at the exact same time that Starship or Super Heavy lands and an explosive event subsequently occurs. Landings of Starship and Super Heavy will only result in an explosive event a maximum of 20 times (for each vehicle) across all portions of the action area before the launch vehicle is fully reusable. Therefore, given the limited number of explosions and the large areas over which ESA-listed species can be distributed, it is extremely unlikely that ESA-listed species will be exposed to in-air acoustic effects from explosive events. We conclude that in-air acoustic effects from explosive events to ESA-listed species in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species.

4.1.2 Species Not Likely to be Adversely Affected

In addition to the potential stressors that are not likely to adversely affect ESA-listed species discussed above in Section 4.1.1, other stressors (i.e., underwater acoustic effects from explosive events) resulting from the proposed action, may affect, but are not likely to adversely affect a majority of ESA-listed species that may be present in the action area. This section identifies the ESA-listed species for which underwater acoustic effects from explosive events are NLAA and will not be analyzed further in this opinion.

4.1.2.1 ESA-Listed Marine Mammals

The ESA-listed marine mammal species that are not likely to be adversely affected by explosive events due to the proposed action are: blue whale, Main Hawaiian Islands insular DPS of false killer whale, fin whale, Western North Pacific DPS of gray whale, Central America DPS and Mexico DPS of humpback whale, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice’s whale, Guadalupe fur seal, and Hawaiian monk seal.

NMFS uses acoustic thresholds to predict how an animal’s hearing will respond to sound exposure (see NMFS’s Acoustic Technical Guidance website). Acoustic thresholds differ based on marine mammal hearing groups (Table 3) because not all marine mammal species have identical hearing or susceptibility to noise-induced hearing loss. Marine mammal hearing groups are also used to establish marine mammal auditory weighting functions.

Table 3. Marine mammal hearing groups (NMFS 2024)

Hearing Group	Generalized Hearing Range
Low-frequency (LF) cetaceans	7 Hz to 36 kHz
High-frequency (HF) cetaceans	150 Hz to 160 kHz
Very High-frequency (VHF) cetaceans	200 Hz to 165 kHz
Phocid pinnipeds (PW)	40 Hz to 90 kHz
Otariid pinnipeds (OW)	60 Hz to 68 kHz

Hz = Hertz; kHz = kilohertz

To calculate potential exposure of ESA-listed species (marine mammals and sea turtles) to the underwater acoustic effects of explosive events for both Starship and Super Heavy, SpaceX used a hemispherical model, estimating that half of the explosive weight on each vehicle will be directed towards the water and the other half released into the air. The model assumes an explosive weight of approximately 4,974 kg for Starship (half of approximately 9,947 kg) and 3,330 kg for Super Heavy (half of 6,660 kg) will enter the water. Then, using the explosions' distance above the ocean's surface (4.5 m for Starship and 3 m for Super Heavy), a transmission coefficient of 0.0326, SpaceX calculated the peak sound pressure level for both vehicle explosions. The peak sound pressure level for a Starship explosion is 267.7 decibels referenced to a pressure of one microPascal (dB re 1μPa), and the peak sound pressure level for a Super Heavy explosion is 270.7 dB re 1μPa. Using these values, SpaceX calculated the ensonified areas (i.e., area filled with sound from the explosive event) as a hemisphere within which species could respond to the underwater acoustic stressor are then calculated as a circle. Insignificant responses are anticipated outside of the ensonified areas identified below for each ESA-listed marine mammal for a Super Heavy (Table 4) or Starship (Table 5) explosion.

Table 4. ESA-listed marine mammals in the Gulf of Mexico and Atlantic Ocean portions of the action area, hearing group, minimum threshold for a response, and associated ensonified areas related to the underwater acoustic effects from a Super Heavy explosive event within which there could be a response

Species	Hearing Group	Minimum Threshold to Response* (dB re 1μPa)	Ensonified Area (km^2)
Blue Whale	Low-frequency	216	0.93
Fin Whale	Low-frequency	216	0.93
North Atlantic Right Whale	Low-frequency	216	0.93
Rice's whale	Low-frequency	216	0.93
Sei Whale	Low-frequency	216	0.93
Sperm Whale	High-frequency	224	0.15

* Note peak sound pressure level thresholds are used
dB re 1μPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

Table 5. ESA-listed marine mammals in the Indian Ocean, Hawai'i and Central North Pacific, Northeast and Tropical Pacific, and South Pacific portions of the action area, hearing group, minimum threshold for a response, and associated ensonified areas related to the underwater acoustic effects from a Starship explosive event within which there could be a response

Species	Hearing Group	Minimum Threshold to Response* (dB re 1μPa)	Ensonified Area (km^2)
Blue Whale	Low-frequency	216	0.46
False Killer Whale – Main Hawaiian Islands Insular DPS	High-frequency	224	0.07
Fin Whale	Low-frequency	216	0.46
Guadalupe Fur Seal	Otariid	224	0.07
Hawaiian Monk Seal	Phocid	217	0.37
Humpback Whale – Central America DPS	Low-frequency	216	0.46
Humpback Whale – Mexico DPS	Low-frequency	216	0.46
Sei Whale	Low-frequency	216	0.46
Sperm Whale	High-frequency	224	0.07

* Note peak sound pressure level thresholds are used
dB re 1μPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

To estimate the number of exposures resulting from an explosive event, the maximum species densities in each relevant portion of the action area were multiplied by the ensonified areas. Because the portions of the action area where explosions could occur cover large swaths of the ocean, for some portions of the action area, multiple density datasets were used to have data coverage over as much of the action area as possible. Regardless of the number of datasets, the maximum density for each species was used as a conservative estimate. For marine mammals, the best available density data in the Indian Ocean were obtained from the U.S. Navy's Final Supplemental Environmental Impact Statement/Supplemental Overseas Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency (SURTASS LFA) Sonar in 2019 (U.S. Navy 2019). Areas modeled in U.S. Navy (2019) do not completely cover the Indian Ocean portion of the action area, but the modeled area of Northwest Australia, does overlap with the eastern portion of the Indian Ocean portion of the action area. It is worth noting that the Northwest Australia modeled area is based on data from the Eastern Tropical Pacific (U.S. Navy 2019). This is because survey data in the Indian Ocean are limited or non-existent, while the Eastern Tropical Pacific has been extensively surveyed for marine mammals and is an area with similar oceanographic and ecological characteristics as the Northwest Australia modeled area (U.S. Navy 2019). Marine mammal and sea turtle density data for the South Pacific portion of the action area were not available. The following datasets were used for each action area (Table 6). Species densities and estimated number of exposures that would amount to more than insignificant for up to 20 explosions are summarized in Tables 7–11 (excluding the South Pacific portion of the action area because no density data were available).

Table 6. Species (marine mammal and sea turtle) density data sources for each portion of the action area

Portion of the Action Area	Density Data Sources
Gulf of Mexico	Marine mammals: Roberts et al. (2023); Garrison et al. (2023a) Sea turtles: Garrison et al. (2023b)
Atlantic Ocean	Marine mammals: Roberts et al. (2023); Roberts et al. (2016); Roberts et al. (2024) Sea turtles: DiMatteo et al. (2024)
Indian Ocean	Marine mammals: U.S. Navy (2019)*
Hawai'i and Central North Pacific	Marine mammals: Becker et al. (2022b); Becker et al. (2021); Bradford et al. (2020); Forney et al. (2015); Forney et al. (2012) Sea turtles: U.S. Navy (2024)
Northeast and Tropical Pacific	Marine mammals: Becker et al. (2020); Becker et al. (2022a); Forney et al. (2015); Ferguson and Barlow (2003); Forney et al. (2020) Sea turtles: U.S. Navy (2024)
South Pacific	Not available

* Densities were only available for blue, fin, and sperm whales

Table 7. ESA-listed marine mammal densities in the Gulf of Mexico portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Rice's Whale	0.01123	0.93	0.21
Sperm Whale	0.01392	0.15	0.04

km^2 = square kilometers

Although estimated exposures for Rice's whale do not appear to be discountable, given conservation measures related to Rice's whale (see Section 2.2) such as avoiding Super Heavy landings in a majority of Rice's whale proposed critical habitat, which encompasses water depths where Rice's whale are known to occur, it is extremely unlikely that Rice's whale will be exposed to underwater acoustic effects of a Super Heavy explosion. Only a small portion of Rice's whale proposed critical habitat may overlap with Super Heavy landings (less than approximately 700 km^2 out of approximately 73,220 km^2 of proposed critical habitat); and this area does not occur near Rice's whale core distribution area.

Table 8. ESA-listed marine mammal densities in the Atlantic Ocean portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.000024	0.93	0.0004
Fin Whale	0.018352	0.93	0.34
North Atlantic Right Whale	0.001939	0.93	0.036
Sei Whale	0.000319	0.93	0.005
Sperm Whale	0.032160	0.15	0.096

km^2 = square kilometers

Although estimated exposures for fin whale do not appear to be discountable, maximum densities for fin whales occur only in the far northwest corner of the Atlantic Ocean (non-Gulf of Mexico) portion of the action area and are a conservative estimate of the density of fin whales in the action area. It is extremely unlikely that all of the up-to-20 Super Heavy explosive events will occur in a small corner of the large Atlantic Ocean portion of the action area. Based on the average density of fin whales in the Atlantic Ocean portion of the action area (0.000029 individuals per km^2), the estimated number of exposures more than insignificant for up to 20 Super Heavy explosions is 0.0005; thus, it is extremely unlikely that fin whales will be exposed to underwater acoustic effects of a Super Heavy explosion.

Table 9. ESA-listed marine mammal densities in the Indian Ocean portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.0000281	0.46	0.00026
Fin Whale	0.0008710	0.46	0.008
Sperm Whale	0.002362	0.07	0.003

km^2 = square kilometers

There are very little data on sei whales that may occur in the action area. Based on data from the Ocean Biodiversity Information System's Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP; Halpin et al. 2009), there have been observations of sei whales off Northwest Australia, near the eastern boundary of the Indian Ocean portion of the action area. However, sei whales generally prefer more temperate waters than those that make up the majority of the Indian Ocean portion of the action area, and have been detected between 40° and 50° South in the southern Indian Ocean and in the Southern Ocean (Miyashita et al. 1995; Calderan et al. 2014). Therefore, we expect that sei whale densities in the Indian Ocean portion of the action area will be lower than the available densities of blue, fin, and sperm whales. In addition, given the small ensonified area within which more than insignificant responses are expected for sei whales, we believe that the estimated number of exposures that would be more than insignificant for sei whales would be lower than that for blue, fin, and sperm whales.

Table 10. ESA-listed marine mammal densities in the Hawai'i and Central North Pacific portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.00006	0.46	0.00055
False Killer Whale – Main Hawaiian Islands Insular DPS	0.000568	0.07	0.0008
Fin Whale	0.00008	0.46	0.00074
Hawaiian Monk Seal	0.00004	0.37	0.0003
Sei Whale	0.00016	0.46	0.0015
Sperm Whale	0.007734	0.07	0.01

km^2 = square kilometers

Table 11. ESA-listed marine mammal densities in the Northeast and Tropical Pacific portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.004515	0.46	0.04
Fin Whale	0.003897	0.46	0.036
Guadalupe Fur Seal	0.06283	0.07	0.088
Humpback Whale – Central America DPS	0.002713	0.46	0.025
Humpback Whale – Mexico DPS	0.003747	0.46	0.034
Sei Whale	0.0001	0.46	0.0009
Sperm Whale	0.003829	0.07	0.005

km^2 = square kilometers

There were no density estimates available for ESA-listed marine mammals in the South Pacific portion of the action area; however, the South Pacific portion of the action area is located far from shore, where ESA-listed marine mammals are not expected to occur in high numbers. Sperm whales are known to congregate in waters around the Galápagos Archipelago (Eguiguren et al. 2021), but the Galápagos are more than 250 NM from the South Pacific portion of the action area. Thus, we do not expect ESA-listed marine mammals to occur in high numbers or congregate within the South Pacific portion of the action area.

In summary, given the low estimated exposures that could amount to an effect beyond insignificant and small ensonified areas outside of which insignificant responses are expected, we expect that potential effects of Super Heavy or Starship explosive events on ESA-listed marine mammals will be extremely unlikely to occur and therefore discountable. We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed blue whale, Main Hawaiian Islands insular DPS of false killer whale, fin whale, Western North Pacific DPS of gray whale, Central America DPS and Mexico DPS of humpback whale, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, and Hawaiian monk seal.

4.1.2.2 ESA-Listed Sea Turtles

The ESA-listed sea turtle species that are not likely to be adversely affected by explosive events due to the proposed action are: Central North Pacific DPS, East Indian-West Pacific DPS, East Pacific DPS, North Atlantic DPS, North Indian DPS, South Atlantic DPS, and Southwest Indian DPS of green turtle, hawksbill turtle, leatherback turtle, North Indian Ocean DPS, North Pacific Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtle, and all other areas/not Mexico's Pacific coast breeding colonies and Mexico's Pacific coast breeding colonies of olive ridley turtle. The Kemp's ridley turtle and Northwest Atlantic Ocean DPS of loggerhead turtle are discussed in Section 4.2 and 6.

Using the same methodology described in Section 4.1.2.1, SpaceX estimated the number of sea turtle exposures that would be more than insignificant (Tables 12–16). There were no density data available for sea turtles in the Indian Ocean or South Pacific portions of the action area.

Table 12. ESA-listed sea turtles in the Gulf of Mexico portion of the action area, minimum threshold for a response, associated ensonified areas, species densities, and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy explosive events

Species	Minimum Threshold to Response* (dB re 1µPa)	Ensonified Area (km^2)	Maximum Density (individuals per km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	226	0.09	0.309158	0.556
Leatherback Turtle	226	0.09	0.380480	0.685

* Note peak sound pressure level thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers
Note: no densities were available for hawksbill turtles. The Kemp's ridley turtle and Northwest Atlantic Ocean DPS of loggerhead turtle are analyzed in Section 6.

Although the estimated exposures do not appear to be discountable, maximum densities for green and leatherback turtles occur in coastal areas of the Gulf of Mexico portion of the action area and are a conservative estimate of the density of green and leatherback turtles in the action area. It is extremely unlikely that all of the up-to-20 Super Heavy explosive events will occur in relatively small, coastal areas of the large Gulf of Mexico portion of the action area. Based on the average density of green and leatherback turtles in the action area (0.0133590 individuals per km^2 and 0.009529 individuals per km^2), the estimated number of exposures more than insignificant for up to 20 Super Heavy explosions is 0.024 and 0.017 for green and leatherback turtles, respectively. Higher densities of green and leatherback turtles occur in coastal areas where a Super Heavy landing is less likely to occur. Hawksbill turtles nest at low densities throughout the southern Gulf of Mexico (April–September; Cuevas et al. 2019) and wider Caribbean region (Piniak and Eckert 2011), with infrequent nesting in southern Texas and Florida (Eckert and Eckert 2019; Valverde and Holzwart 2017). Based on telemetry data compiled by The State of the World's Sea Turtles (SWOT 2022) and sightings recorded in the OBIS-SEAMAP database, hawksbill turtles are rare in the Gulf of Mexico portion of the action area. Thus, it is extremely unlikely that green, hawksbill, and leatherback turtles will be exposed to underwater acoustic effects of a Super Heavy explosion so these effects would be discountable.

Table 13. ESA-listed sea turtles in the Atlantic Ocean portion of the action area, minimum threshold for a response, associated ensonified areas, species densities, and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy explosive events

Species	Minimum Threshold to Response* (dB re 1µPa)	Ensonified Area (km^2)	Maximum Density (individuals per km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	226	0.09	0.111815	0.2
Kemp's Ridley Turtle	226	0.09	0.006466	0.012
Leatherback Turtle	226	0.09	0.003821	0.0068
Loggerhead Turtle	226	0.09	0.012947	0.023

* Note peak sound pressure level thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers
Note: no densities were available for hawksbill turtles.

Upon reviewing DiMatteo et al. (2024), NMFS found discrepancies in the maximum densities used to estimate exposure for sea turtles. Therefore, NMFS used the maximum monthly mean densities (for the months where there could be explosive events, March–October) to estimate sea turtle exposures in the Atlantic Ocean (non-Gulf of Mexico) portion of the action area (Table 14). In the Atlantic Ocean portion of the action area, the maximum sea turtle density is not representative of the actual likely exposure. For example, the maximum density for loggerhead turtles (>11.5 individuals per km^2) occurs in only 200 km^2 (two 10 km by 10 km cells of the density model) out of over 1 million km^2 of the Atlantic Ocean portion of the action area. In this case, using the mean represents a closer estimate of the actual exposure that is likely to occur, given that explosions can happen anywhere in the action area.

