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 (non-U.S. waters), Gulf of America, 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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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 or proposed 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, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. 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 reinitiated consultation and conference is the Federal Aviation Administration (FAA). The Space Exploration Technologies Corporation (SpaceX) is the applicant. The FAA proposes to modify and issue a vehicle operator license authorizing SpaceX to conduct launches of SpaceX's Starship-Super Heavy launch vehicle, including Super Heavy landings in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), and Gulf of America[1], and Starship landings in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), Gulf of America, North Pacific Ocean, South Pacific Ocean, and Indian Ocean.

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 affirms 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 conference and biological opinion (opinion) and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402. The following listed and proposed species, and designated and proposed critical habitat, were considered in this consultation and conference: 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

[1] OPR-2024-01147, issued on January 17, 2025, referred to this area as the Gulf of Mexico. In accordance with Presidential Executive Order 14172, "Restoring Names that Honor American Greatness," we are updating this opinion to refer to the area formerly known as the Gulf of Mexico (U.S. waters), to the Gulf of America. We note that there are citations and references in this opinion that published prior to Executive Order 14172 and refer to the Gulf of America by its former name, the Gulf of Mexico. In those cases, and cases where 'Gulf of Mexico' is part of a formal name (e.g., loggerhead turtle Northern Gulf of Mexico Recovery Unit), we have not updated accordingly, because, at the time of this consultation, those names and references have not been updated.

Pacific Coast breeding colonies and all other areas/not Mexico's Pacific Coast breeding colonies; Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS, Chesapeake Bay 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*) – 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*), boulder star coral (*Orbicella franksi*), elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), pillar coral (*Dendrogyra cylindrus*), rough cactus coral (*Mycetophyllia ferox*), staghorn coral (*Acropora cervicornis*), proposed sunflower sea star (*Pycnopodia helanthoides*); 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, North Atlantic right whale, leatherback turtle, North Atlantic DPS of green turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, 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 National Oceanic and Atmospheric Administration (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).

This opinion (OPR-2025-00164) is a reinitiation of OPR-2024-01147. In OPR-2024-01147, the FAA proposed to modify and issue a vehicle operator license authorizing SpaceX to conduct Starship-Super Heavy launch and reentry operations, with Starship and Super Heavy landings occurring at least five nautical miles (NM) from shore: Super Heavy in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), and Gulf of America, and Starship in the North Pacific Ocean, South Pacific Ocean, and Indian Ocean. After our biological opinion was issued on January 17, 2025 concluding consultation (OPR-2024-01147), the FAA submitted a series of documents to NMFS regarding changes to the action after SpaceX notified FAA of these changes. The changes to the action are as follows: 1) the inclusion of Starship landings in all portions of the action area; 2) the expansion of the Gulf and Atlantic Ocean portions of the action area to include Starship and Super Heavy landings 1–5 NM from shore; 3) the consideration of a maximum of 20 explosive events, 25 soft water landings (with no explosive events), and 25 in-flight breakups of each vehicle in each portion of the action area; and 4) the extension of the timeline to reach a fully reusable vehicle (a fully reusable vehicle will be achieved October 2030).

This reinitiated opinion (OPR-2025-00164) considers the changes to the action and supersedes OPR-2024-01147.

1.2 Consultation History

- **January 28, 2025:** FAA submitted, via email to NMFS, an addendum to the proposed action consulted on in OPR-2024-01147, to include Starship contingency landings 1–5 NM from shore in the Gulf portion of the action area.
- **January 31, 2025:** NMFS requested, via email to FAA, additional information on the Starship contingency landings, including how Starship will be recovered, clarification on ensonified areas from explosive events, and potential mitigation measures.
- **February 12, 2025:** FAA provided, via email, revised boundaries of the Hawaii and Central North Pacific portion of the action area and conveyed SpaceX's concerns regarding two conservation measures related to North Atlantic right whales that were agreed upon and included in OPR-2024-01147.
- **February 14, 2025:** SpaceX, through FAA, provided responses, via email, to some of NMFS's January 31, 2025 requests for additional information.
- **February 20, 2025:** Via email to FAA, NMFS summarized telephone calls with FAA, confirming: 1) Starship recovery actions are not included in the consultation because they are not part of FAA's federal action; and 2) NMFS will include forthcoming Starship contingency landings in the Atlantic Ocean portion of the action area in the same consultation as the Starship contingency landings in the Gulf portion of the action area in order to ensure maximum efficiency.
- **March 11, 2025:** FAA submitted, via email to NMFS, a second addendum to the proposed action, including Starship contingency landings 1–5 NM from shore in the Atlantic Ocean portion of the action area, Starship operational landings in the Atlantic Ocean portion of the action area, and an extension of the time over which vehicles may be expended. NMFS requested, via email to FAA, clarification of the action area. On March 14, 2025, FAA requested the consultation be completed by the end of March 2025.
- **March 17, 2025:** NMFS requested, via email, additional information on the various changes to FAA's proposed action. These included clarification of the action area; number of explosive events, soft water landings, and in-flight breakups; landing locations; reporting requirements from previous consultations covering portions of SpaceX Starship-Super Heavy launch and reentry activities (OPR-2024-01147 and OPR-2024-00211); and revisions to the conservation measures associated with the changes to the action.

- **March 20, 2025:** NMFS and FAA met to discuss the necessary time to complete the reinitiated consultation. Given the extensive additional information needed to understand and analyze the nature and scope of the proposed action, which was still in flux, NMFS agreed to expedite the consultation's completion by April 18, 2025, in advance of FAA's license issuance. On March 21, 2025, NMFS met with FAA and SpaceX to clarify the changes to the proposed action. On the same day, SpaceX and NMFS continued to clarify the changes to the action and action areas via email. On March 21, 24, and 26, 2025, SpaceX provided responses, via email, to some of NMFS's March 17, 2025 requests for additional information and questions discussed in the March 21, 2025 meeting.
- **March 28, 2025:** FAA submitted, via email to NMFS, a revised addendum to the proposed action. The revised addendum did not differentiate between Starship contingency landings and operational landings, and included landing burns for all vehicle landings (landing burns are conducted to slow the vehicle for landing and require a large amount of propellant). Including landing burns for all vehicle landings are anticipated to result in much smaller explosive events than considered in OPR-2024-01147. On March 31, 2025, during a telephone call with FAA, NMFS requested clarification of discrepancies in the revised addendum related to the number of explosive events, soft water landings, and in-flight breakups that may occur before the vehicle achieves full reusability. During another telephone call on the same day, FAA notified NMFS that another revised addendum would be submitted.
- **April 1, 2025:** FAA submitted, via email to NMFS, a revised addendum to the proposed action, which did not consider landing burns. Excluding landing burns are anticipated to result in much larger explosive events (as considered in OPR-2024-01147), and would give FAA flexibility in ESA coverage while SpaceX's launch vehicle is still in development. On April 2, 2025, in an effort to expedite the process, NMFS responded to FAA via email and relayed our conclusions on discrepancies between the revised addendum and previous addenda or discussions. These included discrepancies related to vehicle landings in the expanded Gulf and Atlantic Ocean portions of the action area, recovery of Starship, and species densities. On April 3, 2025, NMFS received final responses from FAA clarifying vehicle landings in the expanded Gulf and Atlantic Ocean portions of the action area, and concurring with NMFS's conclusions that Starship recovery actions are not included in the consultation because they are not part of FAA's federal action, and that NMFS will conduct analyses to determine the appropriate species densities for the expanded Gulf and Atlantic Ocean portions of the action area.

1.3 Analytical Approach

This opinion includes a jeopardy analysis and an adverse modification or destruction of critical habitat analysis. Prior to 2016, the designation of critical habitat for Northwest Atlantic Ocean DPS of loggerhead turtle used the term primary constituent element (PCE), 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 physical or biological features (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 rely on the action for their occurrence.
- 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 and proposed 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 or proposed 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.
- Compile our jeopardy and destruction or adverse modification analysis relying on the justification in the integration and synthesis.
- 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, we suggest a reasonable and prudent alternative to the proposed action and assess the effects of that alternative action.
- For actions that do not violate section 7(a)(2) of the ESA or an alternative action is identified that does not violate section 7(a)(2) of the ESA, after we conclude our opinion, we provide an incidental take statement that specifies the impact of the take on listed species (amount or extent), reasonable and prudent measures, and terms and conditions to implement those measures.

In each of the steps above, we rely on the best scientific and commercial data available. In order to ensure we reach supportable conclusions, we used information from FAA including the 2024

Biological Assessment (ManTech SRS Technologies Inc. 2024), Revised Draft Tiered Environmental Assessment (FAA 2024b), Starship addenda and revised addenda (FAA 2025a; FAA 2025b; FAA 2025c; FAA 2025d), responses to our requests for additional information, and 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 following information was obtained from FAA's initiation materials, including the 2024 Biological Assessment (ManTech SRS Technologies Inc. 2024), Revised Draft Tiered Environmental Assessment (FAA 2024b), Starship addenda (FAA 2025a; FAA 2025b; FAA 2025c; FAA 2025d), FAA and SpaceX responses to our requests for additional information, NMFS meetings and telephone calls with FAA, NMFS meetings with FAA and SpaceX, and previous consultations regarding FAA's licensing of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, OPR-2021-02908, and OPR-2024-01147).

The FAA proposes to modify and issue vehicle operator license (VOL 23-129), authorizing SpaceX to conduct launch and reentry operations of their launch vehicle, Starship-Super Heavy. The modifications include Starship and Super Heavy landings more than 1 NM from shore in the Gulf of Mexico (non-U.S. waters), Gulf of America, and North Atlantic Ocean, and launches from Kennedy Space Center's Launch Complex 39A (LC-39A). While the current launch site, the Boca Chica Launch Site, is already operational, the launch site at LC-39A needs to be constructed for launches to begin in fall of 2025. The maximum number of launches per year from each launch site is as follows: 25 from the Boca Chica Launch Site and 44 from LC-39A. Launch cadence at both sites is expected to ramp up over time, although at an unknown rate. The Federal action is the modification and subsequent issuance of VOL 23-129, which expires April 14, 2028. Thus, this opinion and ITS are valid until April 14, 2028, corresponding with the FAA license.

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, OPR-2021-02908, and OPR-2024-01147).

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 2030 (i.e., Starship and Super Heavy will land back at the launch site or on a floating platform/ocean-going barge, or autonomous spaceport drone ship [drone ship] after October 2030). Between the date of issuance of this opinion and October 2030, Starship and/or Super Heavy may be expended in the ocean. The interstage (see below) may still be expended in the Gulf of Mexico (non-U.S. waters) or Gulf of America through calendar year 2026. As noted above, the FAA license covers the period until April 2028, which is also the period considered in this consultation.

Starship-Super Heavy is approximately 404 feet (ft; 123 meters [m]) tall by 30 ft (9 m) in diameter: Super Heavy, the first stage (or booster), is approximately 233 ft (71 m) tall, and Starship, the second stage (or spacecraft), is approximately 171 ft (52 m) tall. Super Heavy will be equipped with up to 37 Raptor engines and Starship will be equipped with up to nine Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH_4). Super Heavy can hold up to 3,748 tons (t; 3,400 metric tons [MT]) of propellant and Starship can hold up to 1,653 t (1,500 MT) of propellant.

During a Starship-Super Heavy launch, the launch vehicle reaches supersonic speeds, generating a sonic boom. After launch, Super Heavy's engines cut off at high altitude and Super Heavy separates from Starship. After Super Heavy separates from Starship, Super Heavy conducts a boost-back burn prior to descent and Starship flies to its desired orbit. Starship conducts an in-space coast phase before beginning its descent. A sonic boom is generated as Super Heavy and Starship reach supersonic speeds during descent. Super Heavy and/or Starship may conduct a landing burn as it returns to the launch site, lands on a floating platform/ocean-going barge or drone ship, or lands in the ocean.