Table 14. ESA-listed sea turtles in the Atlantic Ocean portion of the action area, minimum threshold for a response, associated ensonified areas, species densities using the maximum monthly mean, and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy explosive events

Species	Minimum Threshold to Response* (dB re 1µPa)	Ensonified Area (km^2)	Maximum Monthly Mean Density (individuals per km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	226	0.09	0.05329	0.095922
Kemp's Ridley Turtle	226	0.09	0.00875	0.01575
Leatherback Turtle	226	0.09	0.02909	0.052362
Loggerhead Turtle	226	0.09	0.29242	0.526356

* Note peak sound pressure level thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

Given these estimated exposures, it is extremely unlikely that green, Kemp's ridley, and leatherback turtles will be exposed to underwater acoustic effects from explosive events. Although estimated exposures for loggerhead turtles do not appear to be discountable, given that higher densities occur in more coastal areas which are comparatively small compared to the large Atlantic Ocean portion of the action area and where a Super Heavy explosive event will be less likely, it is extremely unlikely that loggerhead turtles will be exposed to underwater acoustic effects of a Super Heavy explosion. It is also extremely unlikely that hawksbill turtles, for which there are no density estimates, will be exposed to the underwater acoustic effects of a Super Heavy explosion. Hawksbill turtles are relatively rare in the Atlantic Ocean portion of the action area, and only occasional nesting has been documented off Florida and North Carolina (Finn et al. 2016; NMFS and USFWS 2013). Based on data from (SWOT 2022) and sightings recorded in OBIS-SEAMAP, hawksbill turtles are rare in the Atlantic Ocean portion of the action area.

Data on sea turtles in the middle of ocean basins is limited because of challenging conditions and logistics of conducting surveys offshore. North Indian Ocean DPS, Southwest Indian Ocean DPS, and East Indian-West Pacific DPS of green turtles may occur in the Indian Ocean portion of the action area. Nesting beaches occur in countries near the western and eastern boundaries of the Indian Ocean portion of the action area, and coastlines much further north (NMFS 2007; Seminoff et al. 2015). These DPSs of green turtles forage mainly in seagrass beds found in coastal waters, but may move into and transit through oceanic zones. Southwest Indian Ocean DPS, Southeast Indo-Pacific DPS, and North Indian Ocean DPS of loggerhead turtles may occur in the action area. Foraging areas for these DPSs of loggerhead turtles are generally coastal (Rees et al. 2010; Harris et al. 2018; Robinson et al. 2018). Juveniles in the North Indian Ocean may undertake trans-equatorial movements (Dalleau et al. 2014). In fact, the few sighting records of ESA-listed sea turtles within the Indian Ocean portion of the action area are of a tagged loggerhead turtle migrating north-south through the westernmost portion of the Indian Ocean portion of the action area (Halpin et al. 2009; Dalleau et al. 2014). Southwest Indian Ocean DPS individuals also migrate between foraging and nesting areas, though these migration corridors are generally close to shore (Harris et al. 2015; Harris et al. 2018) and outside of the Indian Ocean portion of the action area. The Southeast Indo-Pacific DPS generally forages off coastal Western Australia to Indonesia (Casale et al. 2015). Olive ridley turtles appear to be most abundant in coastal waters of the northern Indian Ocean (NMFS 2014a), although satellite tagging of one individual showed movement to waters deeper than 200 m (Rees et al. 2012). Hawksbill turtles in the eastern Indian Ocean generally forage in waters less than 100 m deep (Fossette et al. 2021). Leatherback turtles occur throughout the Indian Ocean (Hamann et al. 2006; Nel 2012). Satellite tagging of post-nesting leatherback turtles in South Africa showed that less than half of the tagged individuals moved south and then east into oceanic waters of the Indian Ocean, below the Indian Ocean portion of the action area (Robinson et al. 2016). Leatherback nesting populations in the southwest Indian Ocean (e.g., South Africa) and northeast Indian Ocean (e.g., Sri Lanka, Andaman Islands) total approximately 100 nesting females, and between 100–600 nesting females per year, depending on the island, respectively (Hamann et al. 2006). The number of nesting females (the only population estimates available) is relatively small given the large Indian Ocean portion of the action area. Therefore, we expect that densities of ESA-listed sea turtles in the Indian Ocean portion of the action area will be lower than the available densities of blue, fin, and sperm whales (Table 9). In addition, given the small ensonified area within which significant responses could be expected for ESA-listed sea turtles, we believe that the estimated number of exposures that would be more than insignificant for ESA-listed sea turtles will be lower than that for blue, fin, and sperm whales.

Table 15. ESA-listed sea turtles in the Hawai'i and Central North Pacific portion of the action area, minimum threshold for a response, associated ensonified areas, species densities, and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Minimum Threshold to Response* (dB re 1µPa)	Ensonified Area (km^2)	Density (individuals per km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	226	0.05	0.00027	0.0003
Hawksbill Turtle	226	0.05	0.00005	0.00005
Leatherback Turtle	226	0.05	0.00115	0.001
Loggerhead Turtle	226	0.05	0.00184	0.002
Olive Ridley Turtle	226	0.05	0.00178	0.002

* Note peak sound pressure level thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

Table 16. ESA-listed sea turtles in the Northeast and Tropical Pacific portion of the action area, minimum threshold for a response, associated ensonified areas, species densities, and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Minimum Threshold to Response* (dB re 1µPa)	Ensonified Area (km^2)	Density (individuals per km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	226	0.05	0.00	0
Leatherback Turtle	226	0.05	0.001	0.001
Loggerhead Turtle	226	0.05	0.00	0

* Note peak sound pressure level thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

There have been no documented hawksbill turtle nests off the U.S. West Coast, and a majority of nesting occurs in Mexico, El Salvador, Nicaragua, Panama and Ecuador (Rguez-Baron et al. 2019). There is a small (< 20 females) nesting population in the Hawaiian Island; however, observations of hawksbill turtles in Hawai'i are rare (Chaloupka et al. 2008; Van Houtan et al. 2012). Most juveniles and adults use nearshore habitats (Rguez-Baron et al. 2019). Olive ridley turtles are also rare in offshore areas of the Northeast and Tropical Pacific portion of the action area, as occurrence is typically associated with warmer waters further south (Eguchi et al. 2007; Montero et al. 2016). Therefore, hawksbill and olive ridley turtles are not expected to occur in high numbers or densities in the Northeast and Tropical Pacific portion of the action area, to where they would be exposed to the underwater acoustic effects from Starship explosive events, meaning exposure would be extremely unlikely to occur and the effects discountable.

There were no available density data, and limited data overall, for ESA-listed sea turtles in the South Pacific portion of the action area. Seminoff et al. (2015) summarized nesting sites for all DPSs of green turtles, including the DPSs that may occur in the South Pacific portion of the action area: Central South Pacific DPS and East Pacific DPS. There are no nesting sites of the Central South Pacific DPS of green turtles within or near the South Pacific portion of the action area; thus, we expect that Central South Pacific DPS green turtles do not occur in high numbers or congregate within the South Pacific portion of the action area. The two primary nesting sites of the East Pacific DPS of green turtle are at Michoacán, Mexico and the Galápagos Islands, Ecuador (Seminoff et al. 2015). Neither occurs near the South Pacific portion of the action area, nor do any of the nesting sites monitored in Seminoff et al. (2015). Therefore, we expect that the East Pacific DPS of green turtle does not occur in high numbers or congregate within the South Pacific portion of the action area. Loggerhead, olive ridley, and hawksbill turtles are relatively rare in offshore waters where the South Pacific portion of the action area is located (OBIS-SEAMAP). Thus, we expect that loggerhead, olive ridley, and hawksbill turtles do not occur in high numbers or congregate within the South Pacific portion of the action area. Leatherback turtles transit to the South Pacific from nesting sites in Mexico and Costa Rica to forage, and thus are expected to transit through and search for prey within the South Pacific portion of the action area (Bailey et al. 2012a; Bailey et al. 2012b; Benson et al. 2015). However, given the relatively large area where leatherbacks have been documented (e.g., see Bailey et al. 2012a) compared to the South Pacific portion of the action area, patchy distribution of prey in offshore areas, movement of individual leatherbacks searching for prey aggregations, and the limited number of times Starship could explode, we expect it is extremely unlikely a leatherback turtle will be exposed to the underwater acoustic effects from a Starship explosion.

In summary, given the low estimated exposures that could amount to an effect beyond insignificant and small ensonified areas outside of which insignificant responses are expected, we expect that potential effects of Super Heavy or Starship explosive events on ESA-listed sea turtles to be extremely unlikely and therefore discountable. We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed Central North Pacific DPS, East Indian-West Pacific DPS, East Pacific DPS, North Atlantic DPS, North Indian DPS, South Atlantic DPS, and Southwest Indian DPS of green turtle, hawksbill turtle, leatherback turtle, North Indian Ocean DPS, North Pacific Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtle, and all other areas/not Mexico's Pacific coast breeding colonies and Mexico's Pacific coast breeding colonies of olive ridley turtle.

4.1.2.3 ESA-Listed Fish

The ESA-listed fish species that are not likely to be adversely affected by explosive events due to the proposed action are: Carolina DPS and South Atlantic DPS of Atlantic sturgeon, giant manta ray, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, Central and Southwest Atlantic DPS, Eastern Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark, shortnose sturgeon, U.S. portion of range DPS of smalltooth sawfish, and South-Central California Coast DPS and Southern California DPS of steelhead trout.

Species that spend a majority of time in or congregate in nearshore waters and rivers such as the Carolina DPS and South Atlantic DPS of Atlantic sturgeon, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, Central and Southwest Atlantic DPS, Eastern Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark, shortnose sturgeon, U.S. portion of range DPS of smalltooth sawfish, and South-Central California Coast DPS and Southern California DPS of steelhead trout, are not expected to be adversely affected by underwater acoustic effects from a Super Heavy or Starship explosion. These species are not expected to occur in high numbers or densities in areas where a Super Heavy or Starship explosion is likely to occur. Additionally, based on NMFS's physical injury acoustic thresholds for large fish (> 2 grams, which is expected for ESA-listed fishes that occur further from the coast), the ensonified area from a Super Heavy or Starship explosion (outside of which insignificant responses are expected) is 9.34 km^2 and 4.63 km^2, respectively. Given the relatively small ensonified areas compared to the action area, the limited number of explosive events, and the infrequent or rare occurrence of these species in areas where there could be an explosion, it is extremely unlikely these species will be exposed to underwater acoustic effects of a Super Heavy or Starship explosion. Thus, the effects are discountable.

ESA-listed fishes that are more likely to occur in offshore areas where Super Heavy and Starship explosions will occur include the oceanic whitetip shark and giant manta ray.

Oceanic whitetip sharks are sometimes caught in the yellowfin tuna fishery in the Gulf of Mexico and Northwest Atlantic Ocean. In the 1950's, during exploratory tuna surveys, nearly 400 oceanic whitetip sharks were caught, relative to only five caught in the 1990's during the commercial yellowfin tuna fishery in the Gulf of Mexico (Baum and Myers 2004). Although Young et al. (2018) estimate oceanic whitetip shark abundance declined only about 4% between 1992 and 2005. Given significant historic declines in abundance (88% in the Gulf of Mexico; FAO 2012) and recent information, Young et al. (2018) conclude that oceanic whitetip sharks are now relatively rare in the Northwest Atlantic and Gulf of Mexico. The Flower Garden Banks National Marine Sanctuary may serve as a nursery habitat for giant manta ray, given multiple studies on the prevalence of juvenile giant manta rays within the Sanctuary (Childs 2001; Stewart et al. 2018a; Stewart et al. 2018b). A buffer of 37 km from the Flower Garden Banks National Marine Sanctuary will be implemented for any Super Heavy landings and potential explosive events to avoid the sanctuary. Based on sightings and survey data of giant manta ray along the U.S. East Coast and Gulf of Mexico from 1925–2020, Farmer et al. (2022a) modeled the probability of occurrence for giant manta rays in the Gulf of Mexico and Northwest Atlantic. Farmer et al. (2022a) modeled higher probabilities of occurrence nearshore compared to areas offshore. Thus, we do not expect oceanic whitetip sharks and giant manta rays to occur in high numbers or densities within the Gulf of Mexico and Atlantic Ocean portions of the action area. Given the low probabilities of occurrence, relatively small ensonified areas within which non-insignificant responses could be expected for ESA-listed oceanic whitetip sharks and giant manta rays, and the limited number of times Super Heavy may explode in either portion of the action area, oceanic whitetip shark and giant manta ray exposure to the underwater acoustic effects of an explosive event in the Gulf of Mexico and Atlantic Ocean portions of the action area is extremely unlikely and thus discountable.

Very little data exist on oceanic whitetip sharks in the Indian Ocean portion of the action area. Most data come from fisheries bycatch data, collected by the Indian Ocean Tuna Commission, and there are no quantitative stock assessments for the oceanic whitetip shark. Oceanic whitetip sharks are generally found offshore in the open ocean, on the outer continental shelf, or around oceanic islands in deep waters, and prefer warm (> 20°C; Bonfil et al. 2008) open ocean waters between 10° North and 10° South latitude, which overlaps with the Indian Ocean portion of the action area (NMFS 2017b). Oceanic whitetip sharks have been bycaught in tuna purse seine fisheries adjacent to the western boundary of the Indian Ocean portion of the action area (Lopetegui-Eguren et al. 2022), and have also been bycaught in the Spanish longline swordfish fishery (Ramos-Cartelle et al. 2012) that overlaps the Indian Ocean portion of the action area. However, the majority of oceanic whitetip sharks bycaught in the Indian Ocean were caught between latitudes 0° and 10° South, outside of the Indian Ocean portion of the action area. Oceanic whitetip shark bycatch within the Indian Ocean portion of the action area is likely higher than what would be expected with standard survey data, because fishing vessels put out bait that attracts predators like the oceanic whitetip shark. Anecdotal reports suggest that oceanic whitetip sharks have become rare throughout most of the Indian Ocean over the past 20 years (IOTC 2015). Giant manta rays are generally found in coastal waters in the Indian Ocean, outside of the Indian Ocean portion of the action area (Kashiwagi et al. 2011; Kitchen-Wheeler

2010; Miller and Klimovic 2017). Given the small ensonified area within which non-insignificant responses could be expected for ESA-listed oceanic whitetip sharks and giant manta rays and the limited number of Starship explosive events, we believe that the estimated number of exposures that would be more than insignificant for ESA-listed oceanic whitetip sharks and giant manta rays will be lower than that for blue, fin, and sperm whales (Table 9).

Oceanic whitetip shark and giant manta ray occurrence within the Hawai'i and Central North Pacific portion of the action area were estimated from the NMFS Pacific Islands Regional Office's fisheries observer data. Data from 2023, the most recent year with complete data, were obtained from the Hawai'i deep-set long line fisheries observer data. There were 452 interactions with oceanic whitetip sharks and two interactions with giant manta rays in 2023. The deep-set long line fishery operates year-round and had a 17.41% average observer coverage in 2023 (between one in five or one in six fishing trips had an observer on board). This is likely higher than what would be expected with standard survey data, because fishing vessels put out bait that attracts predators like the oceanic whitetip shark. These are also observations, not targeted surveys to identify species densities in an area. These observations were made over 12 months, representing individuals moving in and out of the action area, and are not representative of densities at any particular time of year. The Hawai'i deep-set long line fishery only overlaps a relatively small portion of the Hawai'i and Central North Pacific portion of the action area, which is over 10 million km^2 in size. Thus, given the low estimated exposures of oceanic whitetip shark and limited giant manta ray interactions in the action area, small ensonified area within which non-insignificant responses could be expected for ESA-listed oceanic whitetip sharks and giant manta rays, and the limited number of Starship explosive events, it is extremely unlikely that the oceanic whitetip shark and giant manta ray would be exposed to underwater acoustic effects from Starship explosive events in the Hawai'i and Central North Pacific portion of the action area.

Expected occurrence of oceanic whitetip sharks and giant manta rays in the Northeast and Tropical Pacific portion of the action area is similar to that in the Hawai'i and Central North Pacific portion of the action area. Young et al. (2018) synthesize information from multiple studies showing a clear decline of approximately 80–95% in catches of oceanic whitetip sharks in fisheries operating in the Eastern Pacific. Giant manta rays are relatively scarce throughout the Northeast and Tropical Pacific portion of the action area except for the southeast corner of the action area, which overlaps Isla Clarión of Mexico's Revillagigedo National Park (Revillagigedo Archipelago). Revillagigedo National Park is Mexico's largest fully protected marine reserve. Giant manta rays aggregate at the Revillagigedo National Park and Bahia de Banderas (Banderas Bay), Mexico with estimated populations of 1,172 and > 400 individuals, respectively (Cabral et al. 2023; Domínguez-Sánchez et al. 2023; Gómez-García et al. 2021; Harty et al. 2022). Tagged giant manta rays appeared to move between four main sites: the Gulf of Mexico, Banderas Bay, Barra de Navidad, and the three eastern-most islands of Revillagigedo National Park (Rubin et al. 2024). Isla Clarión, which is the only island of Revillagigedo National Park that overlaps the Northeast and Tropical Pacific portion of the action area, was not one of the sites that tagged giant manta rays visited in the Rubin et al. (2024) study. It appears that giant manta rays do not frequent Isla Clarión to the same degree as the other islands in the Revillagigedo National Park, as giant manta ray cleaning sites (where animals aggregate in larger numbers) are located near the other three islands (Cabral et al. 2023; Rubin et al. 2024; Stewart et al. 2016). Thus, we do not expect oceanic whitetip sharks or giant manta rays to occur in high numbers or densities within the Northeast and Tropical Pacific portion of the action area. In addition, given the small ensonified area within which non-insignificant responses could be expected for ESA-listed oceanic whitetip sharks and giant manta rays and the limited number of Starship explosive events, it is extremely unlikely that oceanic whitetips sharks and giant manta rays will be exposed to the underwater acoustic effects of Starship explosive events.

In the South Pacific, oceanic whitetip sharks have also undergone a 80–95% decline in population abundance (Hall and Roman 2013). Oceanic whitetip sharks in the South Pacific portion of the action area are expected to be scarce and widely distributed, with no aggregations of sharks in large numbers or densities. The giant manta ray population is estimated at 22,316 individuals off Ecuador (Harty et al. 2022). Coastal aggregations of giant manta rays have been observed off the coast of Ecuador, and movements documented between foraging and cleaning aggregation sites, northern Peru, and the Galapagos Islands (Andrzejaczek et al. 2021; Burgess 2017). Thus, giant manta ray are not expected to occur in the South Pacific portion of the action area in high numbers or densities. In addition, given the small ensonified area within which non-insignificant responses could be expected for ESA-listed oceanic whitetip sharks and giant manta rays and the limited number of Starship explosive events, it is extremely unlikely that oceanic whitetips sharks and giant manta rays will be exposed to the underwater acoustic effects of Starship explosive events.

In summary, given the relatively sparse occurrence of ESA-listed fishes across the action area, small ensonified areas outside of which insignificant responses are expected, and limited number of explosive events, we expect that potential effects of Super Heavy or Starship explosive events on ESA-listed fishes to be extremely unlikely to occur and therefore discountable. We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed Carolina DPS and South Atlantic DPS of Atlantic sturgeon, giant manta ray, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, Central and Southwest Atlantic DPS, Eastern Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark, shortnose sturgeon, U.S. portion of range DPS of smalltooth sawfish, and South-Central California Coast DPS and Southern California DPS of steelhead trout.

4.1.2.4 Black Abalone

Black abalone occur along the coast from Point Arena, California to Northern Baja California, Mexico in waters from the high intertidal zone to about 6 m depth (VanBlaricom et al. 2009). Because the range and distribution of black abalone is restricted to coastal waters, it is extremely unlikely that black abalone will be exposed to Starship explosive events that will occur offshore in the Northeast and Tropical Pacific portion of the action area. Thus, the potential effects of a Starship explosive event on black abalone are extremely unlikely to occur and therefore discountable. We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed black abalone.

4.1.3 Critical Habitat Not Likely to be Adversely Affected

Critical habitats that are not likely to be adversely affected by the explosive events due to the proposed action are the designated critical habitats of the Main Hawaiian Islands insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, and black abalone, and the proposed critical habitats of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle, and Rice's whale.

As stated previously, given the low overpressures and short duration of the sonic booms or impulse noise described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2, will be so small as to be immeasurable and are therefore insignificant.

Falling objects may affect designated or proposed habitat that occurs in areas where falling objects may occur (Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, North Atlantic DPS of green turtle, and Rice's whale). Falling objects may affect PBFs related to waters/passage free of obstructions and prey/cover availability: Northwest Atlantic Ocean DPS of loggerhead turtle foraging habitat, constricted migratory habitat, *Sargassum* habitat; Gulf sturgeon, North Atlantic DPS of green turtle, and Rice's whale (prey-related PBF only; Table 2). Falling objects could create obstructions to waterways or access to refugia if they land in shallow enough areas or on top of underwater refugia, which is extremely unlikely given Starship and Super Heavy will be expended at least 5 NM from shore, the limited number of times either vehicle will be expended, the small area of critical habitat relative to the action area, and the small size of Super Heavy and Starship (71x9 m and 50x9 m, respectively) and debris relative to critical habitat (generally a couple thousand to hundreds of thousands of square kilometers except for one unit of Gulf sturgeon critical habitat off Florida which is approximately 500 km^2). Falling objects may also temporarily displace prey species as they sink through the water column; however, this is not expected to affect the density, abundance, availability, or accessibility of prey in a manner that would measurably affect prey populations. Thus, the effect from falling objects on critical habitat would be discountable or insignificant.

Pollution may also affect designated or proposed critical habitats that have PBFs related to prey and water quality. Prey-related PBFs include the designated critical habitats of the Main Hawaiian Islands insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle (foraging habitat and *Sargassum* habitat), Gulf sturgeon, black abalone, and the proposed critical habitats of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle (benthic foraging/resting feature and surface pelagic foraging/resting feature), and Rice's whale (Table 2). Unrecovered debris could provide substrate for certain prey species. Hawkins et al. (1984) observed mortality in estuarine fish located in proximity to NASA's space shuttle launch site due to a substantial decrease in the pH of the water, which was a result of large depositions of hydrochloric acid from the solid rocket motor exhaust (Dreschel and Hinkle 1984). Hydrochloric acid is not an expected emission from the combustion of propellants used in Starship and Super Heavy. Given the limited number of times Starship and Super Heavy will be expended in a manner which facilitates pollutants entering the ocean, and the large areas over which prey species may be distributed across the action areas, pollution is not expected to affect the density, abundance, availability, or accessibility of prey in a manner that would measurably affect prey populations. Thus, the effects of pollution on prey-related PBFs of designated or proposed critical habitat is insignificant.

Water quality-related PBFs include the designated critical habitats of the Main Hawaiian Islands insular DPS of false killer whale, Gulf sturgeon, black abalone, and Rice's whale (Table 2). As previously discussed, pollutants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the limited number of times either vehicle can be expended in the ocean, unlikely scenario of a launch failure, and brief exposure of residual propellants, it is highly unlikely that the water quality PBFs would have an effect on these critical habitats. Thus, the effects of pollution on water quality-related PBFs of designated or proposed critical habitat is insignificant.

Given the temporary use and low sound levels of vessel operations described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2) will be so small as to be immeasurable and are therefore insignificant.

Given the temporary use and limited amount of acoustic energy that enters the water from aircraft activities described previously, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2) will be so small as to be immeasurable and are therefore insignificant.

The remaining stressor is underwater acoustic effects from Super Heavy or Starship explosive events. This stressor may affect designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands insular DPS of false killer whale and Rice's whale, see Table 2). However, given the limited amount of acoustic energy that enters the water from an explosive event and the limited number of times either vehicle will explode, effects to designated or proposed critical habitat with acoustic-related PBFs will be so small as to be immeasurable and are therefore insignificant.

We conclude that the proposed action may affect, but it not likely to adversely affect designated or proposed critical habitats of the Main Hawaiian Islands insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, black abalone, Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle, and Rice's whale.

4.2 Status of the Species Likely to be Adversely Affected

The remainder of this opinion examines the status of each species that is likely to be adversely affected by the proposed action (Kemp's ridley sea turtle and Northwest Atlantic Ocean DPS of loggerhead sea turtle in the Gulf of Mexico portion of the action area). The status is an assessment of the abundance, recent trends in abundance, survival rates, life stages present, limiting factors, and sub-lethal or indirect changes in population trends such as inter-breeding period, shifts in distribution or habitat use, and shifts in predator distribution that contribute to the extinction risk that the listed species face. The status of each species below is described in terms of life history, threats, population dynamics, and recovery planning.

The information used in each of these sections is based on parameters considered in documents such as status reviews, recovery plans, and listing decisions and based on the best available scientific and commercial information. This section informs the description of the species' likelihood of both survival and recovery in terms of their "reproduction, numbers, or distribution" as described in 50 CFR §402.02. 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 the NMFS OPR web site (https://www.fisheries.noaa.gov/species-directory/threatened-endangered).

4.2.1 Life History Common to Kemp's Ridley and Loggerhead Turtles

ESA-listed sea turtles in the Gulf of Mexico portion of the action area undergo the same general life stages: adult females nest and lay multiple clutches on coastal beaches, eggs are incubated in the sand and after approximately 1.5–2 months of embryonic development, hatchlings emerge and swim offshore into deep, open ocean water where they feed and grow, until they migrate to the neritic zone (nearshore) as juveniles. Males generally arrive at breeding grounds before females and return to foraging grounds months before females (Hays et al. 2022). When individuals reach sexual maturity, adult turtles generally return to their natal beaches where they mate in nearshore waters and nest. In the Gulf of Mexico, sea turtles generally nest from late spring to late summer.

Sea turtles generally can hear low-frequency sounds, with a typical hearing range of 30 Hertz (Hz) to 2 kiloHertz (kHz) and a maximum sensitivity between 100–800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Ridgway et al. 1969). Juvenile Kemp's ridley turtles can hear from 100–500 Hz, with a maximum sensitivity between 100–200 Hz at thresholds of 110 dB re 1μPa (Bartol and Ketten 2006). Bartol et al. (1999) reported effective hearing range for juvenile loggerhead turtles is from at least 250–750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re 1μPa and two-year olds: about 86 dB re 1μPa), with the threshold increasing rapidly above and below that frequency (Bartol and Ketten 2006). Underwater tones elicited behavioral responses to frequencies between 50 and 800 Hz and auditory evoked potential responses between 100 Hz and 1.1 kHz in one adult loggerhead turtle (Martin et al. 2012). The lowest threshold recorded in this study was 98 dB re one μPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50–800 Hz, while juveniles responded to sounds in the range of 50 Hz to 1 kHz.

4.2.2 Threats Common to Kemp's Ridley and Loggerhead Turtles

ESA-listed sea turtles in the Gulf of Mexico portion of the action area were threatened by overharvesting and poaching. Although intentional take of sea turtles and their eggs does not occur extensively within the Gulf of Mexico portion of the action area currently, sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Other major threats to ESA-listed sea turtles are habitat degradation and habitat loss (e.g., human-induced and coastal erosion, storm events, light pollution, coastal development or stabilization, plastic pollution, oil pollution), fisheries interactions and bycatch, climate change, oceanic events such as cold-stunning, natural predation, and disease. Kemp's ridley turtles are the most vulnerable to threats, especially threats that cause population-level impacts such as the Deepwater Horizon (DWH) oil spill and response, due to their already low numbers and location of nesting habitat. Disease, particularly fibropapillomatosis (FP), which results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989) can also affect sea turtle populations. When tumors are particularly large or numerous, they can debilitate turtles, affecting swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989), and can even result in mortality. Perrault et al. (2021b) observed reduced immune function in green turtles with FP. FP is cosmopolitan; however, it mostly affects green turtles (Blackburn et al. 2021; Foley et al. 2005; Manes et al. 2022; Shaver et al. 2019; Tristan et al. 2010).

4.2.3 Kemp's Ridley Turtle

The Kemp's ridley 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 turtle is considered the most endangered sea turtles (Groombridge 1982; TEWG 2000; Zwinenberg 1977).

Life History

Adult female Kemp's ridley turtles nest from April–July. Age to sexual maturity ranges greatly from five to 16 years, though NMFS et al. (2011a) determined the best estimate of age to maturity for Kemp's ridley sea turtles was 12 years. The average remigration rate for Kemp's ridley turtles is approximately two years. Females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M. 1994). Nesting is limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico but also in Veracruz, Mexico and Padre Island National Sea Shore, Texas.

Population Dynamics

Of the sea turtles 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. Nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century. Following a significant, unexplained one-year decline in 2010, Kemp's ridley turtle nests in Mexico reached a record high of 21,797 in 2012 (NPS 2013). In 2013, there was a second significant decline, with 16,385 nests recorded. In 2014, there were an estimated 10,987 nests (approximately 4,395 females) 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 2009, and 119 in 2014 (NMFS and USFWS 2015). Gallaway et al. (2013) estimated the female population size for age 2 and older in 2012 to be 188,713 (SD = 32,529). If females comprise 76% of the population, the total population of age 2+ of Kemp's ridley turtles was estimated to have been 248,307 in 2012 (Gallaway et al. 2013). DiMatteo et al. (2024) modeled survey data to estimate an in-water abundance of juvenile and adult Kemp's ridley sea turtles along the U.S. Atlantic Coast of 10,762 turtles.

Kemp's ridley turtle nesting population was exponentially increasing (NMFS et al. 2011a); however, since 2009 there has been concern over the slowing of recovery (Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016). From 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2015). In fact, nest counts dropped by more than a third in 2010 and continue to remain below predictions (Caillouet et al. 2018).

Recovery Planning

In response to 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 of this consultation. 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 and USFWS 2011). The following items were identified as priorities to recover Kemp's ridley turtles:

1. Protect and manage nesting and marine habitats.
2. Protect and manage populations on the nesting beaches and in the marine environment.
3. Maintain a stranding network.
4. Manage captive stocks.
5. Sustain education and partnership programs.
6. Maintain, promote awareness of and expand U.S. and Mexican laws.
7. Implement international agreements.
8. Enforce laws.

4.2.4 Loggerhead Turtle – Northwest Atlantic Ocean DPS

The loggerhead turtle was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated 9 DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS listed as threatened (75 FR 12598).

Life History

Adult female loggerhead turtles generally nest between April–September. Females deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins 1984), but an individual female only nests every 3.7 years on average (Tucker 2010). Each nest contains an average of

100 to 126 eggs (Dodd 1988). Loggerhead turtles reach sexual maturity between 20–38 years of age, although this varies widely among populations (Frazer and Ehrhart 1985; NMFS 2001). Mean age at first reproduction for female loggerhead turtles is 30 years. The majority of nesting occurs at the western rims, concentrated in the north and south temperate zones and subtropics, of the Atlantic and Indian Oceans (NRC 1990). For the Northwest Atlantic Ocean DPS of loggerhead turtle, most nesting occurs in the Southeast U.S., from southern Virginia to Alabama. Additional nesting occurs along the northern and western Gulf of Mexico, eastern Yucatán peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), off the southwestern coast of Cuba (Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern islands of the Caribbean Sea.

Population Dynamics

The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead sea turtles from Texas through Virginia and Quintana Roo, Mexico, is over 110,000 (NMFS and USFWS 2023). In-water estimates of abundance are difficult to perform on a wide scale. In the summer of 2010, NMFS's Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, based on Atlantic Marine Assessment Program for Protected Species (AMAPPS) aerial line-transect sighting survey and satellite tagged loggerheads (NMFS 2011). They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000–817,000) based on positively identified loggerhead sightings (NMFS 2011). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead sea turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023). Ceriani et al. (2019) estimated the total number of adult females nesting in Florida to be 51,319, based on nest count data from 2014–2018. The annual rate of nesting females increased 1.3% from 1983–2019 for the Northern Recovery Unit (i.e., loggerheads nesting in Georgia, North Carolina, South Carolina, and Virginia; Bolten et al. 2019; NMFS and USFWS 2023). There is no significant trend in the annual number of nesting females in either the Peninsular Florida (1989–2018) or Northern Gulf of Mexico (1997–2018) units over the last several decades (NMFS and USFWS 2023). Overall, the latest 5-year status review concluded that the DPS as a whole demonstrates a stable (neither increasing nor decreasing) population trend (NMFS and USFWS 2023). DiMatteo et al. (2024) modeled survey data to estimate an in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 turtles. We are not aware of any current range-wide in-water estimates for the DPS.

Based on genetic analysis of subpopulations, the Northwest Atlantic Ocean DPS of loggerhead turtle is further categorized into 5 recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit (Conant et al. 2009). An analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico's Caribbean coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS of loggerhead turtle should be considered as 10 management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012).