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

Super Heavy Operations

Super Heavy may be expended in the Gulf of Mexico (non-U.S. waters) or Gulf of America (Gulf portion of the action area; Figure 1), or the Northwest Atlantic Ocean (Atlantic Ocean portion of the action area; Figure 2). Super Heavy will be expended more than 5 NM from shore in the Gulf and Atlantic Ocean portions of the action area, or expended 1–5 NM from shore directly east of the Boca Chica Launch Site or LC-39A. In the Gulf portion of the action area, Super Heavy will be expended at least 20 NM from the Flower Garden Banks National Marine Sanctuary. Super Heavy landings are expected to generate an overpressure of up to 21 pounds per square foot (psf). A landing on a floating platform/ocean-going barge or drone ship would produce an overpressure of up to 8 psf.

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 or Atlantic Ocean portions of the action area.
2. Explosive event: Super Heavy lands in the ocean either at terminal velocity, breaking up upon impact with debris contained within approximately 0.6 miles (mi; 1 kilometer [km])

of the landing point, or conducts a soft water landing and tips over, impacting the ocean. Both result in an explosive event at the surface of the water.
3. Soft water landing: Super Heavy conducts a soft water landing, tips over, and sinks to the bottom of the ocean.

FAA and SpaceX stated there is no specific information on the Super Heavy landing locations, or on the probability or frequency that Super Heavy landings will occur more often in any given portion of the action area (e.g., closer to the launch site compared to further offshore, or within one portion of the action area more than another portion of the action area). Thus, we conclude that, based on the best available information, Super Heavy landings are equally likely to occur throughout the action area.

If Super Heavy is expended in an area where it becomes a navigational hazard, it will need to be removed from the seafloor. Activities related to the recovery or removal of Super Heavy or Super Heavy debris are not part of FAA's Federal action. Those activities would be subject to Section 7(a)(2) if they require authorization from, are funded by, or are carried out, in whole or in part, by a Federal agency.

SpaceX provided the best available information on how a Super Heavy explosive event will occur, based on previous launches and tests of similar vehicles. A Super Heavy explosive event is the result of a breakdown of the fuel transfer tube and subsequent mixing and igniting of residual propellant, which will be located approximately 9.8 ft (3 m) from the ocean's surface due to the vertical orientation of Super Heavy. SpaceX calculated an explosive weight of 14,551 pounds (lb; 6,660 kilograms [kg]) based on a 9% explosive yield and 82 t (74 MT) of residual propellant (no landing burn).

Super Heavy Interstage

The Super Heavy interstage (also known as the hot-staging ring or forward heat shield) will continue to be expended in the Gulf portion of the action area (see OPR-2024-02422), approximately 0.6–249 mi (1–400 km) from shore directly off of the Boca Chica Launch Site and approximately 18.6–248.5 mi (30–400 km) from shore in the western Gulf of Mexico (non-U.S. waters) and Gulf of America (Figure 1). The interstage landing area is at least 20 NM from the Flower Garden Banks National Marine Sanctuary. The interstage is comprised of stainless steel and is approximately 30 ft (9.1 m) in diameter, 5.9 ft (1.8 m) long, and weighs 20,000 lb (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 portion of the action area or back at the Boca Chica Launch Site, the interstage will release from Super Heavy. After release, the interstage will gradually drift away from Super Heavy and is expected to land approximately 1.9–2.5 mi (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 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.

Starship Operations

Starship may be expended in the Gulf portion of the action area (Figure 1), Atlantic Ocean portion of the action area (Figure 2), Indian Ocean (Indian Ocean portion of the action area; Figure 3), North Pacific Ocean (Hawaii and Central North Pacific portion of the action area and Northeast and Tropical Pacific portion of the action area; Figure 4), or Southeast Pacific (South Pacific portion of the action area; Figure 5). When Starship will be expended in the Gulf and Atlantic Ocean portions of the action area, it will be more than 5 NM from shore, 1–5 NM from shore between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site in the Gulf portion of the action area, or 1–5 NM from shore between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A in the Atlantic Ocean portion of the action area. Starship may also be expended in the Indian Ocean portion of the action area at least 200 NM from any land area. When landing in the Hawaii and Central North Pacific portion of the action area, Starship will be expended at least 100 mi (161 km) from Hawaii and at least 150 mi (241 km) from the Papahānaumokuākea National Marine Sanctuary. Starship landings are expected to generate an overpressure of up to 4 psf.

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 Gulf, Atlantic Ocean, Indian Ocean, Hawaii and Central North Pacific, Northeast and Tropical Pacific, and/or South Pacific portions of the action area.
2. Explosive event: Starship lands in the ocean either at terminal velocity, breaking up upon impact with debris contained within approximately 0.6 mi (1 km) of the landing point, or conducts a soft water landing and tips over, impacting the ocean. Both result in an explosive event at the surface of the water.
3. Soft water landing: Starship conducts a soft water landing, tips over, and sinks to the bottom of the ocean.

FAA and SpaceX stated there is no specific information on the Starship landing locations, or on the probability or frequency that Starship landings will occur more often in any given portion of the action area (e.g., closer to the launch site compared to further offshore, or within one portion of the action are more than another portion of the action area). Thus, we conclude that, based on the best available information, Starship landings are equally likely to occur throughout the action area.

As for Super Heavy, if Starship is expended in an area where it becomes a navigational hazard, it will need to be removed from the seafloor and the removal action may be subject to the section 7(a)(2) requirements.

SpaceX provided the best available information on how a Starship explosive event will occur, based on previous launches and tests of similar vehicles. A Starship explosive event is the result of a breakdown of the fuel transfer tube and subsequent mixing and igniting of residual propellant, which will be located, at minimum, 12.8 ft (4.5 m) from the ocean's surface due to the horizontal orientation of Starship. SpaceX calculated an explosive weight of approximately 21,929 lb (9,947 kg) based on a 9% explosive yield and approximately 77 t (70 MT) of residual propellant in the main tanks, and an 11.9% yield and approximately 34 t (31 MT) of residual propellant in the header tanks (no landing burn).

Number of Launches and Expended Super Heavy and Starship Landings

As noted above, SpaceX anticipates there will be no more than 25 in-flight breakups, 25 soft water landings, and 20 explosive events of each vehicle in each portion of the action area, from the date of issuance of this opinion up to October 2030. Given the launch cadence will increase at an unknown rate before the maximum number of launches from each launch site is reached, NMFS estimated the number of launches and landings that could occur from each launch site for the duration of the proposed FAA license, which expires April 14, 2028 and is also the end date considered in this consultation.

The maximum number of launches that will occur from the Boca Chica Launch Site is 25 per year, and the maximum number of launches that will occur from LC-39A, once operational, is 44 per year. Given the launch cadence will ramp up over time, but the rate of increase is unknown and FAA and SpaceX do not have estimates of launch frequency, NMFS estimated launches will be evenly distributed throughout any given year. At the time of this reinitiation (April 2025), SpaceX has conducted two launches from the Boca Chica Launch Site in 2025 (January 16 and March 6). Thus, there could be an additional 23 launches from Boca Chica in 2025. Launches from LC-39A are expected to start in fall of 2025; the start of the fall season in the United States is approximately three-quarters into the year – September 22, 2025. Thus, a quarter of the maximum number of launches (11) may occur in the last quarter of 2025 from LC-39A. For 2026, there may be a maximum of 25 launches from the Boca Chica Launch Site, and, because there is no information on the rate of launch cadence increase, NMFS estimates the maximum number of launches (44) may occur from LC-39A. For 2027, there may be a maximum of 25 launches from the Boca Chica Launch Site and a maximum of 44 launches from LC-39A. For the portion of 2028 that falls under the current license (January–April 2028), which is approximately one-third of the year, NMFS estimates that one-third of the maximum number of launches from the Boca Chica Launch Site (approximately 9) and LC-39A (approximately 15) will occur. In summary, NMFS estimates that 34 launches will occur in 2025 (April–December), 69 launches will occur in 2026, 69 launches will occur in 2027, and 24 launches will occur in 2028 until the current license expires on April 14, 2028.

FAA and SpaceX do not have estimates of the frequency of in-flight breakups, soft water landings, or explosive events per year, or the distribution of in-flight breakups, soft water landings, or explosive events within a year. Unlike launches, estimating an even distribution of expended vehicle landings across a given year would be inaccurate given the goal is to reach full reusability of the launch vehicle. The launch vehicle is expected to be fully reusable by October of 2030. Thus, while the launch vehicle is still in development, it is reasonable to estimate that a larger proportion of expended vehicle landings will occur earlier within the April 2025 (estimated issuance of this opinion) to October 2030 timeframe (i.e., there should be zero expended vehicle landings by the time the launch vehicle is fully reusable in October 2030). However, there is no estimate on the rate of decrease of these expended vehicle landings, and changes made to the launch vehicle while in development may temporarily increase the number of expended vehicle landings because developing a fully reusable launch vehicle is not a linear process. Thus, NMFS estimates that the maximum number of in-flight breakups (25), soft water landings (25), and explosive events (20) indicated by SpaceX until full reusability will occur for each vehicle, in each portion of the action area over the duration of the license (through April 14, 2028).