The Northern Recovery Unit, from North Carolina to northeastern Florida, is the second largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 5,215 nests from 1989 through 2008, and approximately 1,272 nesting females per year (NMFS and USFWS 2008b). The nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989 through 2008. Aerial surveys of nests showed a 1.9% decline annually in nesting in South Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the Northern Recovery Unit has experienced a long-term decline over that period. Data since that analysis are showing improved nesting numbers and a departure from the declining trend. Nesting in Georgia has shown an increasing trend since comprehensive nesting surveys began in 1989. Nesting in North Carolina and South Carolina has begun to show a shift away from the declining trend of the past. Increases in nesting were seen from 2009 through 2012.

The Peninsular Florida Recovery Unit is the largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 64,513 nests per year from 1989 through 2007, and approximately 15,735 nesting females per year (NMFS and USFWS 2008a). Following a 52% increase between 1989 through 1998, nest counts declined sharply (53%) from 1998 through 2007. However, annual nest counts showed a strong increase (65%) from 2007 through 2017 (FFWCC 2018). Index nesting beach surveys from 1989 through 2013 have identified 3 trends. From 1989 through 1998, a 30% increase was followed by a sharp decline over the subsequent decade. Large increases in nesting occurred since then. From 1989 through 2013, the decade-long decline had reversed and there was no longer a demonstrable trend. From 1989 through 2016, the Florida Fish and Wildlife Research Institute concluded that there was an overall positive change in the nest counts, but the change was not statistically significant.

The Dry Tortugas, Gulf of Mexico, and Greater Caribbean Recovery Units are much smaller nesting assemblages, but they are still considered essential to the continued existence of loggerhead turtles. The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 through 2004 (excluding 2002), which provided a range of 168 to 270 (mean of 246) nests per year, or about 60 nesting females (NMFS and USFWS 2007). There was no detectable trend during this period (NMFS and USFWS 2008a).

The Gulf of Mexico Recovery Unit has between 100 to 999 nesting females annually, and a mean of 910 nests per year. Analysis of a dataset from 1997 through 2008 of index nesting beaches in the northern Gulf of Mexico shows a declining trend of 4.7% annually. Index nesting beaches in the panhandle of Florida has shown a large increase in 2008, followed by a decline in 2009 through 2010 before an increase back to levels similar to 2003 through 2007 in 2011.

The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903–2,331 nests annually (Zurita et al. 2003a). Other significant nesting sites are found throughout the Caribbean Sea, and including Cuba, with approximately 250–300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008a). Survey effort at nesting beaches has been inconsistent, and not trend can be determined for this subpopulation (NMFS and USFWS 2008a). Zurita et al. (2003b) found an increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico from 1987 through 2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008a).

Critical Habitat

Loggerhead turtle critical habitat was found to be NLAA (Section 4.1.3) and is not considered further in the opinion.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover loggerhead turtle populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2009 Final Recovery Plan for the Northwest Atlantic Population of loggerhead turtles for complete down-listing/delisting criteria for each of the following recovery objectives (NMFS 2008):

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
3. Manage sufficient nesting beach habitat to ensure successful nesting.
4. Manage sufficient feeding, migratory, and internesting marine habitats to ensure successful growth and reproduction.
5. Eliminate legal harvest.
6. Implement scientifically based nest management plans.
7. Minimize nest predation.
8. Recognize and respond to mass/unusual mortality or disease events appropriately.
9. Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerheads and their terrestrial and marine habitats.
10. Minimize bycatch in domestic and international commercial and artisanal fisheries.
11. Minimize trophic changes from fishery harvest and habitat alteration.
12. Minimize marine debris ingestion and entanglement.
13. Minimize vessel strike mortality.

4.3 Climate Change Effects to ESA-Listed Species

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 affect the ESA-listed sea turtles in the Gulf of Mexico portion of the action area. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://climate.gov). This section provides some examples of impacts to ESA-listed sea turtles that have occurred or may occur as the result of climate change in the action area.

The rising concentrations of greenhouse gases in the atmosphere, now higher than any period in the last 800,000 years, have warmed global ocean surface temperatures by 0.68–1.1°C between 1850–1900 and 2011–2020 (IPCC 2023). Over the last 100 years, sea surface temperatures have increased across much of the northwest Atlantic, consistent with the global trend of increasing sea surface temperature due to anthropogenic climate change (Beazley et al. 2021). Large-scale changes in the earth's climate are in turn causing changes locally in the Gulf of Mexico's climate and environment. Changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, warming surface temperatures) 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 ESA-listed sea turtles in the action area. For example, ocean acidification negatively affects organisms such as crustaceans, crabs, mollusks, and other calcium carbonate-dependent organisms such as pteropods (free-swimming pelagic sea snails and sea slugs). Some studies in nutrient-rich regions have found that food supply may play a role in determining the resistance of some organisms to ocean acidification (Markon et al. 2018; Ramajo et al. 2016). Reduction in prey items can create a collapse of the zooplankton populations and thereby result in potential cascading reduction of prey at various levels of the food web, including prey for sea turtles.

In addition to impacts on prey species, higher trophic level marine species' ranges in the action area are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions. For example, in the Gulf of Mexico, northward shifts in seagrass-associated fish species occurred over a period where air and sea surface temperatures increased more than 3°C (Fodrie et al. 2010). This northward shift has also been observed in cetacean and sea turtle species in the North Atlantic Ocean. Chavez-Rosales et al. (2022) identified a northward shift of an average of 178 km when examining habitat suitability models for 16 cetacean species in the western North Atlantic Ocean. Record et al. (2019b) also documented a shift in North Atlantic right whale distribution, based on a climate-driven shift in their main prey source. Based on climate, energetics, and habitat modeling, loggerhead and leatherback turtle distributions are expected to shift northward in the North Atlantic Ocean so that animals can stay within the environmental characteristics of suitable habitat (Dudley et al. 2016; McMahon and Hays 2006; Patel et al. 2021). Bevan et al. (2019) predicted a northward shift in Kemp's ridley nests, from Tamaulipas, Mexico, where a majority of Kemp's ridley nesting currently occurs, to Texas, U.S. on North and South Padre Island, the largest Kemp's ridley nesting sites in the U.S., with warming temperatures. They also predicted that Kemp's ridley turtles would ultimately be unlikely to mitigate the effects of a rapidly warming environment such that highly skewed sex ratios or even mortality of eggs and hatchlings would occur. Temperature changes may also affect important life stages such as foraging and nesting, and shift the timing of those stages (Neeman et al. 2015).

In addition to increased ocean warming and changes in species' distribution, climate change is linked to increased extreme weather and climate events including, but not limited to, hurricanes, cyclones, tropical storms, heat waves, and droughts (IPCC 2023). Research from IPCC (2023) shows that it is likely extratropical storm tracks have shifted poleward in both the Northern and Southern Hemispheres, and heavy rainfalls and mean maximum wind speeds associated with hurricane events will increase with continued greenhouse gas warming. These extreme weather events have the potential to have adverse effects on ESA-listed sea turtles in the action area. For example, in 1999, off Florida, Hurricane Floyd washed out many loggerhead and green turtle nests, resulting in as many as 50,000–100,000 hatchling deaths (see https://conserveturtles.org/11665-2/). Rising sea levels can cause coastal erosion, inundation, and flooding, and can also affect sea turtle nesting beaches (Fish et al. 2005; Fuentes et al. 2011; Fuentes et al. 2010a; Fuentes et al. 2010b). Warming ocean temperatures may also increase cold-stunning events of Kemp's ridley turtles in the northwest Atlantic (Griffin et al. 2019).

For sea turtles, egg incubation temperature determines sex, such that warming temperatures can lead to a higher proportion of female hatchings. Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most nests, leading to egg mortality (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

This review provides some examples of impacts to ESA-listed species and their habitats that may occur as the result of climate change within the action area. While it is difficult to accurately predict the consequences of climate change to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats, and may be exacerbated by additional threats in the action area.

5. 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 impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

5.1 Condition of Listed Species in the Gulf of Mexico Portion of the Action Area

5.1.1 Sea Turtle Harvesting

Directed harvest of sea turtles and their eggs for food and other products has existed for years and was a significant factor causing the decline of several species, including the Kemp's ridley and loggerhead turtle considered in this consultation. In the U.S., the harvest of nesting sea turtles and eggs is now illegal, although there has been recent documented harvesting in the eastern Atlantic Ocean (see https://www.justice.gov/usao-sdfl/pr/poachers-93-protected-sea-turtle-eggs-sentenced-prison).

5.1.2 Vessel Operations

The Gulf of Mexico is a highly active region for maritime vessel activity, including shipping, transit, fishing, and offshore operations, all of which have baseline impacts to listed species and their habitats. Vessels have the potential to affect ESA-listed sea turtles through vessel strikes and the production of sound that cause behavioral and physiological disturbance. Potential sources of adverse effects from federal vessel operations in the action area include operations of the DoD, Bureau of Ocean Energy Management (BOEM)/Bureau of Safety and Environmental Enforcement (BSEE), Federal Energy Regulatory Commission (FERC), U.S. Coast Guard (USCG), NOAA, and U.S. Army Corps of Engineers (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. Vessel operations associated with oil and gas activities, have been considered in previous ESA section 7 consultations.

Sea turtle vessel interactions are poorly studied compared to marine mammals; however, vessel strikes have the potential to be a significant threat to sea turtles given that they can results in serious injury and mortality (Work et al. 2010). Sea turtles can move somewhat rapidly but are not adept at avoiding vessels that are moving at more than 4 km per hour most vessels move much faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007b; 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 of time, potentially increasing the risk of vessel strike. Hazel et al. (2007b) documented live and dead sea turtles with deep cuts and fractures indicative of a vessel strike, and suggested that green turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to vessel strike or vessel speed increases. Stacy et al. (2020) analyzed Texas sea turtle stranding data for 2019, a year where sea turtle strandings were more than two times above average based on statewide stranding numbers for the previous 5 and 10 years, and analyzed causes of stranding by species and stranding zone. Vessel strike-type injuries were the most common type of trauma observed in Kemp's ridley, green, and loggerhead turtles (Stacy et al. 2020). Approximately 61% of Kemp's ridley turtles studied had documented vessel strike injuries (Stacy et al. 2020).

5.1.3 Fisheries Bycatch

Fisheries constitute an important and widespread use of the ocean resources throughout the Gulf of Mexico. Fishery interactions can adversely affect ESA-listed sea turtles. Direct effects of fisheries interactions on sea turtles include entanglement, tackle/gear injuries, and bycatch, which can lead to fitness consequences or mortality because of injury or drowning. Indirect effects include reduced prey availability, including overfishing of targeted species, and habitat destruction. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by sea turtles.

Fishing gears that are known to interact with sea turtles include trawls, longlines, purse seines, gillnets, pound nets, dredges and to a lesser extent, pots and traps (Finkbeiner et al. 2011; Lewison et al. 2013). Within the action area, both recreational and commercial fisheries occur in the Gulf of Mexico. Lost traps and disposed monofilament and other fishing lines are a documented source of mortality in sea turtles due to entanglement that may anchor an animal to the bottom leading to death by drowning. Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health (Derraik 2002). Entanglements also make animals more vulnerable to additional threats (e.g., predation and vessel strikes) by restricting agility and swimming speed. The majority of ESA-species that die from entanglement in fishing gear likely sink at sea rather than strand ashore, making it difficult to accurately determine the extent of such mortalities.

Within the Gulf of Mexico, fisheries-related injuries (hooking injuries, entanglement, and internal injuries resulting from ingestion of fishing gear) were the second-most documented injuries in sea turtles off Texas in 2019 (Stacy et al. 2020). Approximately 22% of Kemp's ridley turtles studied had documented fishing-related injuries (Stacy et al. 2020).

Regulations that went into effect in the early 1990's require shrimp trawlers in the Atlantic and Gulf of Mexico to modify their gear with turtle excluder devices (TEDs), which are designed to allow turtles to escape trawl nets and avoid drowning. Analyses by Epperly and Teas (2002) indicated that, while early versions of TEDs were effective for some species, the minimum requirements for the escape opening dimension were too small for larger sea turtles, particularly loggerheads and leatherbacks. NMFS implemented revisions to the TED regulations in 2003 to address this issue (68 FR 8456; February 21, 2003). Revised TED regulations in 2014 were estimated to reduce shrimp trawl-related mortality by 94% for loggerheads (NMFS 2014b). In 2019, a final rule was published (84 FR 70048) requiring TEDs on skimmer trawls greater than 12.19 m. The conservation benefit from the 2019 rule was estimated to prevent bycatch of up to 801–1,168 sea turtles in Southeastern U.S. shrimp fisheries. Furthermore, in 2021, NMFS introduced an advanced notice of a proposed rule to require TEDs on skimmer trawls less than 12.19 m operating in Southeast U.S. shrimp fisheries (86 FR 20475).

Federal fisheries managed by NMFS under the Magnuson-Stevens Act in the Gulf of Mexico have interacted with sea turtles in the past. Threatened and endangered sea turtles are 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. A recent study assessing relative bycatch risk in U.S. federal fisheries determined that the Gulf of Mexico's highly-migratory species pelagic longline, shrimp trawl, and fish vertical line fisheries had the highest interaction rates with marine mammals and ESA-listed turtles, based on reported bycatch data from 2010–2015 (Savoca et al. 2020).

Impacts to listed species and critical habitats have been evaluated via ESA section 7 consultation for all fisheries managed under a fishery management plan (FMP; 15 USC § 1853) or for which any federal action is taken to manage that fishery. 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. NMFS has issued an ITS for the take of sea turtles in each of these fisheries.

Several coastal state fisheries are known to incidentally take listed species, and available information on these fisheries is documented through different agencies (NMFS 2014c). State commercial and recreational fisheries use gear types including trawling, pot fisheries, gillnets, and vertical line, which are all known to incidentally take sea turtles (NMFS 2014c). However, most available state data are based on extremely low observer coverage, or sea turtles were not part of data collection. Thus, these data provide insight into gear interactions that could occur but are not indicative of the magnitude of the overall problem.

In addition to commercial state fisheries, protected sea turtles can also be incidentally captured by hook and line recreational fishers. Observations of state recreational fisheries have shown that Kemp's ridley and loggerhead sea turtles are known to bite baited hooks. Further, observations show that Kemp's ridley and loggerhead turtles 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 1998; TEWG 2000).

5.1.4 Oil and Gas

Oil and gas operations on the outer continental shelf (OCS) that have been ongoing for more than 50 years involve a variety of activities that may adversely affect ESA-listed Kemp's ridley and loggerhead sea turtles in the Gulf of Mexico portion of the action area. As of 2022, Gulf of Mexico federal offshore operations produce 1.7 million barrels (bbl) of crude oil per day, representing 15% of all U.S. crude oil production (EIA 2024). These activities and resulting impacts include vessels making supply deliveries, drilling operations, seismic surveys, fluid spills, oil spills and response, and oil platform removals. To the extent the past, present, or anticipated impacts from federal actions that are not part of the federal action under consultation here occur, they form part of the environmental baseline (e.g., prior, completed exploration, development and decommissioning activities).

Natural seeps are actually a major petroleum input to the offshore Gulf of Mexico waters. There are an estimated 1,401 "seep zones" located in the northern Gulf of Mexico in U.S. waters delineated by BOEM lease blocks; natural seeps in the entire Gulf of Mexico are estimated to release a range of 173,000 to 669,000 bbl per year (O'Reilly et al. 2022). Previous studies (NRC 2003b) estimated higher annual seepage for the entire Gulf of Mexico at about 980,000 bbl (140,000 tonnes) per year, or about three times the estimated amount of oil spilled by the 1989 Exxon Valdez event (about 270,000 bbl; SteynSteyn 2010) or a quarter of the amount released by the DWH event (4.9 million bbl of oil; Lubchenco and Sutley 2010).

Lease Sales and Drilling

The sale of OCS leases in the Gulf of Mexico and the resulting exploration and development of these leases for oil and natural gas resources affects the status of ESA-listed Kemp's ridley and loggerhead sea turtles. BOEM administers the Outer Continental Shelf Lands Act and authorizes the exploration and development of wells in Gulf leases. As of August 1, 2023, there are a total of 2,193 leases in the Gulf of Mexico, 13 of which occur within the Eastern Planning Area. On September 29, 2023, BOEM published the Proposed Final Program covering 2024 to 2029, which outlines three scheduled lease sales in 2025, 2027, and 2029 (BOEM 2023).

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 in the Gulf of Mexico (see below). Previous opinions on BOEM's oil and gas program in the Gulf of Mexico determined that oil and gas leasing may adversely affect protected sea turtles, 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

Seismic Surveys

Seismic exploration is an integral, on-going activity throughout the life-cycle of oil and gas production in the Gulf of Mexico and contribute to noise impacts on ESA-listed species. Seismic surveys are routinely conducted in virtually all water depths. NMFS considered the effects of seismic operations in biological opinions issued to BOEM on its Gulf of Mexico program. BOEM implements "Seismic Survey Mitigation and Protected Species Observer Protocols" that are applied in future lease sale stipulations and conditions of approval for permits, plans, and other authorizations approved by BOEM after March 13, 2020. Oil and gas activities are not permitted in the Flower Garden Banks National Marine Sanctuary, except for occasional geological and geophysical (G&G) surveys that require approval to occur.

Oil Rig Removals

Both the USACE and BSEE permit the removal of oil rigs in the Gulf of Mexico. These removals often use explosives to sever associated pile structures that can impact a variety of species, including any ESA-listed species, in the action area. The USACE oversees rig removals in state waters while BSEE permits these activities in federal waters of the OCS. The USACE consults with NMFS on a project-by-project basis for decommissioning activities that use explosives. According to BSEE, the offshore energy industry has averaged 127 platform removals per year over the past decade (for more information, see: https://www.bsee.gov/decommissioning).

In regard to rig removals in federal waters, a formal ESA section 7 consultation was completed with BSEE in 2006, and the ITS was amended in 2008 following completion of an MMPA rule. That opinion found that the permitting of structure removals in the Gulf of Mexico was not likely to result in jeopardy for loggerhead, Kemp's ridley, green, hawksbill, or leatherback sea turtles. Incidental take, by injury or mortality, of three sea turtles per year or 18 sea turtles during the six-year period of the action covered in the opinion was anticipated during detonations. Most of the takes were predicted to be loggerhead sea turtles. In addition to the Reasonable and Prudent Measures within the ITS, BOEM has also issued "Idle Iron Decommissioning Guidance for Wells and Platforms" (NTL 2018-G03) to inform lessees about mitigation and reporting requirements. The removal of non-operating oil platforms is expected to continue to affect protected sea turtles.

Since the issuance of the 2020 opinion on BOEM's oil and gas program in the Gulf of Mexico, the Gulf of Mexico rig-to-reef program has also expanded; rather than physically removing structures with explosives, non-operating platforms are converted to artificial reefs. As of December 2021, 573 platforms have been converted to reefs within the Gulf of Mexico (BSEE 2024).

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. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Any discharge of hydrocarbons into the environment is prohibited under U.S. law. Instances oil spills are generally small (less than 1,000 bbl) but there are spills that occur that are of larger size. BSEE tracks spills greater than one barrel and posts those data to their website: https://www.bsee.gov/stats-facts/offshore-incident-statistics/spills. Since the issuance of the 2020 opinion on BOEM's oil and gas program in the Gulf of Mexico, oil and gas production has caused several spills and leak incidents, releasing crude oil into the Gulf of Mexico's coastal and marine environment. The summary presented here includes examples of recent events, but may not be comprehensive of all incidents. For more information, BSEE tracks spills greater than one barrel and posts those data to their website: https://www.bsee.gov/stats-facts/offshore-incident-statistics. Following Hurricane Ida's landfall in the Gulf of Mexico region in September 2021, NOAA responded to 282 individual discharges of oil from wells, pipelines, and vessels caused by storm damage (NOAA 2021). On December 24, 2022, a pipeline failure at a crude oil terminal in Corpus Christi Bay, Texas, released around 14,000 gallons of light crude oil, with recorded impacts to green sea turtles (NOAA 2024a). On November 16, 2023, a pipeline crude oil leak off the coast of Louisiana was reported to NOAA and other federal and state agencies, with an estimated 1.1 million gallons at risk of spill and an observed slick over 40 miles in length (NOAA 2023).

When compared with the rest of the world, more than 50% of the loss of well control events come from the federally regulated waters of the U.S. Gulf of Mexico (BSEE 2017). According to (BSEE 2017) from 2000–2015, four of the 117 loss of well control events were categorized as total loss, and the event with the highest risk is the blowout or surface flow type incident.

In addition to accidental spills, leakage from operating and decommissioned sites can pose an ongoing threat to the ocean ecosystem and listed species by potentially introducing hydrocarbons and other pollutants such as dispersants to surrounding waters. Under OCSLA, decommissioning regulations require that within one year after lease termination, operators must permanently plug wellbores and remove all platforms (30 CFR §250). A study from 2023 estimates that as of 2020, a total of 7,188 inactive wells or inactive leases in Federal waters of the Gulf of Mexico have not been permanently plugged (Agerton et al. 2023). The Government Accountability Office similarly determined that around 2,700 end-of-lease wells and 500 end-of-lease platforms were overdue for decommissioning procedures as of June 2023 (GAO 2024). Deteriorating structures from delayed decommissioning can become more vulnerable to damage and destruction from storms that are increasingly frequent due to climate change, which increases the risk of oil spills and the introduction of harmful debris into species' habitat (GAO 2024).

Deepwater Horizon

On April 20, 2010, the semi-submersible drilling rig DWH experienced an explosion and fire while working on an exploratory well approximately 50 miles offshore of Louisiana. The rig subsequently sank and oil and natural gas began leaking into the surrounding waters of the Gulf of Mexico. Oil flowed for 86 days, until the well was capped on July 15, 2010. By then, 134 millions of barrels of oil were spilled into the Gulf. In addition, approximately 1.84 million gallons of chemical dispersant was applied both subsurface and on the surface to attempt to break down the oil. The unprecedented DWH event and associated response activities (e.g., skimming, burning, and application of dispersants) resulted in severe adverse effects on listed species and changed the baseline for the Gulf of Mexico ecosystem. 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 7 below displays visible and toxic (brown), invisible and toxic (yellow), and non-toxic (blue) oil concentrations.

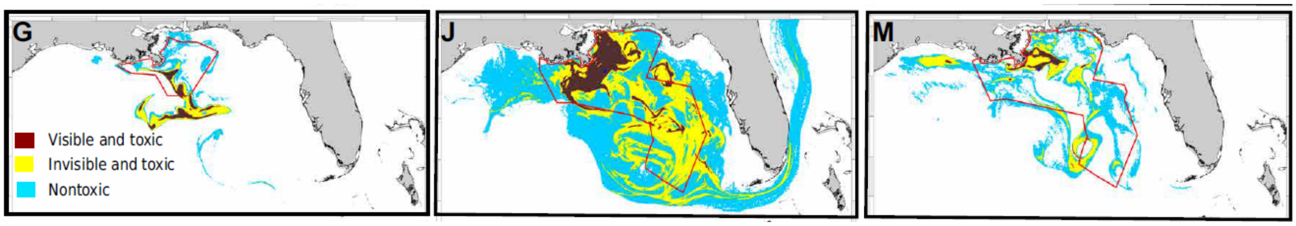

Figure 7. Figure from Berenshtein et al. (2020a) showing spatiotemporal dynamics of the spill for dates showing cumulative oil concentrations in figures G- 15 May 2010; J- 18 June 2010; and M- 2 July 2010.

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 effort evaluated specific impacts to Kemp's ridley, green, loggerhead, and hawksbill sea turtles, sperm whales, Rice's whales, Gulf sturgeon, and habitats of these species (Trustees 2016). The findings of this assessment provide details regarding impacts to the environmental baseline of ESA-listed sea turtles in the Gulf of Mexico and is summarized below and can be found at http://www.gulfspillrestoration.noaa.gov/restoration-planning/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.

Over a decade following DWH, multiple studies demonstrate both long-term impacts of the spill to species abundance and community structure, as well as status ecosystem recovery from the event. 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; Trustees 2016). A review of current literature by Patterson et al. (2023) found that there were clear impacts of the DWH on shelf taxa – at the population level as well as shifts in community structure (especially for reef fish and invertebrates) — and that the shelf ecosystem overall has proven to be remarkably resilient. 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).

According to Joye (2015), offshore oil and gas from the spill had the potential to disperse across the entire water column (both pelagic and benthic environments) during DWH. While post-spill restoration 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 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.

Three hundred and nineteen live oiled turtles were rescued and showed disrupted metabolic and osmoregulatory functions, likely attributable to oil exposure, physical fouling and exhaustion, dehydration, capture and transport (Stacy et al. 2017). Accounting for turtles that were 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 spill due to the duration and large footprint of the spill. It was estimated that as many 7,590 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and unidentified hardshelled sea turtles), and up to 158,900 small juvenile sea turtles (Kemp's ridleys, green turtles, loggerheads, hawksbills, and hardshelled sea turtles not identified to species) were killed by the DWH oil spill. Small juveniles were affected in the greatest numbers and suffered a higher mortality rate than large sea turtles (NMFS USFWS 2013; Trustees 2016).

Subsequent to the PDARP 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% of all oceanic turtles affected by DWH and not heavily oiled were estimated to have died from ingestion of oil (Mitchelmore et al. 2017).

The DWH incident 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 loggerheads, Kemp's ridleys, and green 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 turtles emerged and were released into the Atlantic Ocean.

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 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 oil spill. It is estimated that nearly 35,000 hatchling sea turtles (loggerheads, Kemp's ridleys, and green turtles) were injured by response activities, and thousands more Kemp's ridley and loggerhead hatchlings were lost due to unrealized reproduction of adult sea turtles that were killed by the DWH oil spill.

Kemp's ridley sea turtles were the most affected sea turtle species, as they accounted for 49% (239,000) of all exposed turtles (478,900) during DWH. Kemp's ridley sea turtles were the turtle species most impacted by the DWH event at a population level. The DWH damage assessment calculated the number of unrealized nests and hatchlings because all Kemp's ridleys nest in the Gulf of Mexico and belong to the same population (NMFS et al. 2011b). The total population abundance of Kemp's ridleys 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 would have contributed to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley nests is between 1,300 and 2,000, which translates to approximately 65,000 and

95,000 unrealized hatchlings. This is a minimum estimate because of the overall potential DWH effect because the sub-lethal effects of DWH oil on turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years and contributed substantially to additional nesting deficits observed following DWH. 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 DWH effect on reduced Kemp's ridley nesting abundance and associated hatchling production after 2010 requires further evaluation.

Loggerheads made up 12.7% (60,800 animals) of the total sea turtle exposures (478,900). A total of 14,300 loggerhead sea turtles died as a result of exposure to DWH oil. Unlike Kemp's ridleys, the majority of nesting for the Northwest Atlantic Ocean loggerhead DPS 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 turtle would be proportionally much greater than the impacts occurring to other recovery units, and likely included impacts to mating and nesting adults. Although the long-term effects remain unknown, the DWH impacts 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 during DWH. However, the overall impact on the population recovery of the entire Northwest Atlantic Ocean DPS of loggerhead turtle is likely small.

5.1.5 Marine Debris

Marine debris is an ecological threat that is introduced into the marine environment through ocean dumping, littering, or hydrological transport of these materials from land-based sources or weather events (Gallo et al. 2018). Sea turtles within the action area may ingest marine debris, particularly plastics, which can cause intestinal blockage and internal injury, dietary dilution, malnutrition, and increased buoyancy. These can result in poor health, reduced fitness, growth rates, and reproduction, or even death (Nelms et al. 2016).

Plastic pollution in the marine environment is of particular concern to endangered and threatened species because plastic materials are highly persistent and can degrade into microplastics rather than fully disintegrating. Globally, between 4.8 to 12.7 million metric tons of plastic waste entered the ocean from 192 coastal countries in 2010 (Jambeck et al. 2015). Debris can originate from a variety of marine industries including fishing, oil and gas, and shipping. Many of the plastics discharged to the sea can withstand years of saltwater exposure without disintegrating or dissolving. Further, floating materials have been shown to concentrate in ocean gyres and convergence zones, notably in regions with *Sargassum* habitat and consequently juvenile sea turtles are known to occur, and microplastics have consistently been detected in *Sargassum* mats in coastal ecosystems (Arana et al. 2024; Law et al. 2010). Climate change is further exacerbating marine plastic fluxes; increasing storms and flooding can transport large amounts of debris into aquatic systems and microplastics, in particular, are now being transported through the atmosphere as part of biogeochemical cycles (Ford et al. 2022).

Entanglement in plastic debris (including abandoned 'ghost' fishing gear) is known to cause lacerations, increased drag (thereby reducing the ability to forage effectively or avoid predators), and may lead to drowning or death by starvation. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby reducing the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist 1987; Laist 1997). Weakened animals are then more susceptible to predators and disease and are also less fit to migrate, breed, or, in the case of turtles, nest successfully (Katsanevakis 2008; McCauley and Bjorndal 1999). There are limited studies of debris ingestion in sea turtles within the action area; however, Plotkin et al. (1993) found that over half of the studied loggerhead turtles had anthropogenic debris, mainly pieces of plastic bags, present in digestive tract contents. Plotkin et al. (1993) attributed the deaths of three loggerhead turtles to debris ingestion, including one loggerhead turtle whose esophagus was perforated by a fishing hook, one loggerhead turtle whose stomach lining was perforated by a piece of glass, and one loggerhead turtle whose entire digestive tract was impacted by plastic trash bags. Elsewhere in the Gulf of Mexico, debris such as plastic, fishing gear, rubber, aluminum foil, and tar were found in green and loggerhead turtles (Bjorndal et al. 1994). At least two turtles died as a result of debris ingestion, although the volume of debris represented less than 10% of the volume of the turtle's gut contents; therefore, even small quantities of debris can have severe health and fitness consequences (Bjorndal et al. 1994).

Sea turtles can also become entanglement in marine debris, namely fishing gear, which was discussed in Section 5.1.3.

5.1.6 Pollutants and Contaminants

Exposures to pollution and contaminants have the potential to cause adverse health effects in ESA-listed cetaceans and sea turtles. 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 2002). Sources of pollution within or adjacent to the action area include agricultural and industrial runoff/dumping, and oil and gas exploration and extraction, each of which can degrade marine habitats used by sea turtles.

Agricultural and industrial runoff into rivers and canals empty into bays and the ocean (e.g., Mississippi River into the Gulf of Mexico). Such runoff, especially from agricultural sources, is nutrient-rich from fertilizers containing nitrogen and phosphorous, and can cause eutrophication. Eutrophication occurs when an environment becomes nutrient-loaded, stimulating plankton and algae growth. This can lead to algal blooms, which create hypoxic (low-oxygen) waters within which most marine life cannot survive (also called "dead zones"). In these hypoxic zones and adjacent waters, pelagic marine life are displaced and many benthic organisms are lost (Rabalais and Turner 2001). For more information on how hypoxic zones affect the baseline, see Section 5.1.14.

Dumping of waste and sewage from shipping and ships used for coastal construction can also contribute to nutrient-loading and coastal pollution. Adjacent to the action area, ships must pass through the Houston Ship Channel, spanning from the Gulf of Mexico through Galveston Bay, just north of the action area, to reach the Port of Houston. The Houston Ship Channel is the busiest waterway in the U.S., with more than 8,300 large ships, 231,000 commercial small craft, and 230 million tons of cargo a year (TDOT 2016). As a result, the action area contains major shipping routes, increasing the risk for pollutants to enter the marine environment.

Chemical pollutants (e.g., DDT, PCBs, polybrominated diphenyl ethers, perfluorinated compounds, and heavy metals) accumulate up trophic levels of the food chain, such that high trophic level species like sea turtles have higher levels of contaminants than lower trophic levels (Bucchia et al. 2015; D'ilio et al. 2011; Mattei et al. 2015). These pollutants can cause adverse effects including endocrine disruption, reproductive impairment or developmental effects, and immune dysfunction or disease susceptibility (Bucchia et al. 2015; Ley-Quiñónez et al. 2011). In sea turtles, maternal transfer of persistent organic pollutants threatens developing embryos with a pollution legacy and poses conservation concerns due to its potential adverse effects on subsequent generations (Muñoz and Vermeiren 2020). Although there is limited information on chemical pollutants in sea turtles in the action area, there are studies that have investigated heavy metals, brevetoxins, and persistent organic pollutants in some sea turtle species in other areas of the Gulf of Mexico and adjacent waters. Two studies have investigated heavy metals in Kemp's ridley, loggerhead, hawksbill, and green turtles off eastern Texas and Louisiana (Kenyon et al. 2001; Presti et al. 2000). Heavy metal (mercury, copper, lead, silver, and zinc) concentrations in blood and scute (the scales on the shell, also known as carapace) samples increased with turtle size (Kenyon et al. 2001; Presti et al. 2000). After a red tide bloom near Florida's Big Bend, Perrault et al. (2017) found brevetoxins and heavy metals in Kemp's ridley and green turtles. Perrault et al. (2017) analyzed the turtles' health relative to the presence of brevetoxins and heavy metals, and found that the presence of toxic elements was related to oxidative stress, increased tumor growth, decreased body condition, inflammation, and disease progression.