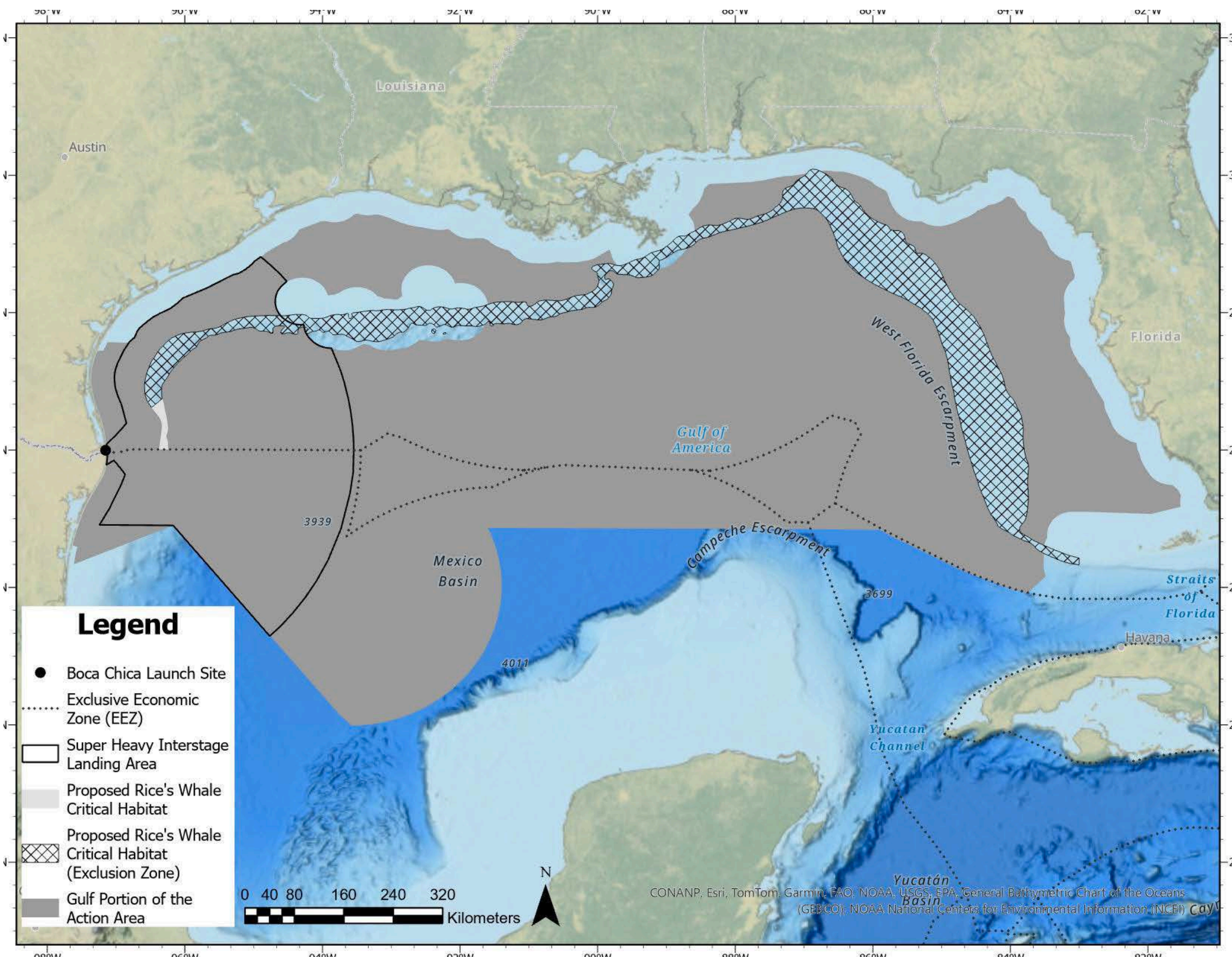

Figure 1. Map of the Gulf portion of the action area (dark grey) with the portion of proposed Rice's whale critical habitat that will be excluded (hatched) and portion of proposed Rice's whale critical habitat that will be included (light grey) in the area where Starship and Super Heavy may land, and Super Heavy interstage landing area (black outline).

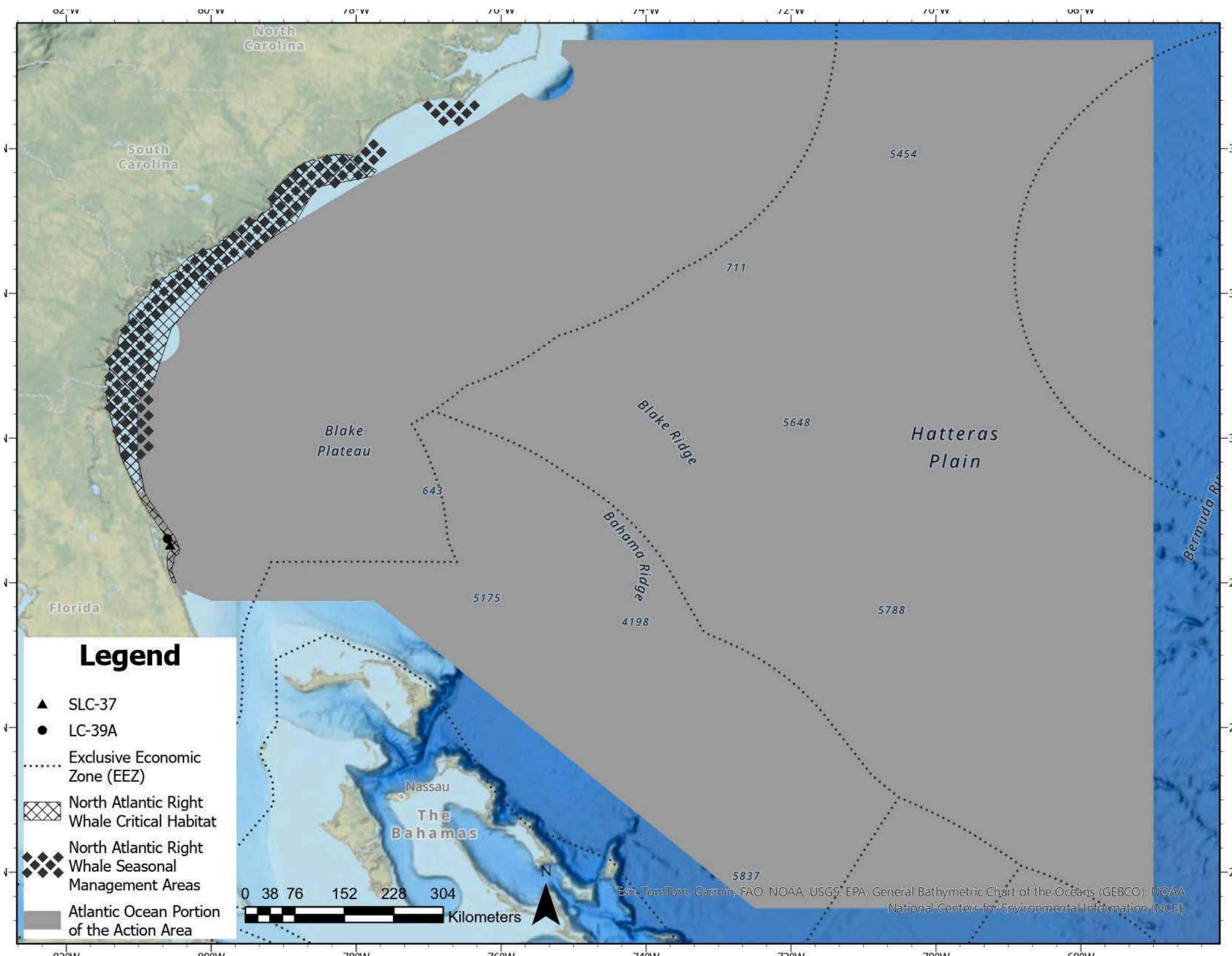

Figure 2. Map of the Atlantic Ocean portion of the action area (non-Gulf), North Atlantic right whale critical habitat (hatched) and Seasonal Management Area (diamonds) shown to illustrate overlap with the Atlantic Ocean portion of the action area.

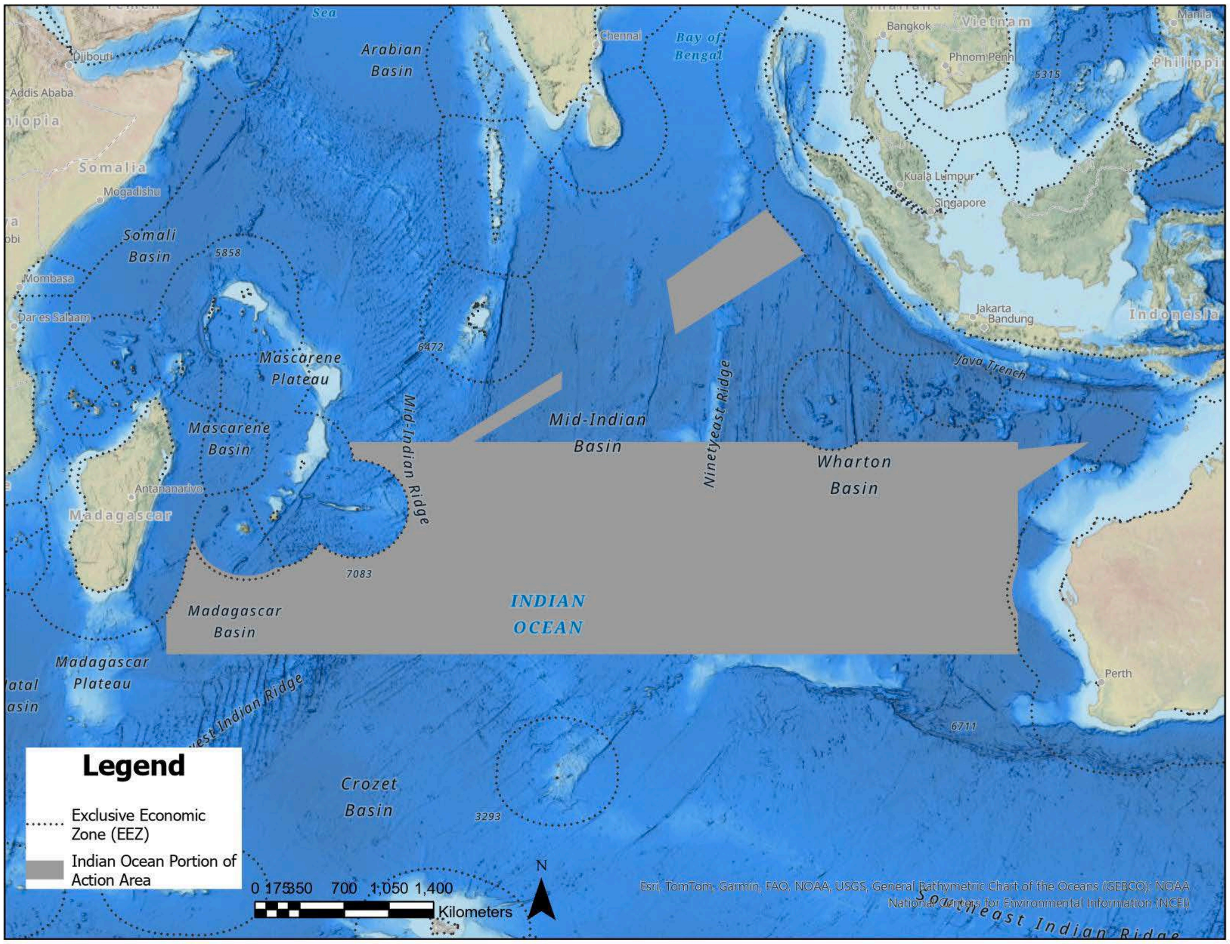

Figure 3. Map of the Indian Ocean portion of the action area.

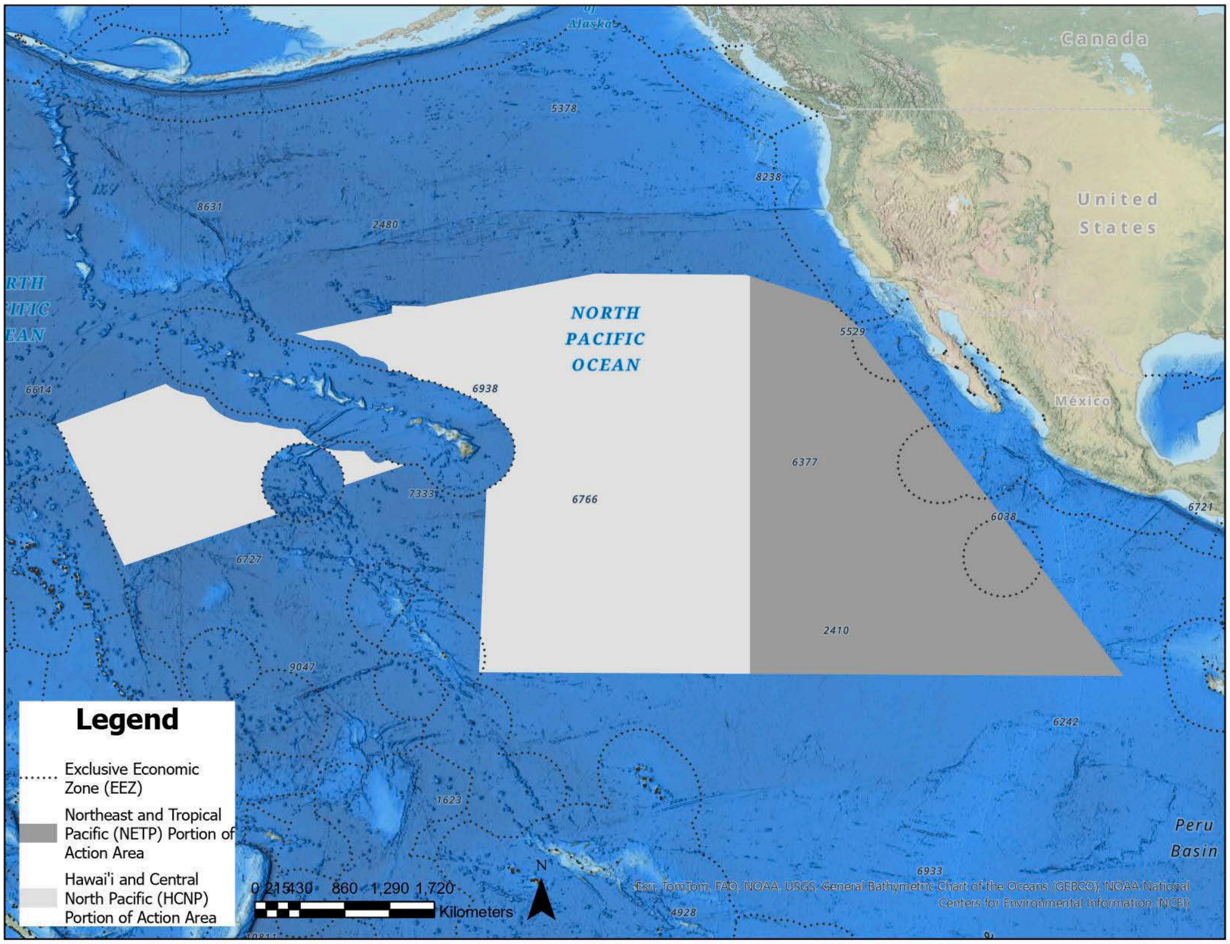

Figure 4. Map of the Hawaii and Central North Pacific portion of the action area (light grey) and Northeast and Tropical Pacific portion of the action area (dark grey).

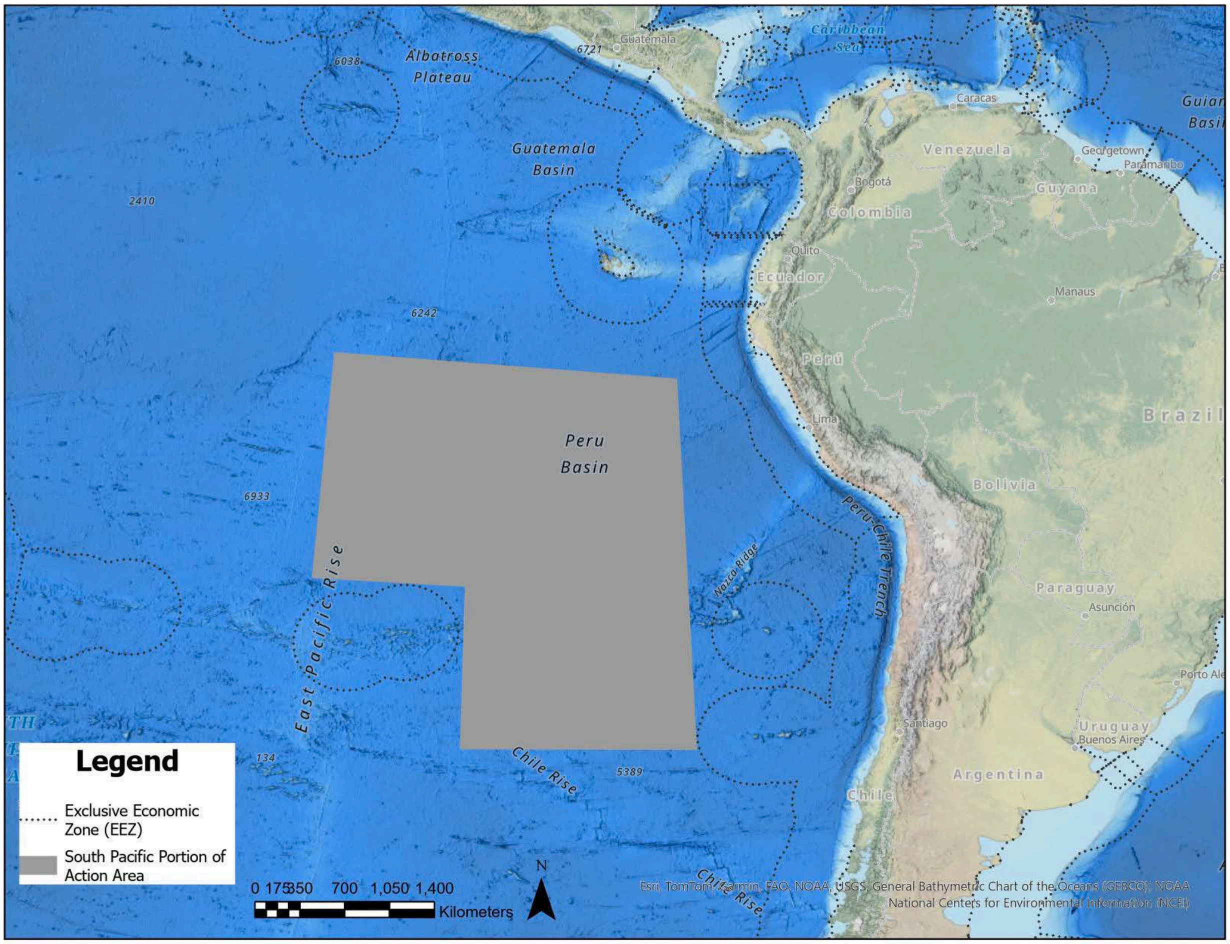

Figure 5. Map of the South Pacific portion of the action area.

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 four feet (1.2 m). When a balloon is deployed, it rises approximately 12–18 mi (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 15,000 ft (4,572 m) but may drop to 1,500 ft (457 m) to obtain a call sign visually from a non-participating vessel.

2.2 Conservation Measures

The FAA will require the implementation of conservation measures in order for their action to result in the least practicable adverse impact to ESA-listed species and their habitat in the different portions of the action area. Conservation measures 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, OPR-2021-02908, and OPR-2024-01147). Conservation measures from previous consultations are incorporated into this consultation and described below. General conservation measures applicable to all portions of the action area are listed first, followed by conservation measures applicable to 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, except between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site and between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A, where launch and reentry activities will occur at least 1 NM from the coast. The only activities that will occur within 1 or 5 NM from the coast will be interstage landings in the Gulf portion of the action area (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 reports to NMFS prior to the launch vehicle reaching full reusability (see below).

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 *Vessel Operations* 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 (kt) or less when mother/calf pairs or groups of marine mammals are observed.
9. All vessels will maintain, at minimum, a distance of 300 ft (91.4 m) from all ESA-listed marine mammals and MMPA-protected species (except for greater distances specified below), and 150 ft (45.7 m) from sea turtles. If this distance becomes less than 300 ft (91.4 m) or 150 ft (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 (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-2025-00164– Collision, Injury, or Mortality Report."
    a. For operations in the Gulf 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 (Hawaii)

c. In the Gulf 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 1,000 ft (304.8 m) over ESA-listed or MMPA-protected species and 1,500 ft (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 portion of the action area conservation measures:

1. Reentry trajectories will be planned to avoid vehicle (Super Heavy and Starship) landings, explosions, and breakups within Rice's whale core distribution area and proposed critical habitat. Vehicles may only land in a small portion of Rice's whale proposed critical habitat (see Figure 1) off Boca Chica, Texas. For a single flight, Super Heavy and Starship will not both land in this small portion of Rice's whale proposed critical habitat.
2. All vessels will slow to 10 kt or less when Rice's whales are observed and maintain a minimum distance of 1,500 ft (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 area or proposed critical habitat. If transit in the Rice's whale area or proposed critical habitat is required, avoid areas where water depth is 328–1,394 ft (100–425 m; where Rice's whale has been observed; Rosel et al. 2021) and transit as slowly as practicable, limiting speeds to 10 kt or less.

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

1. All vessels will slow to 10 kt or less when North Atlantic right whales are observed and maintain a minimum distance of 1,500 ft (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. For a single flight, Super Heavy and Starship will not both land in the portion of the Atlantic Ocean portion of the action area that overlaps North Atlantic right whale critical habitat and North Atlantic right whale Seasonal Management Areas from November 1 through April 30.
4. No vehicle (Super Heavy or Starship) 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.

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.

Hawaii 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 National Marine 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– 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 National Marine 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, OPR-2021-02908, and OPR-2024-01147). Reporting requirements from previous consultations are incorporated into this consultation and 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

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[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/.

reusability, should be submitted no more than 30 days after the flight to NMFS electronically at nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2025-00164 [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:

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.

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 165 t (150 MT) and expendable payloads of up to 276 t (250 MT), there are various activities that will occur because 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 later in time) 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 2030). 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 or conference.

Anomalies and mishaps have also occurred and may continue to occur as a result of FAA's licensing of Starship-Super Heavy launch and reentry operations. An *anomaly* is any condition during a licensed activity "that deviates from what is standard, normal, or expected, during the verification or operation of a system, subsystem, process, facility, or support equipment" and a *mishap* means "any event, or series of events associated with a licensed or permitted activity resulting in any of the following: (1) a fatality or serious injury; (2) a malfunction of a safety-critical system; (3) a failure of the licensee's or permittee's safety organization, safety operations, safety procedures; (4) high risk, as determined by the FAA, of causing a serious or fatal injury to any space flight participant, crew, government astronaut, or member of the public; (5) substantial damage, as determined by the FAA, to property not associated with licensed or permitted activity; (6) unplanned substantial damage, as determined by the FAA, to property associated with licensed or permitted activity; (7) unplanned permanent loss of a launch or reentry vehicle during licensed activity or permitted activity; (8) the impact of hazardous debris outside the planned landing site or designated hazard area; or (9) failure to complete a launch or reentry as planned as reported in" the licensee's mission information (14 CFR §401.7). At the time of this reinitiation, SpaceX had conducted eight flights of Starship-Super Heavy. The first three flights resulted in mishaps to both vehicles within the action area considered in the ESA section 7 consultations conducted for the flights. The most recent flights, Flights 7 and 8, resulted in mishaps to Starship outside the action area of previous consultations. Mishaps occurred due to a variety of reasons related to engine failure, propellant leaks, and vehicle malfunctions, and were characterized by the vehicle(s) exploding at altitude, with debris entering the ocean. As SpaceX works towards a fully reusable vehicle, mishaps are expected to continue.

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 stressors. This section identifies all of the stressors that may affect listed species, 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 launches and landings;
2. Direct impact by fallen objects (radiosonde, Super Heavy, Starship, interstage, debris);
3. Impacts from unrecovered debris;
4. Impacts from pollution (vessel and vehicle emissions, propellant);
5. Vessel presence, strike, and noise;
6. Aircraft overflight;
7. In-air acoustic effects from vehicle landings and explosive events;
8. Vibration, heat, and debris from launches;
9. Heat from vehicle landings and explosive events; and
10. Underwater acoustic effects 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 (non-U.S. waters), Gulf of America, another area in the Atlantic Ocean, Indian Ocean, North Pacific Ocean, and South Pacific Ocean (see Figures 1–5) where Super Heavy and/or Starship will be expended until full reusability is achieved. 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 are coastal waters 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, and North Carolina.

They do not include ports or waters that occur within or adjacent to the critical habitats of ESA-listed anadromous fishes, and where those species aggregate for spawning, recruitment, and other important life functions.