Sea turtle tissues have been found to contain organochlorines and many other persistent organic pollutants. PCB 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 (Davenport et al. 1990; Orós et al. 2009). 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

5.1.7 Noise Pollution

The ESA-listed sea turtles 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 sound and commercial shipping), aircraft, 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. Anthropogenic noise is a known stressor that has the potential to affect sea turtles, although effects to sea turtles are not well understood. Within the action area, ESA-listed sea turtles may be impacted by anthropogenic sound in various ways. Responses to sound exposure may include lethal or nonlethal injury, permanent or temporary noise-induced hearing loss, behavioral harassment and stress, or no apparent response.

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/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 sperm whales from sound produced by geological and geophysical surveying activities and explosive removal of offshore structures.

NOAA has also implemented the 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. 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. In addition, 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; see also Haver et al. 2018). This network uses static passive acoustic monitoring (PAM) hydrophone (sound recorder) units to monitor trends and changes in the ambient sound field in U.S. federal waters.

Vessel Sound and Commercial Shipping

Individual 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. Sound levels are typically higher for the larger and faster vessels. Peak spectral levels for individual commercial vessels are in the frequency band of 10–50 Hz and range from 195 dB re 1 $\mu Pa^2/Hz$ at 1 m for fast-moving (greater than 37 km/hour) supertankers to 140 dB re 1 $\mu Pa^2/Hz$ at 1 m for smaller vessels (NRC 2003d). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels about 2 kHz, which may interfere with important biological functions of cetaceans (Holt 2008). At frequencies below 300 Hz, ambient sound levels are elevated by 15–20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013).

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 2003d; 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. In the Gulf of Mexico, shipping noise dominates the low frequency soundscape (Snyder and Orlin 2007). For example, ships must pass through the Houston Ship Channel, spanning from the Gulf of Mexico through Galveston Bay, to reach the Port of Houston. The Houston Ship Channel is the busiest waterway in the U.S., with more than 8,300 large ships, 231,000 commercial small craft, and 230 million tons of cargo a year (TDOT 2016), resulting in areas of high density vessel traffic adjacent to the action area.

Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kHz. The low frequency sounds from large vessels overlap with the estimated hearing ranges of sea turtles (approximately 50–1500 Hz; Dow Piniak et al. 2012) and may affect their behavior and hearing. There is limited published information on how these sounds may affect important biological functions of sea turtles. Analysis of sound from vessels revealed that their propulsion systems are a dominant source of radiated underwater sound at frequencies less than 200 Hz (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.

Sonar and Military Activities

Sonar systems are commonly used on commercial, recreational, and military vessels and may affect sea turtles. The action area may host many of these vessel types during any time of the year. Although little information is available on potential effects of multiple commercial and recreational sonars to ESA-listed sea turtles, 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).

Active sonar emits high-intensity acoustic energy and receives reflected and/or scattered energy. A wide range of sonar systems are in use for both civilian and military applications. The primary sonar characteristics that vary with application are the frequency band, signal type (pulsed or continuous), rate of repetition, and sound source level. Sonar systems can be divided into categories, depending on their primary frequency of operation; low-frequency for ≤ 1 kHz, mid-frequency for 1–10 kHz, high-frequency for 10–100 kHz; and very high-frequency for > 100 kHz (Hildebrand 2004). Low-frequency systems are designed for long-range detection (Popper et al. 2014a). The effective sound source level of a low-frequency airgun array, when viewed in the horizontal direction can be 235 dB re 1 μPa at 1 m or higher (Hildebrand 2004). Commercial sonars are designed for fish finding, depth sounds, and sub-bottom profiling. They typically generate sound at frequencies of 3–200 kHz, with sound source levels ranging from 150–235 dB re 1 μPa at 1 m (Hildebrand 2004). Depth sounders and sub-bottom profilers are operated primarily in nearshore and shallow environments; however, fish finders are operated in both deep and shallow areas.

Aircraft

Aircraft within the action area may consist of small commercial or recreational airplanes or helicopters, to large commercial airliners. These aircraft produce a variety of sounds that can potentially impact sea turtles. While it is difficult to assess these impacts, and there is little data on sea turtle response to aircraft, several studies have documented what appear to be minor cetacean behavioral disturbances in response to aircraft presence (Nowacek et al. 2007). Erbe et al. (2018) recorded underwater noise from commercial airplanes reaching as high as 36 dB above ambient noise. Sound pressure levels received at depth were comparable to cargo and container ships traveling at distances of 1–3 km (0.5–1.6 NM) away, although the airplane noises ceased as soon as the airplanes left the area, which was relatively quick compared to a cargo vessel. Green and hawksbill turtles showed no response to drones flying at a minimum of 10 m away (Bevan et al. 2018). While such noise levels are relatively low and brief, they still have the potential to be heard by sea turtles at certain frequencies. Nevertheless, noise from aircraft is expected to be minimal due to the location of the action area, which is not located near an airport and has sparse aircraft traffic.

Seismic Surveys

There are seismic survey activities involving towed airgun arrays that may occur within the action area. Airgun surveys are the primary exploration technique to locate oil and gas deposits (discussed in Section 5.1.4), 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 kHz (Goold and Coates 2006). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). Seismic surveys dominated the northern Gulf of Mexico soundscape (Estabrook et al. 2016; Wiggins et al. 2016); thus, noise produced by the seismic survey activities could impact ESA-listed 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 10–20 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 235–240 dB at dominant frequencies of 5–300 Hz (NRC 2003a). Most of the sound energy is at frequencies below 500 Hz, which is within the hearing range of sea turtles (Dow Piniak et al. 2012; Lavender et al. 2014). In the U.S., seismic surveys involving the use of airguns with the potential to take ESA-listed species, undergo formal ESA section 7 consultation. In addition, BOEM authorizes oil and gas activities in domestic waters, and the National Science Foundation and U.S. Geological Survey funds and/or conducts these seismic survey activities in domestic, international, and foreign waters. In doing so, these Federal agencies consult 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 (e.g., NMFS 2020; NMFS 2023a; NMFS 2023b).

5.1.8 Invasive Species

Aquatic nuisance species are nonindigenous species that threaten the diversity or abundance of native species, the ecological stability of infested waters, or any commercial, agricultural or recreational activities dependent on such waters. Aquatic nuisance species or invasive species include nonindigenous species that may occur within inland, estuarine, or marine waters and that presently or potentially threaten ecological processes and natural resources. Invasive species have been referred to as one of the top four threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007). Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove et al. 1998). A variety of vectors are thought to have introduced non-native species including, but not limited to aquarium and pet trades, recreation, and shipping. Shipping is the main vector of aquatic nuisance species (species hitchhiking on vessel hulls and in ballast water) in aquatic ecosystems; globally, shipping has been found to be responsible for 69% of marine invasive species (e.g., Drake and Lodge 2007; Keller and Perrings 2011; Molnar et al. 2008). Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002; Norse et al. 2005), potentially affecting prey availability and habitat suitability for ESA-listed species. They have been implicated in the endangerment of 48% of ESA-listed species (Czech and Krausman 1997). Currently, there is little information on the level of aquatic nuisance species and the impacts of these invasive species may have on sea turtles in the action area through the duration of the project. Therefore, the level of risk and degree of impact to ESA-listed sea turtles is unknown.

Lionfish (*Pterois* sp.) have become a major invasive species in the western North Atlantic Ocean and have rapidly dispersed into the Caribbean Sea and Gulf of Mexico. Since lionfish were first captured in the northern Gulf of Mexico in 2010 and 2011, they have rapidly dispersed throughout the northern Gulf of Mexico, with the western most collection of lionfish off Texas (Fogg et al. 2013). Lionfish are voracious predators to native fishes having decimated native fish populations on Caribbean reefs, have a broad habitat distribution, with few natural predators in the region (Ingeman 2016; Mumby et al. 2011). It is unclear what impact lionfish will have on prey species for Kemp's ridley and loggerhead sea turtles in the Gulf of Mexico portion of the action area. Although it is not possible to predict which aquatic nuisance species will arrive and thrive in the northwestern Gulf of Mexico, it is reasonably certain that they will be yet another facet of change and potential stress to native biota which may affect either the health or prey base of native fauna.

5.1.9 Dredging

Dredging involves the removal and relocation of submerged sediment in waterways, nearshore areas, and offshore, and supports activities such as maintaining coastal navigation channels, beach nourishment, levee construction, and coastal restoration. 29 of the Gulf of Mexico lease areas that BOEM manages within the action area host blocks with significant sediment resources that may be dredged (BOEM 2024). Dredging activities can pose significant impacts to aquatic ecosystems by: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant re-suspension; (4) sound/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat (Chytalo 1996; Winger et al. 2000).

Marine dredging vessels are common within U.S. coastal waters. Dredging may harm sea turtle species by injuring individuals with the equipment used or degrade and modify their foraging habitat (such as soft bottom and seagrass beds), affecting available food resources. Although the underwater sounds from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea turtles. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites ("borrow areas") have been identified as sources of sea turtle mortality. Hopper dredges can lethally harm sea turtles by entraining them in dredge drag arms and impeller pumps. Hopper dredges in the dredging mode are capable of moving relatively quickly and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes a resting or swimming organism.

To reduce take of listed species, relocation trawling may be utilized to capture and move sea turtles. In relocation trawling, a boat equipped with nets precedes the dredge to capture sea turtles and then releases the animals out of the dredge pathway, thus avoiding lethal take. Relocation trawling has been successful and routinely moves sea turtles in the Gulf of Mexico. In 2003, NMFS completed a regional biological opinion on USACE hopper dredging in the Gulf of Mexico that included impacts to sea turtles via maintenance dredging. NMFS determined that Gulf of Mexico hopper dredging would adversely affect four sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads) but would not jeopardize their continued existence. An ITS for those species adversely affected was issued.

Numerous other opinions have been produced that analyzed hopper dredging projects that did not fall under the scope of actions contemplated by the regional opinion, including: the dredging of Ship Shoal in the Gulf of Mexico Central Planning Area for coastal restoration projects in 2005, the Gulfport Harbor Navigation Project in 2007, the East Pass dredging in Destin, Florida in 2009, the Mississippi Coastal Improvements Program in 2010, and the dredging of City of Mexico beach canal inlet in 2012. Each of the above free-standing opinions had its own ITS and determined that hopper dredging during the proposed actions would not jeopardize the continued existence of any ESA-listed species, including sea turtles.

5.1.10 Construction and Operation of Public Fishing Piers

The Gulf coast experienced an active hurricane season in 2020, as well as a destructive Category 4 hurricane in 2021, which required the reconstruction and repairs of several fishing piers along Mississippi, Louisiana, and Alabama. The USACE permits the building of these structures and, in many of these cases, FEMA provides funding. Six FEMA funded projects along the Gulf coast were authorized in 2022 to repair piers damaged in recent storms. NMFS determined that the activities associated with the demolition/reconstruction/repair of each pier was not likely to adversely affect any ESA-listed species. However, NMFS also concluded that the fishing likely to occur following the completion of each pier project was likely to adversely affect certain species of sea turtles, but was not likely to jeopardize their continued existence. Incidental capture of sea turtles is generally nonlethal, though some captures result in severe injuries, which may later lead to death. Fishing effort is expected to continue at Gulf piers into the foreseeable future.

5.1.11 Research Permits

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 Atlantic Ocean, some of which extend into portions of the action area for the proposed action.

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 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.

There have been numerous research permits issued since 2009 under the provisions of both the Marine Mammal Protection Act 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 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.

5.1.12 Military Operations

Military testing and training affects listed species and their habitat through activities such as ordinance detonation, active sonar, and live munitions. 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 58% of the area. 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.

Formal consultations on overall U.S. Navy activities in the Atlantic have been completed by NMFS, including U.S. Navy's Activities in East Coast Training Ranges (June 1, 2011); U.S. Navy Atlantic Fleet Sonar Training Activities (AFAST; January 20, 2011); Navy AFAST LOA 2012-2014: U.S. Navy 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); and Navy's East Coast Training Ranges (Virginia Capes, Cherry Point, and Jacksonville; June 2010). These opinions concluded that, although there is a potential for some USN activities to affect sea turtles, those effects were not expected to impact any species on a population level. Therefore, the activities were determined to be not likely to jeopardize the continued existence of any ESA-listed species.

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 2018). The AFTT action area includes the Gulf of Mexico Range Complex which encompasses approximately 17,000 square nautical miles (NM^2) of sea and undersea space and includes 285 NM 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); Pensacola OPAREA off the coast of Florida west of the Panama City OPAREA (approximately 4,900 NM^2); New Orleans OPAREA off the coast of Louisiana (approximately 2,600 NM^2); and Corpus Christi OPAREA off the coast of Texas (approximately 6,900 NM^2). The AFTT Phase III opinion includes an ITS with exempted incidental take for ESA-listed sea turtles.

NMFS has completed consultations on Eglin Air Force Base testing and training activities in the Gulf of Mexico. These consultations concluded that the incidental take of sea turtles is likely to occur. These opinions included an ITS these actions: Eglin Gulf Test and Training Range (NMFS 2004b), the Precision Strike Weapons Tests (NMFS 2005a), the Santa Rosa Island Mission Utilization Plan (NMFS 2005b), Naval Explosive Ordnance Disposal School (NMFS 2004a), Eglin Maritime Strike Operations Tactics Development and Evaluation (NMFS 2013), and Ongoing Eglin Gulf Testing and Training Activities (NMFS 2017a). These consultations determined the training operations would adversely affect sea turtles but would not jeopardize their continued existence.

5.1.13 Aquaculture

Aquaculture is an emerging industry in the Gulf of Mexico, though there are currently no active commercial offshore aquaculture operations. In 2020, Presidential Executive Order 13921, “Promoting American Seafood Competitiveness and Economic Growth,” identified the U.S. Gulf of Mexico as one of the first regions to be evaluated for offshore aquaculture opportunities (85 FR 28471; May 12, 2020). Farmer et al. (2022b) developed a method to identify aquaculture opportunity areas (AOA’s) with the least conflict with protect species, including sea turtles. In November 2021, NOAA’s National Centers for Coastal Ocean Science published a comprehensive spatial modeling study, “An Aquaculture Opportunity Atlas for the U.S. Gulf of Mexico,” which identified nine potential options for AOA locations in federal waters in the Gulf of Mexico (Figure 8). These nine locations were identified using spatial suitability modeling intended to minimize conflicts with protected/sensitive species and habitats, as well as other ocean user groups, and included data layers relevant to administrative boundaries, national security (i.e., military), navigation and transportation, energy and industry infrastructure, commercial and recreational fishing, natural and cultural resources, and oceanography (i.e., non-living resources; Riley et al. 2021).

Aquaculture development may affect vulnerable anadromous and marine protected species, including sea turtles that rely on marine habitats (e.g., surface, mid-water, and benthic environments) for survival and reproductive success. Aquaculture impacts to protected species can vary across a range of activities, including environmental and cultural resource surveys, construction, operation and management, and farm decommissioning. Potential impacts can include attraction to farms or displacement from critical habitats, which can result in changes to distribution, behaviors, or social structures (Clement 2013). Physical interactions with gear, vessel traffic, noise, and light pollution can also result in injuries or mortalities (Farmer et al. 2022b).