The action area also includes waters where mishaps may occur. Based on limited information on where mishaps have previously occurred, NMFS estimated an additional area where mishaps may occur in the future based on limited knowledge of debris areas and trajectories from previous flights (Figure 6). We note that mishaps have occurred shortly after launch, and it is expected that mishaps could occur within the Gulf and Atlantic Ocean portions of the action area downrange of the launch sites.

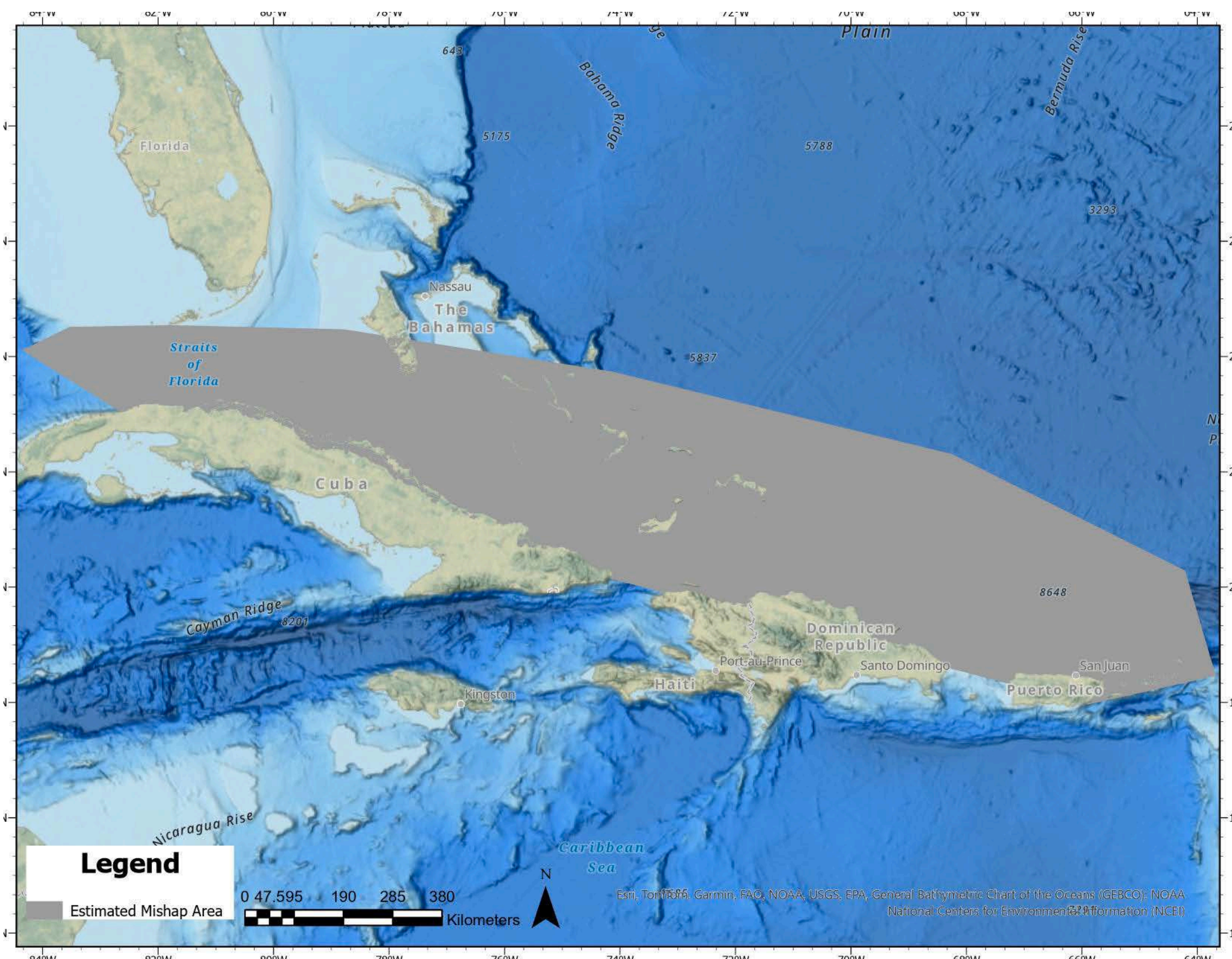


Figure 6. Mishap area estimated by NMFS included in the action area.

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 or proposed 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 or proposed 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*) –	T – 76 Fed. Reg. 58868	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Southwest Indian Ocean DPS			
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*) – Chesapeake Bay DPS	E – 77 Fed. Reg. 5880	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	T – 79 Fed. Reg. 38213	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
(*Sphyrna lewini*) – Central and Southwest 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
Boulder Star Coral (*Orbicella franksi*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Elkhorn Coral (*Acropora palmata*)	T – 79 Fed. Reg. 53851	73 Fed. Reg. 72210	80 Fed. Reg. 12146
Lobed Star Coral (*Orbicella annularis*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Mountainous Star Coral (*Orbicella faveolata*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Pillar Coral (*Dendrogyra cylindrus*)	E – 89 Fed. Reg. 101993	88 Fed. Reg. 54026	03/2015 (Outline)

Species	ESA Status	Critical Habitat	Recovery Plan
Rough Cactus Coral *(Mycetophyllia ferox)*	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Staghorn Coral (*Acropora cervicornis*)	T – 79 Fed. Reg. 53851	73 Fed. Reg. 72210	80 Fed. Reg. 12146
Sunflower Sea Star (*Pycnopodia helanthoides*)	T – 88 Fed. Reg. 16212 (Proposed)	-- --	-- --

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 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 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 DPS 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:

Designated or Proposed Critical Habitat	PBFs
	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 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: Ka'ula, Ni'ihau, Kaua'i, O'ahu, Maui Nui (including Kaho'olawe, Lana'i, Maui, and Moloka'i), 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
North Atlantic Right Whale	Currently Designated CH: Southeastern U.S. Calving Area – Cape Fear, North Carolina to approximately 27 NM below Cape Canaveral, Florida Designated CH PBFs: 1. Calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale 2. Sea surface temperatures from a minimum of 7°C, and never more than 17°C
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:

Designated or Proposed Critical Habitat	PBFs
	Northwest Atlantic Ocean DPS range – neritic (nearshore reproductive, foraging, winter, breeding, and migratory) and *Sargassum* habitat Designated CH PBFs: 1. Nearshore Reproductive Habitat -- 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. Breeding Habitat – (1) High densities of reproductive male and female loggerheads 5. Constricted Migratory Habitat – (1) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas 6. *Sargassum* Habitat – (1) *Sargassum* in concentrations that support adequate prey abundance and cover; (2) Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (3) Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m depth
Gulf Sturgeon	Currently Designated CH: Gulf of America – 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
Nassau Grouper	Currently Designated CH: Puerto Rico – Desecheo Island, Northeast, Vieques Island, Isla De Culebra/Culebrita U.S. Virgin Islands – St. Thomas, St. John Florida – Big Pine Key to Geiger Key, Key West, New Ground Shoal

Designated or Proposed Critical Habitat	PBFs
	Spawning Sites – Grammanik Bank and Hind Bank, and Riley's Hump Designated CH PBFs: 1. Recruitment and developmental habitat – Areas from nearshore to offshore necessary for recruitment, development, and growth of Nassau grouper containing a variety of benthic types that provide cover from predators and habitat for prey, consisting of the following: (1) Nearshore shallow subtidal marine nursery areas with substrate that consists of unconsolidated calcareous medium to very coarse sediments and shell and coral fragments and may also include cobble, boulders, whole corals and shells, or rubble mounds, to support larval settlement and provide shelter from predators during growth and habitat for prey; (2) Intermediate hardbottom and seagrass areas in closer proximity to the nearshore shallow subtidal marine nursery areas that provide refuge and prey resources for juvenile fish; (3) Offshore linear and patch reefs in close proximity to intermediate hardbottom and seagrass areas that contain multiple benthic types to provide shelter from predation during maturation and habitat for prey; and (4) Structures between the subtidal nearshore area and the intermediate hardbottom and seagrass area and the offshore reef area to support juveniles and adults as movement corridors that include temporary refuge that reduces predation risk as Nassau grouper move from nearshore to offshore habitats 2. Spawning habitat --
Black Abalone	Currently Designated CH: California – rocky intertidal and subtidal habitat from the Mean Higher High Water line to a depth of 6 m relative to the Mean Lower Low Water 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. Suitable water quality including temperature, salinity, pH, and other chemical characteristics necessary for normal settlement, growth, behavior, and viability
Boulder Star Coral	Currently Designated CH:

Designated or Proposed Critical Habitat	PBFs
	Florida – Government Cut, Miami-Dade County to Dry Tortugas (0.5–40 m) Puerto Rico – All islands (0.5–90 m) U.S. Virgin Islands – St. Thomas and St. John (0.5–90 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Elkhorn Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Key West, Monroe County (Mean Low Water Line to 30 m); Dry Tortugas (Mean Low Water Line to 30 m) Puerto Rico – All islands (<30 m depth) U.S. Virgin Islands – St. Thomas and St. John (<30 m depth) Designated CH PBFs: Substrate of suitable quality and availability (natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover) to support larval settlement and recruitment, and reattachment and recruitment of asexual fragments
Lobed Star Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Dry Tortugas (0.5–20 m) Puerto Rico – All islands (0.5–20 m) U.S. Virgin Islands – St. Thomas and St. John (0.5–20 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column:

Designated or Proposed Critical Habitat	**PBFs**
	1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Mountainous Star Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Dry Tortugas (0.5–40 m) Puerto Rico – All islands (0.5–90 m) U.S. Virgin Islands – St. Thomas and St. John (0.5–90 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Pillar Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Dry Tortugas (1–25 m) Puerto Rico – All islands (1–25 m) U.S. Virgin Islands – St. Thomas and St. John (1–25 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae

Designated or Proposed Critical Habitat	PBFs
	2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Rough Cactus Coral	Currently Designated CH: Florida – Broward County to Dry Tortugas (5–40 m) Puerto Rico – All islands (5–90 m) U.S. Virgin Islands – St. Thomas and St. John (5–90 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Staghorn Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Key West, Monroe County (Mean Low Water Line to 30 m); Dry Tortugas (Mean Low Water Line to 30 m) Puerto Rico – All islands (<30 m depth) U.S. Virgin Islands – St. Thomas and St. John (<30 m depth) Designated CH PBFs: Substrate of suitable quality and availability (natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover) to support larval settlement and recruitment, and reattachment and recruitment of asexual fragments
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

Designated or Proposed Critical Habitat	PBFs
	Proposed CH PBFs: 1. 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. 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 – North Atlantic DPS	Currently Designated CH: Culebra Island, Puerto Rico – waters surrounding the island of Culebra from the Mean High Water line to 5.6 km Designated CH PBFs: PBFs of green turtle critical habitat are not precisely defined; however, critical habitat was designated to provide protection for important developmental and resting/sheltering habitats Currently Proposed CH: Florida – all nearshore areas from the Mean High Water line to 20 m depth. These areas contain reproductive, migratory, benthic foraging/resting, and surface-pelagic foraging/resting essential features

Designated or Proposed Critical Habitat	PBFs
	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 America and Atlantic Ocean – in the Gulf of America, 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 *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

Designated or Proposed Critical Habitat	PBFs
Rice's Whale	Currently Proposed CH: Gulf of America – 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

CH = critical habitat; PBFs = physical or biological features; DPS = distinct population segment
-- The action will have no effect on PBFs

4.1 May Affect, Not Likely to Adversely Affect

Once we have determined the action may affect ESA-listed or proposed 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 or proposed 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 Generated During Launches and Landings

Sonic booms generated by Super Heavy and Starship landings are expected to be a maximum of 21 and 4 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 acoustic threshold at which harassment of marine mammals and sea turtles may occur from impulsive sound. Rather than responding primarily to sound pressure, invertebrates 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 acoustic threshold for harassment than marine mammals and sea turtles (FHWG 2008); 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 will 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.

Impulse noise from vehicle launches and landings may affect ESA-listed species' hearing underwater. Noise from a launch is unlikely to effectively cross the air-water boundary, as previously discussed. The likelihood that an animal occurs at the same time and place as a Super Heavy or Starship landing, and would be exposed to sound generated by the landing, is expected to be extremely unlikely given relatively low species densities, large areas over which either vehicle may be expended, and the short duration (only a few seconds) of landings. Therefore, any effect from the sonic booms or impulse noise on ESA-listed species while underwater would be insignificant or discountable.

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 is less than 1 second (less than 300 milliseconds) and the duration of an ocean landing is less than 1 minute. ESA-listed marine mammals and sea turtles may be exposed to in-air noise from launches, which lasts approximately 3 minutes (FAA 2024a). However, marine mammals and sea turtles typically surface for only a few seconds. 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 (Rice's whale, see Table 2), will be so small as to be immeasurable. Therefore, effects from sonic booms or impulse noise to designated or proposed critical habitat is 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, impact breakup, or mishap) falling and landing in the Gulf, Atlantic Ocean, Indian Ocean, Hawaii and Central North Pacific, Northeast and Tropical Pacific, and South Pacific portions of the action area, and estimated mishap 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 struck.

Super Heavy and Starship are extremely small relative to the in-water area in which either vehicle could land (see Figures 1–5) and relative to the area over which species are distributed in the Gulf of Mexico (non-U.S. waters), Gulf of America, Atlantic, Indian, North Pacific, and South Pacific oceans. The likelihood that a vehicle strikes an ESA-listed species can be estimated by multiplying the species density by the area of the vehicle. Super Heavy measures approximately 233 ft (71 m) by 30 ft (9 m), is larger than Starship, and covers an area of approximately 6,878 square feet (ft^2; 639 square meters [m^2]) or 0.000247 square miles (mi^2; 0.000639 square kilometer [km^2]). Because NMFS estimates that the probability a vehicle will land in a specific location within a portion of the action area is equal across that portion, and each portion, of the action area (based on the best available information), we used the highest monthly mean species density across all portions of the action area as a proxy for all species considered in this consultation. The highest monthly mean species density is 0.834 Northwest Atlantic Ocean DPS loggerhead turtles per km^2, which occurs in an extremely small area of the Gulf portion of the action area. The species density, 0.834 individuals per km^2, multiplied by the vehicle area, 0.000639 km^2, results in an extremely small number of individuals that may be exposed to a direct impact from a falling object (0.00053).

There may be up to 25 soft water landings of each vehicle, and 20 landings with explosive events of each vehicle. It is extremely unlikely both vehicles would land in the same exact place (i.e., it is extremely unlikely that both would land in the small area where loggerhead turtle densities are highest). However, without information on landing locations of either vehicle, we estimate the likelihood of 90 total landings hitting an ESA-listed species by multiplying the total number of landings by 0.00053 individuals. This results in an estimated 0.048 individuals exposed to direct impact by falling objects. Thus, the likelihood that an ESA-listed species will be in the exact location at the exact same time that a Super Heavy or Starship landing occurs is extremely unlikely, and thus, discountable. Debris pieces from an in-flight breakup, impact breakup (for which debris is expected to be contained within 0.6 mi [1 km] of the landing location), or mishap 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.

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. Using the same methodology as above, NMFS determined 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 (NMFS 2024b).

Falling debris from a mishap may affect ESA-listed corals if debris sink and land directly on a coral. Based on limited information available from previous mishaps, a majority of the vehicle will be destroyed during the mishap. Debris pieces that remain are expected to be widely dispersed given the high altitude at which the mishap occurs and would not be concentrated in any specific area. For example, Flight 7 mishap debris occurred in an area over approximately 6,950 mi^2 (18,000 km^2). ESA-listed corals occur close to shore where debris is less likely to occur because of human safety concerns. After mishaps during Flights 7 and 8, debris was reported on the islands of Turks and Caicos, and the Bahamas, respectively. These debris pieces were found one to a couple of days after the mishaps, suggesting that debris pieces that arrived on shore floated there. Thus, based on the limited information currently available, it is extremely unlikely that debris from a mishap will directly strike an ESA-listed coral.

Falling objects may affect the following designated or proposed habitat present in areas where falling objects may occur: North Atlantic right whale, Northwest Atlantic Ocean DPS of loggerhead turtle, Nassau grouper, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, North Atlantic DPS of green turtle, and Rice's whale (Table 2).

Falling objects may affect PBFs related to the availability of benthic substrate or refugia (e.g., caves, boulders), because a direct impact may reduce the availability of that habitat feature, which applies to: Northwest Atlantic Ocean DPS of loggerhead turtle *Sargassum* habitat, Nassau grouper, corals, and North Atlantic DPS of green turtle (benthic foraging/resting feature and surface-pelagic foraging/resting feature). Super Heavy and Starship are relatively small (hundreds of square meters) compared to the critical habitats for sea turtles (thousands to hundreds of thousands of square kilometers). If a Super Heavy and Starship landing results in debris, the debris pieces will be smaller than either vehicle. For Nassau grouper and coral critical habitat, falling objects are only expected to occur if there is a mishap. In that case, the objects would be widely dispersed and scattered within an area much larger than the critical habitat area, given the high altitude at which the mishap occurs. Thus, the likelihood that falling objects directly impact benthic substrate and refugia/cover would be extremely unlikely.

Falling objects may also disturb the sea surface as they impact the ocean, and disturb the seafloor as they settle, and affect PBFs related to calm conditions and water quality (sediment), which apply to North Atlantic right whale and corals. Objects that are affecting the ocean surface are temporary, with the moment of impact lasting only seconds, and would not result in sea surface conditions more than Force 4 on the Beaufort Wind Scale for more than the duration of the actual impact. Sediment may be suspended by objects falling and hitting the seafloor, and affect water quality and the amount of sediment on top of corals. However, if debris impacts the seafloor in proximity to corals, the sediment would only be displaced temporarily, affecting water quality, but would settle after the debris stops moving; thus, water quality conditions would return to normal. It is extremely unlikely that the displaced sediment would completely cover the coral habitat because of the estimated location of debris (see above paragraph on falling debris from a mishap), and because sediment suspended in the water column will be dispersed by currents and water movement. Thus, effects of falling objects on surface conditions and water quality would be so small as to be immeasurable and, therefore, insignificant.

Falling objects may also temporarily displace prey species as they sink through the water column and temporarily affect PBFs related to prey availability as prey move away from the object (Northwest Atlantic Ocean DPS of loggerhead turtle foraging habitat and *Sargassum* habitat, Nassau grouper, North Atlantic DPS of green turtle proposed benthic foraging/resting feature and surface-pelagic foraging/resting feature, and Rice's whale). However, the temporary sinking of debris or vehicles is not expected to affect the overall 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 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 Unrecovered Debris

Unrecovered debris (from Super Heavy, Starship, weather balloons, and radiosondes) 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 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 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 10 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 from the use of weather balloons as part of the proposed action 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.

Unrecovered debris may also affect PBFs related to water/passage obstruction and water depth: Northwest Atlantic Ocean DPS of loggerhead turtle constricted migratory habitat and *Sargassum* habitat, and North Atlantic DPS of green turtle reproductive feature, migratory feature, and surface-pelagic foraging/resting feature of proposed critical habitat (Table 2). Unrecovered debris could create obstructions to waterways, or affect water depth if they land in shallow areas where the size of the debris blocks the water column. Based on the available information from FAA and SpaceX, Super Heavy and Starship may land intact and sink in a horizontal orientation (unless the vehicle landing results in debris, in which case, the debris pieces would be smaller than either Super Heavy or Starship). When Super Heavy and Starship are horizontal, the maximum height is 30 ft (9 m). Thus, the vehicles could obstruct areas or affect water depth in areas 30 ft (9 m) or shallower. However, this would be a temporary impact because an obstruction of a waterway is a clear navigational hazard (and would likely be a navigational hazard even if a portion of the water column was blocked by debris), and SpaceX would be required to remove any debris. Additionally, the size of Super Heavy and Starship are relatively small (hundreds of square meters) compared to the critical habitats of each species (thousands to hundreds of thousands of square kilometers). Thus, the effects would be temporary and geographically constrained, not expected to impact the habitat suitability of critical habitat in the long term, and would be too small to measure and, thus, insignificant.

In summary, the potential effects to ESA-listed species from unrecovered debris are discountable. The potential effects to designated critical habitat from unrecovered debris are insignificant. We conclude that impacts from unrecovered debris to ESA-listed species and designated 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 Impacts from Pollution

Pollution such as vessel pollutants and the launch vehicle propellant and emissions may affect ESA-listed species and their designated or proposed critical habitat.

Pollutants emitted by vessels used during Starship-Super Heavy surveillance or recovery 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 to breathe. 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 effects to ESA-listed species from pollutants from vessel activities are insignificant.

Emissions from launching and landing each stage include nitrogen oxides, carbon monoxide, and other greenhouse gases (FAA 2024a). Stages and payloads (such as satellites 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 because climate can drive range and distribution shifts in ESA-listed species and their prey (Record et al. 2019a). For a given 25 Starship-Super Heavy launches (and associated operations) from the Boca Chica Launch Site, an estimated 107,301 t (97,342 MT) of carbon dioxide equivalent is expected per year (FAA 2024a). Twenty-five launches is approximately one-sixth of the maximum number of launches expected annually, and the estimated amount of carbon dioxide equivalent is less than approximately two hundred-thousandths (0.00002) of the annual carbon dioxide equivalent emission rate of the United States (FAA 2024a). 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 (82 t [74 MT] and 111 t [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 104 t (94 MT) of residual propellant and Starship contained 62 t (56 MT) of residual propellant; and Flight #4 Super Heavy contained 49 t (44 MT) of residual propellant and Starship contained 13 t (12 MT) of residual propellant (K. Condell, SpaceX, pers. comm. to E. Chou, NMFS OPR, 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. Propellant amounts for subsequent flights were not provided. 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 marine mammals and sea turtles 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 are immeasurable and, thus, insignificant.

Vessel pollution may affect designated or proposed critical habitats that have PBFs related to water quality, including those of the Main Hawaiian Islands Insular DPS of false killer whale, Gulf sturgeon, black abalone, and Rice's whale. Pollutants from vehicles may also affect the water quality PBF of Rice's whale proposed critical habitat (Table 2). As previously discussed, pollutants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the limited use of vessels and brief exposure to pollutants, the effect of pollution on water quality PBFs will be so small as to be immeasurable. Thus, the effects of pollution on water quality-related PBFs of designated or proposed critical habitat are 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.

4.1.1.5 Vessel Presence, Strike, and 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. Vessel presence may disturb animals, vessel strike may result in injury or mortality, and vessel noise may cause disturbance because of elevated noise levels. The duration of vessel operations lasts approximately five days for each launch with a recovery. Vessel operations only apply to pre-launch surveillance and post-launch recovery (i.e., vessels are not active the entire day). The proposed action has a limited amount of vessel activity, especially compared to the amount of recreational and commercial vessel traffic across the action area. Given the relatively small contribution of the vessels associated with the proposed action to the overall vessel activity, effects from vessel presence are expected to be so minor that they cannot be meaningfully evaluated and are thus insignificant.