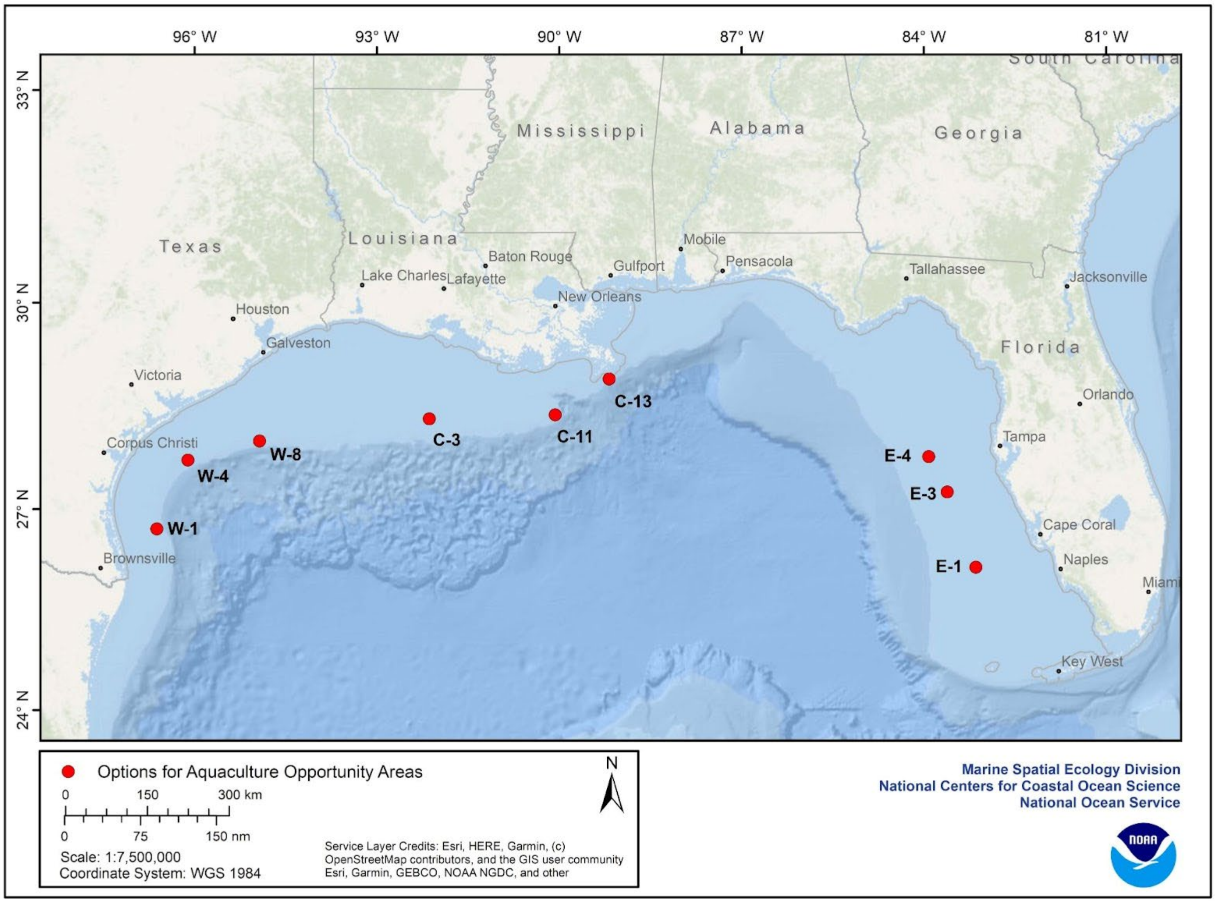

Figure 8. All nine potential location options for AOAs in federal waters in the Gulf of Mexico (Source: NCCOS 2023).

5.1.14 Nutrient Loading and Hypoxia

Nutrient loading from land-based sources, such as wastewater treatment plants and agriculture, and hypoxia remain a threat to protected species and their habitats and prey availability, which in turn can affect survival and reproductive fitness. In the Gulf of Mexico, eutrophication from both point and non-point sources produces a large area with seasonally depleted oxygen levels (< 2 milligrams/liter; Rabalais et al. 2010) on the Louisiana continental shelf. 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 km^2, 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. The Mississippi River/Gulf of Mexico Watershed Nutrient Task Force's 2023 Report to Congress found that determined that the midsummer extent of the hypoxic zone was 16,400 km^2 in 2021, and 8,480 km^2 in 2022 (US-HTF 2023). For 2024, NOAA measured a hypoxic zone in the Gulf of Mexico of 16,853 km^2, the 12th largest zone in 38 years of measurement (NCCOS 2024; NOAA 2024b). Low-oxygen waters can induce fish kills, alter fish diets, growth, and reproduction (Rose et al. 2018), reduce habitat use by shrimp species (Craig 2012), and affect the habitat of sea turtles. Warming waters (a result of climate change) will likely exacerbate hypoxic conditions along the Gulf of Mexico continental shelf, resulting in greater exposure to prolonged and sever hypoxic conditions (Laurent et al. 2018). Projected increases in precipitation over the next few decades in the Mississippi and Atchafalaya River Basin is anticipated to result in more water, sediment, and nutrients entering the coasts as well (US-HTF 2023).

In addition to inducing widespread hypoxia in the action area, nutrient loading and climate change can trigger the development of harmful algal blooms (HABs) in coastal waters. Excess nutrients from freshwater inputs enhance growth of phytoplankton that naturally occur in the ecosystem, forming “blooms” that can often produce a suite of toxins. The majority of HAB species observed in U.S. waters are present on the Gulf coast, and there are frequent blooms including, but not limited to, dinoflagellates *Karenia brevis, Alexandrium,* and *Dinophysis*, and diatom *Pseudo-nitzschia* in the Gulf of Mexico (Anderson et al. 2021). Recent assessments and improved ocean monitoring capabilities have shown that the frequency, duration, and toxicity of HABs in the U.S. may be increasing overall (Anderson et al. 2021). Ocean warming has fostered the geographic expansion of new HAB species into the Gulf of Mexico portion of the action area, such as Ciguatoxin-producing *Gambierdiscus* dinoflagellates into the northern Gulf of Mexico (Anderson et al. 2021). The various toxins produced by these species of HABs can biomagnify up the food chain, ultimately harming protected species (like sea turtles) when ingested (Perrault et al. 2021a); the toxins can affect neurological function, feeding and shelter behavior, and damage other organ systems. In the Gulf of Mexico portion of the action area, researchers have determined HABs to be the cause of marine mammal unusual mortality events (Fire et al. 2020), large-scale fish kills (Overstreet and Hawkins 2017), and sea turtle deaths (NOAA 2024c).

5.1.15 Impact of the Baseline on ESA-Listed Species

Collectively, the environmental baseline described above has had, and likely continues to have, lasting impacts on the ESA-listed species considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strikes), whereas others result in more indirect (e.g., fishing that impacts prey availability) or non-lethal (e.g., invasive species) impacts.

Assessing the aggregate impacts of these stressors on the species considered in this consultation is difficult. This difficulty is compounded by the fact that the sea turtle species in this consultation are wide-ranging and subject to stressors in locations throughout and outside the action area.

We consider the best indicator of the aggregate impact of the environmental baseline section on ESA-listed Kemp’s ridley and loggerhead turtles to be the status and trends of those species. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the activities described in the environmental baseline section. Therefore, while the stressors that affect the environmental baseline in the action area may slow their recovery, recovery is not being prevented. For the species that may be declining in abundance, it is possible that the suite of conditions described in the environmental baseline section is preventing their recovery. However, it is also possible that their populations are at such low levels (e.g., due to historical harvesting) that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself.

6. ANALYSIS OF EFFECTS

The ESA section 7 regulations (50 CFR §402.02) 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 but that are not part of the 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." To understand the effects of the action to listed species and critical habitats, we employ a stressor-exposure-response analysis. The stressors resulting from this action were identified in Section 2.4 and the only stressor analyzed as LAA, in this and subsequent sections, is the underwater acoustic effects from explosive events in the Gulf of Mexico portion of the action area. The following analysis is structured to separately assess the exposure of listed species, followed by separate assessments of the responses of listed species to that exposure. To conclude this section, we summarize the combination of exposure and response for each species.

6.2 Exposure

In this section, we consider the exposures to the various stressors that could cause an effect to ESA-listed species that are likely to co-occur with the action's modifications to the environment in space and time, and identify the nature of that co-occurrence. We describe the timing and location of the stressors to identify the populations, life stages, or sexes of each listed species likely to be exposed. We also describe the duration, frequency, and intensity of stressors to quantify the number of exposures that are reasonably certain to occur. We then determine to which populations those exposed individuals belong.

6.2.1 ESA-Listed Sea Turtle Exposures

The ESA-listed sea turtles that are likely to be adversely affected by underwater acoustic effects from explosive events in the Gulf of Mexico portion of the action area are Kemp's ridley turtle and Northwest Atlantic Ocean DPS of loggerhead turtle. As discussed in Section 4.2, these species' hearing ranges encompass the frequencies from an explosive event. To estimate the number of sea turtles that would be exposed to underwater sound from the explosive event(s), FAA adopted SpaceX's methodology summarized in Section 4.1.2.1. Sea turtle densities were obtained from Garrison et al. (2023b). NMFS acoustic thresholds corresponding to ESA harassment and harm were applied to estimate the number of individuals of each species that would be exposed to and potentially respond to the underwater sound from a maximum of 20 Super Heavy explosions (Table 17).

Table 17. Exposure estimates for ESA-listed sea turtles in the Gulf of Mexico portion of the action area

Species	Threshold* (dB re 1µPa)	Ensonified Area (km^2)	Maximum Density (individuals per km^2)	Estimated Individuals Exposed	Individuals Exposed
Kemp's Ridley Turtle	226	0.09	4.5879760	8.258	9
	232	0.02	4.5879760	1.835	2
Loggerhead Turtle	226	0.09	3.5252770	6.345	7
	232	0.02	3.5252770	1.41	2

* Note peak sound pressure level thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

Kemp's ridley and loggerhead hatchlings, juveniles, and adults of either sex are likely to be exposed during the explosive events. Given that up to 20 explosive events will occur March–October 2025, we expect that animals will be foraging, mating, nesting, hatching, or transiting in the Gulf of Mexico portion of the action area.

It should be noted that the exposure numbers are expected to be conservative because the maximum densities were used to estimate exposure. The maximum densities for Kemp's ridley and loggerhead sea turtles occur in a relatively small part of the more nearshore waters of the Gulf of Mexico portion of the action area. Thus, these exposure numbers are likely an overestimate of the actual number of Kemp's ridley and loggerhead turtles exposed to the underwater sound from the explosive events.

Kemp's Ridley Turtle – The estimated exposure is 11 individuals. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate an in-water abundance of juvenile and adult Kemp's ridley sea turtles along the U.S. Atlantic Coast of 10,762 turtles. Given this population estimate, the estimated exposure of 11 individuals is approximately 0.1% of the population. This estimate is likely higher than the actual exposures for reasons previously described, and because this population estimate is not complete and does not include turtles from the population's entire range.

Northwest Atlantic Ocean DPS Loggerhead Turtle – The estimated exposure of the population is nine individuals. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate an in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 turtles. Based on this population estimate, the estimated exposure of nine individuals is approximately 0.005% of the population. This estimate is likely higher than the actual exposures for reasons previously described, and because this population estimate did not include the entire range of the DPS.

6.3 Response

Given the potential for exposure to stressors associated with the explosive events discussed above, in this section, we describe the range of responses ESA-listed Kemp's ridley and loggerhead sea turtles may display as a result of exposure to those stressors from explosive events that are likely to adversely affect listed species. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals.

6.3.1 ESA-Listed Sea Turtle Responses

For species, we discuss responses in terms of physiological, physical, or behavioral effects to the species. These responses may rise to the level of *take* 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)). NMFS has a definition for the term *harass*, which is to create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (NMFS Policy Directive 02-110-19). *Harm* is defined as an act that 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 (50 CFR §222.102).

Super Heavy explosions transmit a portion of acoustic energy into the water, creating a wave of pressure that can affect ESA-listed Kemp's ridley and loggerhead sea turtles considered in this opinion. Possible sea turtle responses include hearing threshold shifts, behavioral responses, physiological stress, and masking.

Hearing Threshold Shifts

Sea turtles are susceptible to noise-induced hearing loss, or noise-induced threshold shifts (i.e., a loss of hearing sensitivity), when exposed to high levels of sound within their limited hearing range (most sensitive from 100 to 400 Hz and limited over 1 kHz). Types of hearing threshold shifts include temporary threshold shift (TTS), where the hearing threshold eventually returns to normal, or a permanent threshold shift (PTS) where the hearing threshold remains elevated after an extended period. Explosive events are a broadband source (Hildebrand 2009a), so if a sea turtle experiences TTS or PTS from an explosive event, a greater frequency band would be affected compared to TTS or PTS from narrow-band sources (e.g., like sonar).

Because a greater frequency band would be affected due to explosives, there is an increased chance that the hearing impairment will affect frequencies utilized by sea turtles for acoustic cues, such as the sound of waves, coastline noise, or the presence of a vessel or predator. However, sea turtles are not known to rely heavily on sound for life functions (Nelms et al. 2016; Popper et al. 2014b) and instead may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al. 2013) and magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015). As such, the likelihood that the loss of hearing in a sea turtle would impact its fitness (i.e., survival or reproduction) is low when compared to marine mammals, which rely heavily on sound for basic life functions. Sea turtles may use acoustic cues such as waves crashing, wind, vessel and/or predator noise to perceive the environment around them. If such cues increase survivorship (e.g., aid in avoiding predators, navigation), hearing loss may have effects on individual sea turtle fitness. TTS in sea turtles is expected to last for a few hours to days, depending on the severity. TTS can significantly disrupt a turtle's normal behavior patterns for the duration over which their hearing threshold has been altered. However, given TTS is temporary and sea turtles are not known to rely heavily on acoustic cues, we do not anticipate that TTS exposure would result in fitness impacts on individual turtles. PTS could permanently impair a sea turtle's ability to hear environmental cues, depending on the frequency of the cue and the frequencies affected by the hearing impairment. Given this longer time frame, we anticipate that at least some sea turtles that experience PTS may have a reduction in fitness either through some slight decrease in survivorship (e.g., decreased ability to hear predators or hazards such as vessels) or reproduction (e.g., minor effects to the animal's navigation that may reduce mating opportunities).

Behavioral Responses

Any acoustic stimuli within sea turtle hearing ranges in the marine environment could elicit behavioral responses in sea turtles, including noise from explosive events. Based on a limited number of studies, sea turtle behavioral responses to impulsive sounds could consist of temporary avoidance, increased swim speed, startle response, dive response, changes in depth; or there may be no observable response (McCauley et al. 2000; O'Hara and Wilcox 1990; Kastelein et al. 2024; DeRuiter and Doukara 2012). There is no evidence to suggest that any sea turtle behavioral response to acoustic stressors would persist after the sound exposure.

Exposure to a single explosive event (which applies here because, although there could be up to 20 explosive events, explosive events will not happen in succession) will likely result in a short-term startle response. Sea turtles would presumably return to normal behaviors quickly after exposure to a single explosive event, assuming the exposure did not result in TTS or PTS. Significant behavioral responses that result in disruption of important life functions are not likely to occur with a single explosive event. Therefore, while a large number of sea turtles may experience a behavioral response from exposure to explosive events, the anticipated impacts on fitness and survival of these individuals are minor and short-term.

Physiological Stress

ESA-listed sea turtles that experience either TTS, PTS, or a significant behavioral response are also expected to experience a physiological stress response. A short, low-level stress response may be adaptive and beneficial for sea turtles in that it may result in sea turtles avoiding the stressor and minimizing their exposure. Whereas stress is an adaptive response that does not normally place an animal at risk, distress involves a chronic stress response resulting in a negative biological consequence to the individual. Stress responses from underwater acoustic effects of the explosive events are expected to be short-term in nature given that, in most cases, sea turtles would not experience repeated exposure to these stressors over a long period of time. As such, we do not anticipate stress responses would be chronic, involve distress, or have negative long-term impacts on any individual sea turtle's fitness.

Masking

Sea turtles likely use their hearing to detect broadband low-frequency sounds in their environment, so the potential for masking would be limited to sound exposures that have similar characteristics (i.e., frequency, duration, and amplitude). Continuous and near-continuous human-generated sounds that have a significant low-frequency component, are not brief, and are of sufficient received level (e.g., proximate vessel noise and high-duty cycle or continuous active sonar), are most likely to result in masking. Explosive events, even though they have low-frequency components, would have limited potential for masking because they are of short duration. Because sea turtles may rely primarily on senses other than hearing for interacting with their environment, any effect of masking may be mediated by reliance on other environmental inputs.

6.4 Summary of Effects

In this section, we combine the exposure analysis and response analysis to produce estimates of the amount and type of incidental take anticipated caused directly or indirectly by the stressors resulting from this action. This summary of the anticipated effects of the action considers all consequences caused by the action and its activities. The following subsections state the anticipated effects of the action for each species.

6.4.1 Kemp's Ridley Turtle

We expect up to nine Kemp's ridley turtles to be exposed to underwater sound from Super Heavy explosive events within the 226 dB re 1µPa ensonified area and exhibit responses in the form of ESA harassment. We also expect up to two Kemp's ridley turtles to be exposed to underwater sound from Super Heavy explosive events within the 232 dB re 1µPa ensonified area and exhibit responses in the form of ESA harm.