The potential for a vessel striking an ESA-listed species is unlikely because the proposed action consists of relatively little vessel use. 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. A vessel grounding in an area where corals, black abalone, or the proposed sunflower sea star occur would be extremely unlikely because there is no planned vessel activity in coral reef areas, and because a vessel grounding has not occurred during any vessel activities related to the proposed action thus far. 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 compliance with vessel speed rules for critically endangered species (North Atlantic right whale), vessel strikes are considered extremely unlikely to occur. Therefore, ESA-listed species' exposure to vessel strike is discountable.

Noise from 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., maintaining distance from protected species, slowing to 10 kt 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.

Vessel presence may affect designated or proposed critical habitat with prey-related PBFs, including critical habitat for 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 DPS of loggerhead turtle foraging habitat and *Sargassum* habitat, Gulf sturgeon, and proposed 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). Vessels may temporarily displace prey for the duration of the vessel transit through an area. However, limited and temporary vessel use is not expected to measurably affect the distribution, density, quantity, quality, or availability of prey. Therefore, effects from vessels to designated or proposed critical habitat are insignificant.

Given the limited 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.

Vessel noise may also affect the available space for movement and use within shelf and slope habitat for the Main Hawaiian Islands Insular DPS of false killer whale. In the final rule designating Main Hawaiian Islands Insular DPS of false killer whale critical habitat, long-term acoustic disturbance was identified as an obstacle to whale movement. However, given the limited use and temporary duration of vessel operations, the contribution of vessel noise due to the proposed action compared to the overall soundscape will be so small as to be immeasurable and, thus, insignificant.

In summary, the potential effects to ESA-listed species from vessel presence, strike and noise are discountable or insignificant. The potential effects to designated and proposed critical habitat from vessel presence and noise are insignificant. We conclude that impacts from vessel presence, strike and 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.

4.1.1.6 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, and 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.

4.1.1.7 In-Air Acoustic Effects from Vehicle Landings and 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 landing or 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, or an explosive event subsequently occurs. ESA-listed marine mammals and sea turtles spend very little time at the surface, and generally only spend a few seconds to breathe before diving back underwater. Landings, whether they result in an explosive event or not, of Starship and Super Heavy will only occur 90 times in the Gulf and Atlantic Ocean portions of the action area, and only 45 times (for Starship) in the Indian Ocean, Hawaii and Central North Pacific, Northeast and Tropical Pacific, and South Pacific portions of the action area before the launch vehicle is fully reusable. Therefore, given the limited number of landings and explosive events, 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 vehicle landings and explosive events and, thus, the effects are discountable.

In-air acoustic effects from vehicle landings and explosive events may affect acoustic-related PBFs of proposed critical habitat (Rice's whale, see Table 2). However, because explosive events will only occur in a small portion of Rice's whale critical habitat, and the transmission of acoustic energy across the air-water boundary is not effective, and the effects on acoustic PBFs would be so small as to be immeasurable and, thus, insignificant.

We conclude that in-air acoustic effects from vehicle landings and explosive events to ESA-listed species in the action area because of activities covered under this consultation are discountable. We also conclude that effects to proposed critical habitat from in-air acoustic effects from vehicle landings and explosive events are insignificant. Therefore, in-air acoustic effects from vehicle landings and explosive events may affect, but are not likely to adversely affect ESA-listed species or proposed critical habitat.

4.1.1.8 Vibration, Heat, and Debris from Launches

NMFS estimated a maximum of 33 launches in 2025, 69 launches in 2026, 69 launches in 2027, and 24 launches in 2028, for the duration of the current license (see Section 2.1). During previous launches, vibration, heat, and debris were recorded impacting a radius of approximately 0.7 mi (1.1 km), 0.6 mi (1 km) and 0.3 mi (0.5 km), respectively, from the launch site (FAA 2024b). This information is limited because not all monitoring information is available, and, of the information that is available, monitoring only occurred for a handful of launches. Although FAA did not include these stressors in the 2024 Biological Assessment (ManTech SRS Technologies Inc. 2024), the estimated radius of impact extends to the ocean and may affect ESA-listed species that could occur in the immediate vicinity of the launch sites in the Gulf and Atlantic Ocean portions of the action area, including North Atlantic right whale, North Atlantic DPS of green turtle (Atlantic Ocean portion of the action area), Kemp's ridley turtle, leatherback turtle (Atlantic Ocean portion of the action area), Northwest Atlantic Ocean DPS of loggerhead turtle, and smalltooth sawfish (Atlantic Ocean portion of the action area).

Vibration from Starship-Super Heavy launches is likely only to affect smalltooth sawfish because fish are especially able to detect particle motion. Vibration monitoring of previous launches only occurred on land, but determined that a majority of the energy was distributed through the air and not the ground (FAA 2024b). Thus, based on the limited information, we believe that any effects to smalltooth sawfish from launch vibrations will be so small as to be immeasurable and, thus, insignificant.

Monitoring of heat plumes from Starship-Super Heavy launches observed temperatures of approximately 300°F (149°C) at the Boca Chica Launch Site, approximately 212°F (100°C) within a 0.3-mi (0.5-km) radius surrounding the launch site, and approximately 90°F (32°C) (ambient temperature during some seasons) within a 0.6-mi (1-km) radius surrounding the launch site. Water has a significantly higher specific heat capacity (the amount of heat that needs to be added to one unit of mass of a substance to cause an increase of one unit in temperature) than air, meaning it takes much more energy to raise the temperature of water than to raise the temperature of air. Thus, we expect that ocean temperatures are not affected by launches as significantly as the surrounding air. Additionally, ESA-listed marine mammals, sea turtles, and fishes spend a majority of their time underwater compared to at or just above the surface (when breathing, in the case of marine mammals and sea turtles), and water temperatures below the surface are unlikely to be changed by the heat plume from launches. Thus, based on the limited information, we believe that species' exposure to heat plumes from Starship-Super Heavy launches is extremely unlikely and, thus, discountable.

On June 6, 2024, the Coastal Bend Bays & Estuaries Program monitored debris from a Starship-Super Heavy launch and effects to shorebird nests. They observed dust and small debris emanating out from the engine thrust to approximately 1,411 ft (430 m) away, where the further monitored nest was located (LeClaire and Newstead 2024). FAA (2024) states that the report suggests a "gravel plume" consisting of small particles of mud, sand, and gravel, could travel at least 0.3 mi (0.5 km) from the launch site. Thus, it is reasonable to expect that the gravel plume will also enter the water where ESA-listed species may occur. Launch debris are small in size ("pea-sized"; LeClaire and Newstead 2024) and will be scattered across a radius of at least 0.3 mi (0.5 km) from the launch site. Thus, based on the limited information available, we believe that any effects to ESA-listed species in the water would be so small as to be immeasurable and, thus, insignificant.

Heat from Starship-Super Heavy launches may also affect designated critical habitats with PBFs related to water temperature for the North Atlantic right whale. However, because we expect ocean temperatures would not be significantly affected by launch heat plumes, it is extremely unlikely that the PBF will be affected and, thus, the effects are discountable.

We conclude that vibration, heat, and debris effects from Starship-Super Heavy launches to ESA-listed species in the action area because of activities covered under this consultation are discountable or insignificant. We also conclude that effects to designated critical habitat from heat plumes associated with launches are discountable. Therefore, vibration, heat, and debris from launches may affect, but are not likely to adversely affect, ESA-listed species or designated critical habitat.

4.1.1.9 Heat from Vehicle Landings and Explosive Events

Heat from a vehicle landing (produced by engines during the landing burn) or explosive event may affect ESA-listed marine mammals, sea turtles, and fishes. An explosive event would result in a temporary but significant increase in temperatures at the surface of the ocean because of the burning of propellant. To be exposed to this stressor, ESA-listed species would have to be in the exact same place at the exact same time that Starship or Super Heavy lands or an explosive event subsequently occurs. ESA-listed species spend a vast majority of time underwater, and it is unlikely species would occur at the surface at the same time as a landing or explosive event. Additionally, Super Heavy and Starship landings will occur 50 times, and explosive events 40 times, in the Gulf and Atlantic Ocean portions of the action area (and fewer in other portions of the action area where only Starship landings will occur) before the launch vehicle is fully reusable in 2030. Therefore, given the limited number of landings and explosive events and limited time ESA-listed marine mammals and sea turtles in particular spend at the surface, it is extremely unlikely that ESA-listed species will be exposed to heat from vehicle landings and explosive events.

Heat from vehicle landings and explosive events may also affect designated or proposed critical habitat with PBFs related to water temperature for North Atlantic right whale and Rice's whale. Sea surface temperatures in North Atlantic right whale critical habitat would be significantly affected if an explosive event were to occur within the critical habitat. However, the increase in temperature would be temporary, lasting minutes while the explosion consumes the remaining propellant, and, thus, the effects would be so small as to be immeasurable and, thus, insignificant. We expect that sea surface temperatures will return to temperatures prior to the explosive event once the event ends. Bottom temperatures (for proposed Rice's whale critical habitat) are not expected to be significantly affected by vehicle landings and explosive events because the water depth for proposed Rice's whale critical habitat is between 328–1,312 ft (100–400 m), and it is extremely unlikely that heat from the surface would travel to those depths and, thus, effects are discountable.

We conclude that the effects of heat from vehicle landings and explosive events to ESA-listed species in the action area because of activities covered under this consultation are discountable. We also conclude that effects to designated or proposed critical habitat from heat associated with landings and explosive events are discountable or insignificant. Therefore, heat from vehicle landings and explosive events may affect, but is not likely to adversely affect, ESA-listed species or designated or proposed critical habitat.

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 are not 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 be affected by 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 calculated the ensonified area (area filled with sound) resulting from a Starship and Super Heavy explosive event, and multiplied the ensonified area by available species densities to get an estimated number of animals exposed.

To calculate the ensonified area, 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 10,966 lb (4,974 kg) for Starship (half of approximately 21,929 lb or 9,947 kg) and 7,275 lb (3,330 kg) for Super Heavy (half of 14,551 lb or 6,660 kg) will enter the water. The model also considered the distance above the ocean's surface at which the explosive event will occur (14.8 ft or 4.5 m for Starship and 9.8 ft or 3 m for Super Heavy), and a transmission coefficient of 0.0326, to calculate the peak sound pressure level (SPL_{peak}) for both vehicle explosions. The SPL_{peak} for a Starship explosive event is 267.7 decibels referenced to a pressure of one microPascal (dB re 1µPa), and the SPL_{peak} for a Super Heavy explosive event is 270.7 dB re 1µPa. Using these SPL_{peak} values, SpaceX calculated the ensonified areas within which species could respond to the underwater acoustic stressor as a circle, using spherical spreading (generally used for deeper waters, where the sound waves propagate away from the source uniformly in all directions compared to cylindrical spreading where the sound waves cannot propagate uniformly in all directions because the sound will hit the sea surface or seafloor). Measurable responses are not anticipated outside of the ensonified areas identified below for each ESA-listed marine mammal for a Super Heavy and Starship explosive event (Table 4).