As described above, the proposed action will result in ESA harassment (in the form of TTS), which may affect Kemp's ridley turtles' normal behavioral patterns but is not expected to reduce individual fitness. ESA harm (in the form of PTS) could permanently impair a sea turtle's hearing and result in a reduction in fitness either through some decrease in survivorship or reproduction. The estimated number of Kemp's ridley turtles exhibiting measurable responses are likely higher than what the actual exposures would be, and lower numbers are likely to be harassed or harmed given the use of the maximum density when calculating exposures. We do not expect the effects of ESA harassment or harm of Kemp's ridley turtles will have population-level effects.

6.4.2 Loggerhead Turtle – Northwest Atlantic Ocean DPS

We expect up to seven Northwest Atlantic Ocean DPS loggerhead turtles to be exposed to underwater sound from Super Heavy explosive events within the 226 dB re 1µPa ensonified area and exhibit responses in the form of ESA harassment. We also expect up to two Northwest Atlantic Ocean DPS loggerhead turtles to be exposed to underwater sound from Super Heavy explosive events within the 232 dB re 1μPa ensonified area and exhibit responses in the form of ESA harm.

As described above, the proposed action will result in ESA harassment (in the form of TTS), which may affect Northwest Atlantic Ocean DPS loggerhead turtles' normal behavior patterns but is not expected to reduce individual fitness. ESA harm (in the form of PTS) could permanently impair a sea turtle's hearing and result in a reduction in fitness either through some decrease in survivorship or reproduction. The estimated number of Northwest Atlantic Ocean DPS loggerhead turtles exhibiting measurable responses are likely higher than what the actual exposures would be, and lower numbers are likely to be harassed or harmed given the use of the maximum density when calculating exposures. We do not expect the effects of ESA harassment or harm of the Northwest Atlantic Ocean DPS of loggerhead turtle will have population-level effects.

7. Cumulative Effects

Cumulative effects are defined in regulations as "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 CFR §402.02). 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(a)(2) of the ESA.

We assessed the action area of this consultation for any non-Federal activities that are reasonably certain to occur. The past and ongoing impact of existing actions was described in the environmental baseline (Section 5). During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than the activities described in the environmental baseline.

An increase in non-Federal activities described in the environmental baseline (Section 5) could increase their effect on ESA-listed resources and, for some, an increase in the future is considered reasonably certain to occur. Given current trends in global population growth, threats associated with climate change, pollution, fisheries, bycatch, aquaculture, vessel strikes, and sound are likely to continue to increase in the future, although any increase in effect may be somewhat countered by an increase in conservation and management.

8. Integration and Synthesis

This opinion includes a jeopardy analysis for the ESA-listed threatened and endangered species that are likely to be adversely affected by the action. Section 7(a)(2) of the Act and its implementing regulations require every federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species. The jeopardy analysis, therefore, relies upon the regulatory definitions of *jeopardize the continued existence of*.

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 a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). *Recovery*, used in that definition, means "improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act" (50 CFR §402.02).

The Integration and Synthesis is the final step in our jeopardy analyses. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7), taking into account the status of the species, critical habitat, and recovery planning (Section 4), to formulate the agency's biological opinion as to whether the action agency can insure its proposed action is not likely to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution.

8.1 Jeopardy Analysis

The jeopardy analysis assesses the proposed action's effects on ESA-listed species' survival and recovery. The following sections summarize the relevant information in this opinion for each individual species considered.

8.1.1 Kemp's Ridley Turtle

The Kemp's ridley turtle has declined to the lowest population level of all sea turtle species in the world. Nesting aggregations at a single location (Rancho Nuevo, Mexico), which were estimated at 40,000 females in 1947, declined to an estimated 300 females by the mid-1980s. From 1980 through 2003, largely due to conservation efforts, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico increased 15% annually (Heppell et al. 2005). By 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from these three primary nesting beaches. Because females lay approximately 2.5 nests each season they nest, 10,987 nests represents 4,395 females nesting in a season at these primary nesting sites. Increases in nest counts have also been documented over the past two decades at nesting beaches in Texas (NMFS and USFWS 2015). DiMatteo et al. (2024) modeled survey data to estimate an in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 turtles.

Kemp's ridley turtles are expected to experience TTS, PTS, and behavioral and physiological stress responses throughout the Gulf of Mexico portion of the action area from Super Heavy explosive events. FAA and SpaceX predict nine instances of TTS and two instances of PTS are reasonably certain to occur over the 20 anticipated explosive events.

As discussed in Section 6.3.1, PTS could decrease an individual sea turtle's ability to detect danger such as approaching vessels or predators; and may reduce foraging or breeding opportunities or increase risks of sustaining other harm. Therefore, PTS could result in mortality or injury of two individuals, leading to a slight reduction in numbers. This reduction in numbers, as well as the effects of TTS and behavioral responses in nine other individuals, will not have a measureable impact on the reproduction of the species. The anticipated effects leading to TTS in nine individuals and PTS in two individuals will not affect the distribution of this species.

Therefore, the minor reduction in numbers and associated reduction in reproduction, along with the lack of impacts to the distribution of the species will not have measurable impacts to the populations to which these individuals belong. Thus, the effects of the stressors resulting from explosive events as part of the proposed action will not affect the survival of Kemp's ridley sea turtles in the wild.

The 2011 Bi-National Revised Recovery Plan for the Kemp's Ridley Sea Turtle identified the major actions needed to recover this species (NMFS et al. 2011). Relevant to the proposed action, this includes reducing impacts from explosives. Demographic recovery criteria for downlisting the species include the following: 1) a population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico; and 2) recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches. Demographic recovery criteria for delisting the species include the following: 1) an average population of at least 40,000 nesting females per season (as measured by clutch frequency per female per season and annual nest counts) over a 6-year period distributed among nesting beaches in Mexico and the U.S.; and 2) ensure average annual recruitment of hatchlings over a 6-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S. into the future. While we do anticipate Kemp's ridley turtles will be harassed and harmed from explosive events, this will not result in an appreciable reduction in the population numbers or reproductive rate of Kemp's ridley turtles that are important elements in the recovery of the species. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not affect the ability of Kemp's ridley sea turtles to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, effects resulting from stressors caused by the proposed action, are not expected to appreciably reduce the likelihood of the survival of Kemp's ridley turtles in the wild by reducing the reproduction, numbers, or distribution of the species. Similarly, the effects resulting from stressors caused by the proposed action, are not expected to appreciably reduce the likelihood of recovery of Kemp's ridley turtles in the wild. Thus, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of Kemp's ridley turtles in the wild.

8.1.2 Loggerhead Turtle – Northwest Atlantic Ocean DPS

The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead sea turtles from Texas through Virginia and Quintana Roo, Mexico, is over 110,000 (NMFS and USFWS 2023). NMFS's NEFSC and SEFSC estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, at 588,000 individuals (NMFS 2011). A aerial survey over the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, estimated an abundance ranging from 27,508–3,005 loggerheads (NMFS and USFWS

2023). Ceriani et al. (2019) estimated the total number of adult females nesting in Florida to be 51,319, based on nest count data from 2014–2018. The annual rate of nesting females increased 1.3% from 1983–2019 for the Northern Recovery Unit (i.e., loggerheads nesting in Georgia, North Carolina, South Carolina, and Virginia; Bolten et al. 2019; NMFS and USFWS 2023). There is no significant trend in the annual number of nesting females in either the Peninsular Florida (1989–2018) or Northern Gulf of Mexico (1997–2018) units over the last several decades (NMFS and USFWS 2023). Overall, the latest 5-year status review concluded that the Northwest Atlantic DPS is stable (NMFS and USFWS 2023). DiMatteo et al. (2024) modeled survey data to estimate an in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 turtles. We are not aware of any current range-wide in-water estimates for the DPS.

Northwest Atlantic Ocean DPS loggerhead turtles are expected to experience TTS, PTS, and behavioral and physiological stress responses throughout the Gulf of Mexico portion of the action area from Super Heavy explosive events. FAA and SpaceX predict seven instances of TTS and two instances of PTS are reasonably certain to occur over 20 explosive events.

As discussed in Section 6.3.1, PTS could decrease an individual sea turtle's ability to detect danger such as approaching vessels or predators; and may reduce foraging or breeding opportunities or increase risks of sustaining other harm. Therefore, PTS could result in mortality or injury of two individuals, leading to a slight reduction in numbers. This reduction in numbers, as well as the effects of TTS and behavioral responses in seven other individuals, will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS in seven individuals and PTS in two individuals will not affect the distribution of this species.

Therefore, the minor reduction in numbers and associated reduction in reproduction, along with the lack of impacts to the distribution of the species will not have measurable impacts to the populations to which these individuals belong. Thus, the effects of the stressors resulting from explosive events as part of the proposed action will not affect the survival of loggerhead sea turtles in the wild.

The 2009 Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle identified the major actions needed to recover this DPS (NMFS and USFWS 2008). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that explosives can affect loggerheads and cause negative impacts including, but not limited to, injury and mortality. Demographic recovery criteria include the following statistically significant minimum levels of increase in the annual number of loggerhead nests over 50 years for each recovery unit: 1) Northern Recovery Unit: 2% (minimum of 14,000 nests); 2) Peninsular Florida Recovery Unit: 1% (minimum of 106,100 nests); 3) Dry Tortugas Recovery Unit: 3% (minimum of 1,100 nests); and 4) Northern Gulf of Mexico Recovery Unit: 3% (minimum of 4,000 nests). While we do anticipate Northwest Atlantic Ocean DPS loggerhead turtles will be harassed and harmed from explosive events, this will not result in an appreciable reduction in the population numbers or reproductive rate of Northwest Atlantic Ocean DPS loggerhead turtles. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not affect the ability of loggerhead sea turtles to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, effects resulting from stressors caused by the proposed action, are not expected to appreciably reduce the likelihood of the survival of Northwest Atlantic Ocean DPS loggerhead turtles in the wild by reducing the reproduction, numbers, or distribution of the species. Similarly, the effects resulting from stressors caused by the proposed action, are not expected to appreciably reduce the likelihood of recovery of Northwest Atlantic Ocean DPS loggerhead turtles in the wild. Thus, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of Northwest Atlantic Ocean DPS loggerhead turtles in the wild.

9. CONCLUSION

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the consequences of the proposed action and associated activities, and the cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Kemp's ridley turtle or Northwest Atlantic Ocean DPS of loggerhead turtle.

Section 4.1.2 determined the effects of exposure were discountable or a response would be insignificant and, therefore, the effects of this action may affect, but are not likely to adversely affect: blue whale, false killer whale – Main Hawaiian Islands Insular DPS, fin whale, gray whale – Western North Pacific DPS, humpback whale – Mexico DPS and Central America DPS, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, Hawaiian monk seal; green turtle – North Atlantic DPS, South Atlantic DPS, East Pacific DPS, Central North Pacific DPS, East Indian-West Pacific DPS, North Indian DPS, and Southwest Indian DPS, hawksbill turtle, leatherback turtle, loggerhead turtle – North Pacific Ocean DPS, South Pacific Ocean DPS, North Indian Ocean DPS, Southwest Indian Ocean DPS, and Southeast Indo-Pacific Ocean DPS, and olive ridley turtle – Mexico's Pacific Coast breeding colonies and all other areas/not Mexico's Pacific Coast breeding colonies; Atlantic sturgeon – Carolina DPS and South Atlantic DPS, giant manta ray, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, scalloped hammerhead shark – Eastern Atlantic DPS, Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS, shortnose sturgeon, smalltooth sawfish – U.S. portion of range DPS, steelhead trout – South-Central California Coast DPS and Southern California DPS, and black abalone.

Section 4.1.3 determined the effects of the proposed action may affect, but are not likely to adversely affect, designated critical habitat of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, black abalone, and proposed critical habitat of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle and Rice's whale.

10. 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 actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR §222.102). NMFS has defined the term “harass” in policy (PD 02-110-19) as to create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR §402.02). Section 7(b)(4) and section 7(o)(2) of the ESA, as well as in regulation at 50 CFR §402.14(i)(5) 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.

10.1 Amount or Extent of Take

In the opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Table 18. Number and type of ESA takes of sea turtles as a result of up to 20 Super Heavy explosive events

Species	Harassment (TTS/ significant behavioral response)	Harm (PTS)
Kemp’s Ridley Turtle	9	2
Loggerhead Turtle – Northwest Atlantic Ocean DPS	7	2

Up to nine Kemp’s ridley turtles and seven Northwest Atlantic Ocean DPS loggerhead turtles, of either sex and any age class, are expected to be taken by ESA harassment. Up to two Kemp’s ridley turtles and two Northwest Atlantic Ocean DPS loggerhead turtles, of either sex and any age class, are expected to be taken by ESA harm.

10.2 Reasonable and Prudent Measures

“Reasonable and prudent measures” are measures that are necessary or appropriate to minimize the impact of incidental take on the species (50 CFR §402.02). These measures “cannot alter the basic design, location, scope, duration, or timing of the action and may involve only minor changes” (50 CFR §402.14(i)(2)). NMFS believes the following reasonable and prudent measures are necessary and appropriate:

1. The FAA shall minimize effects to ESA-listed Kemp’s ridley and loggerhead sea turtle from explosive events.

2. The FAA shall monitor and report to NMFS's Office of Protected Resources ESA Interagency Cooperation Division on impacts to ESA-listed Kemp's ridley and loggerhead sea turtles from explosive events at nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2024-01147 FAA Starship-Super Heavy Increased Launch Cadence – [Flight #] ITS Report."

10.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the FAA must comply (or must ensure that any applicant complies) with the following terms and conditions. The FAA or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR §402.14(i)(3)).

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. The FAA shall continue to coordinate with NMFS to help inform future consultations on Starship-Super Heavy operations in the action area. Coordination should include review of Starship-Super Heavy fate reports and annual reports, review of ESA section 7 reinitiation triggers (described in Section 12), and potential new measures to increase the effectiveness of mitigation and monitoring.

2. The following terms and conditions implement reasonable and prudent measure 2:
    a. The FAA shall monitor SpaceX and Starship-Super Heavy operations as licensed, and submit fate reports after each Starship-Super Heavy flight and annual reports to NMFS Office of Protected Resources ESA Interagency Cooperation Division.
    b. The FAA shall report any new information regarding the potential effects and ranges to effects used in our analysis of effects of explosive events on ESA-listed species.
    c. The FAA shall report to the NMFS Office of Protected Resources ESA Interagency Cooperation Division all observed injury or mortality of any ESA-listed species resulting from the proposed action within the action area.
    d. The FAA shall report to the NMFS Office of Protected Resources ESA Interagency Cooperation Division on impacts to ESA-listed Kemp's ridley and loggerhead sea turtles from explosive events. The report should be submitted no more than 30 days after each flight prior to reusability. This may be submitted with the fate report.

11. Conservation Recommendations

Conservation recommendations are "suggestions … regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information" (50 CFR §402.02).

The following conservation recommendations should be considered by the FAA to minimize or avoid effects to threatened and endangered species associated with this action:

1. We recommend FAA gather acoustic data (in-air and in-water) on Super Heavy and Starship explosive events. Sound source verification will help to more accurately determine the impacts of explosive events in the future.
2. During any nighttime vessel operations in any action area, we recommend vessel speeds do not exceed 10 knots to reduce the risk of lethal or injurious vessel strike. We also recommend that dedicated observers be equipped with nighttime visual equipment to identify protected species in the dark.
3. We recommend FAA monitor potential impacts to ESA-listed species and designated or proposed critical habitat from debris resulting from space launch and reentry activities. This includes immediate impacts (e.g., reentry debris fields, stage expenditures), as well as potential long-term impacts from the accumulation of debris.
4. We recommend FAA monitor potential impacts to ESA-listed species and designated or proposed critical habitat from barge/floating platform landings (e.g., verification of overpressures, light pollution).
5. The FAA should coordinate with the NOAA Marine Debris Program (MDP) to determine how activities of the MDP may apply to space launch and reentry debris.

In order for NMFS Office of Protected Resources Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on ESA-listed species or their critical habitat, FAA should notify the Interagency Cooperation Division of any conservation recommendations implemented in the final action. Notice can be provided to nmfs.hq.esa.consultations@noaa.gov with the ECO number for this consultation (OPR-2024-01147) in the subject line.

12. REINITIATION OF CONSULTATION

This concludes formal consultation on FAA's proposed action to modify and issue vehicle operator license(s) authorizing SpaceX to conduct up to 145 launches annually of their Starship-Super Heavy launch vehicle including operations in the North Atlantic Ocean, Gulf of Mexico, North Pacific Ocean, South Pacific Ocean, and Indian Ocean. Consistent with 50 CFR §402.16(a), reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

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

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