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

Species	Hearing Group	Minimum Threshold to Response* (dB re 1µPa)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)
Blue Whale	Low-frequency	216	0.9338	0.4625
False Killer Whale – Main	High-frequency	224	N/A	0.0733

Hawaiian Islands Insular DPS				
Fin Whale	Low-frequency	216	0.9338	0.4625
Guadalupe Fur Seal	Otariid	224	N/A	0.0733
Hawaiian Monk Seal	Phocid	217	N/A	0.37
Humpback Whale – Central America DPS	Low-frequency	216	N/A	0.4625
Humpback Whale – Mexico DPS	Low-frequency	216	N/A	0.4625
North Atlantic Right Whale	Low-frequency	216	0.9338	0.4625
Rice's Whale	Low-frequency	216	0.9338	0.4625
Sei Whale	Low-frequency	216	0.9338	0.4625
Sperm Whale	High-frequency	224	0.148	0.0733

* Note SPL_{peak} thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers
N/A = Not Applicable; Super Heavy explosive events will not occur where these species may occur

To estimate the number of exposures resulting from an explosive event, SpaceX multiplied the maximum species densities in each relevant portion of the action area by the ensonified areas. However, NMFS review of the species densities for the Gulf and Atlantic Ocean portions of the action area determined that there were discrepancies in the maximum densities used, and that there was not enough information on the Super Heavy landing area more than 1 NM from shore. FAA and SpaceX did not have information on whether vehicle landings and explosive events would occur in greater number or probability in certain areas (e.g., nearer to the launch site). Thus, based on the best available information on landing or explosive event locations, NMFS estimated there is an equal probability of a landing or explosion anywhere within each portion of the action area. Based on this assumption, the maximum species density is not an accurate representation of species densities across the action area. Thus, NMFS determined the maximum monthly mean density for each marine mammal species in the Gulf and Atlantic Ocean portions of the action area, and used those densities to estimate the number of exposures. All other portions of the action area use the species density identified by FAA/SpaceX.

Information provided by FAA and SpaceX included Super Heavy landings and explosive events 1–5 NM from shore "directly east" of the Boca Chica Launch Site and LC-39A. However, a specific area, which is needed to determine species density, was not provided. Thus, NMFS used the best available information on vehicle landings 1–5 NM from shore, which is between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site, and between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A (the same area as Starship landings and explosive events 1–5 NM from shore), to determine marine mammal densities.

Because the portions of the action area where explosive events 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. 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 density data for the South Pacific portion of the action area were not available. The following marine mammal density datasets were used for each action area (Table 5). Species densities and estimated numbers of exposures that would amount to more than insignificant (i.e., that would be enough to be meaningfully measured) are summarized in Tables 6–10 (excluding the South Pacific portion of the action area because no density data were available). Note that estimated exposures may not match the exact product of the density and ensonified area due to rounding.

Table 5. Marine mammal density data sources for each portion of the action area

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

* North Atlantic right whale densities were determined by using the most recent dataset (2010–2019), as suggested by the authors

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

Table 6. ESA-listed marine mammal densities in the Gulf 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 and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Rice's Whale	0.000024	0.93	0.46	0.00045	0.00022	0.00067
Sperm Whale	0.00499	0.15	0.07	0.0148	0.0073	0.022

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that Rice's whales and sperm whales in the Gulf portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 6).

Table 7. 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 and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Blue Whale	0.0000122	0.93	0.46	0.00022	0.00011	0.000341
Fin Whale	0.000095	0.93	0.46	0.00177	0.00088	0.002653
North Atlantic Right Whale	0.000014	0.93	0.46	0.00026	0.00013	0.000389
Sei Whale	0.00014	0.93	0.46	0.00268	0.0013	0.004005
Sperm Whale	0.00528	0.15	0.07	0.0156	0.0077	0.023366

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue, fin, North Atlantic right, sei, and sperm whales in the Atlantic

Ocean portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 7).

Table 8. 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

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue, fin, and sperm whales in the Indian Ocean portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 8). 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 elicit a measurable response in sei whales would be lower than that for blue, fin, and sperm whales (Table 8).

Table 9. ESA-listed marine mammal densities in the Hawaii 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

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue whales, Main Hawaiian Islands Isular DPS false killer whales, fin whales, Hawaiian monk seals, sei whales, and sperm whales in the Hawaii and Central North Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 9).

Table 10. 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

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue whales, fin whales, Guadalupe fur seals, humpback whales, sei whales, and sperm whales in the Northeast and Tropical Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 10).

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, the small size of ensonified areas within which measurable responses would be expected, and anticipated densities of ESA-listed marine mammals, we believe that ESA-listed marine mammals are extremely unlikely to be exposed to underwater acoustic effects from vehicle explosive events, and, therefore, the effects are 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 underwater acoustic effects from explosive events due to the proposed action are: Central North Pacific DPS, East Indian-West Pacific DPS, East Pacific 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 North Atlantic DPS of green turtle, Kemp's ridley turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle are discussed in Sections 4.2 and 6.

Using the same methodology described for marine mammals in Section 4.1.2.1, SpaceX estimated the number of sea turtle exposures that would be more than insignificant. Insignificant responses are anticipated outside of the ensonified areas identified for each ESA-listed sea turtle species for a Super Heavy and Starship explosive event. The ensonified areas are the same across all sea turtle species because all sea turtle species belong to the same hearing group and have the same minimum threshold to a response (SPL_{peak} 226 dB re 1µPa). The ensonified area for a Super Heavy explosive event is 0.0934 km^2 and the ensonified area for a Starship explosive event is 0.0463 km^2.

Similar to marine mammal densities (see Section 4.1.2.1), NMFS found discrepancies in the maximum sea turtle densities used to estimate the number of exposures in the Gulf and Atlantic Ocean portions of the action area. Because FAA and SpaceX did not have information on whether vehicle landings and explosive events would occur in greater number or probability in certain areas (e.g., nearer to the launch site), NMFS estimated there is an equal probability of a landing or explosion anywhere within each portion of the action area. Based on this assumption, the maximum species density is not an accurate representation of species densities across the action area. Thus, NMFS determined the maximum monthly mean density for each sea turtle species in the Gulf and Atlantic Ocean portions of the action area, and used those densities to estimate the number of exposures. All other portions of the action area use the species density identified by FAA/SpaceX. Additionally, because a specific area was not provided to determine species densities associated with Super Heavy explosive events 1–5 NM from shore in the Gulf and Atlantic Ocean portions of the action area, NMFS determined species densities 1–5 NM from shore, between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site, and between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A.

The following sea turtle density datasets were used for each action area (Table 11). Species densities and estimated number of exposures that would amount to more than insignificant are summarized in Tables 12–15 (excluding the Indian Ocean and South Pacific portions of the action area because no density data were available). Experts noted caveats with the data used to determine sea turtle densities on the U.S. East Coast (DiMatteo et al. 2024; W. Piniak, NMFS OPR pers. comm. to E. Chou, NMFS OPR, March 19, 2025), including but not limited to: limitations in detecting turtles smaller than 16 inches (in; 40 centimeters [cm]) during surveys, apparent discrepancies in the estimated population abundance used to calculate densities, and the assumption of a Gulf species correction factor for the Atlantic. Despite these caveats, DiMatteo et al. (2024b) still represents the best available information on sea turtle densities along the U.S. East Coast. Note that estimated exposures may not match the exact product of the density and ensonified area due to rounding.

Table 11. Sea turtle density data sources for each portion of the action area

Portion of the Action Area	Density Data Sources
Gulf	Garrison et al. (2023b)
Atlantic Ocean	DiMatteo et al. (2024b)
Indian Ocean	Not available
Hawaii and Central North Pacific	U.S. Navy (2024)
Northeast and Tropical Pacific	U.S. Navy (2024)
South Pacific	Not available

Table 12. ESA-listed sea turtle densities in the Gulf 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 and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Green Turtle	0.018254	0.093	0.046	0.0341	0.0169	0.051
Leather-back Turtle	0.019504	0.093	0.046	0.03643	0.01806	0.0545

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.

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that green and leatherback turtles in the Gulf portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 12). Hawksbill turtles nest at low densities throughout the southern Gulf (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 portion of the action area. Thus, it is extremely unlikely that hawksbill turtles will be exposed to underwater acoustic effects of up to 20 Super Heavy and 20Starship explosive events so these effects would be discountable.

Table 13. ESA-listed sea turtle 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 and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Kemp's Ridley Turtle	0.00883	0.093	0.046	0.01649	0.00817	0.024665
Leather-back Turtle	0.02812	0.093	0.046	0.0525	0.02604	0.078583

km^2 = square kilometers
Note: no densities were available for hawksbill turtles. The North Atlantic DPS of green turtle and Northwest Atlantic Ocean DPS of loggerhead turtle are analyzed in Section 6.

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that Kemp's ridley and leatherback turtles in the Atlantic Ocean portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 13). It is also extremely unlikely that hawksbill turtles, for which there are no density estimates, will be exposed to the underwater acoustic effects of up to 20 Super Heavy and 20 Starship explosive events. 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 2013c). 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. Thus, underwater acoustic effects to hawksbill turtles are discountable.

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 Indian Ocean portion of 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 2014b), although satellite tagging of one individual showed movement to waters deeper than 656 ft (200 m; Rees et al. 2012). Hawksbill turtles in the eastern Indian Ocean generally forage in waters less than 328 ft (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 8). In addition, given the small ensonified area within which significant responses would 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 14. ESA-listed sea turtle densities in the Hawaii 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	Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	0.00027	0.046	0.0003
Hawksbill Turtle	0.00005	0.046	0.00005
Leatherback Turtle	0.00115	0.046	0.001
Loggerhead Turtle	0.00184	0.046	0.002
Olive Ridley Turtle	0.00178	0.046	0.002

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that green, hawksbill, leatherback, loggerhead, and olive ridley turtles in the Hawaii and Central North Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 14).

Table 15. ESA-listed sea turtle 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	Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	0.00	0.046	0
Leatherback Turtle	0.001	0.046	0.001
Loggerhead Turtle	0.00	0.046	0

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that green, leatherback, and loggerhead turtles in the Northeast and Tropical Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 15). 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 Northwestern Hawaiian Islands; however, observations of hawksbill turtles in Hawaii 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, likely because 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, meaning they are unlikely to be exposed to the underwater acoustic effects from Starship explosive events, so 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, which are the 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 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 size of the South Pacific portion of the action area, as well as 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 Starship explosive events.

In summary, given the low estimated exposures that could amount to an effect beyond insignificant and small ensonified areas within which measurable responses could occur, we expect that ESA-listed sea turtles are extremely unlikely to be exposed to underwater acoustic effects from vehicle explosive events. Thus, effects from underwater acoustic effects from explosive events on ESA-listed sea turtles are 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 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 Fishes

The ESA-listed fish species that are not likely to be adversely affected by underwater acoustic effects from explosive events due to the proposed action are: Carolina DPS, Chesapeake Bay 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 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 coastal waters (from the coast to the continental shelf edge) and rivers such as the Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark (although scalloped hammerhead shark may occur off the continental shelf edge, the approximate species range does not overlap with portions of the action area where explosive events will occur), 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

Super Heavy or Starship explosive events. These species are not expected to occur in high numbers or densities in areas where Super Heavy or Starship explosive events are likely to occur. Additionally, based on NMFS's physical injury acoustic thresholds for large fish (> 2 grams), the ensonified area from a Super Heavy or Starship explosion is 9.34 km^2 and 4.63 km^2, respectively. Given the relatively small ensonified areas compared to the size of each portion of 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 Super Heavy or Starship explosive events. Thus, the effects are discountable.

Oceanic whitetip sharks are caught in the yellowfin tuna fishery in the Gulf and Northwest Atlantic Ocean. In the 1950s, during exploratory tuna surveys, nearly 400 oceanic whitetip sharks were caught, relative to only five caught in the 1990s during the commercial yellowfin tuna fishery in the Gulf (Baum and Myers 2004). Although Young et al. (2018) estimate oceanic whitetip shark abundance declined about 4% between 1992 and 2005, there was a significant historic decline in abundance (88% in the Gulf; FAO 2012). Young et al. (2018) conclude that oceanic whitetip sharks are now relatively rare in the Northwest Atlantic and Gulf.

The Flower Garden Banks National Marine Sanctuary serves 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 20 NM 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 from 1925–2020, Farmer et al. (2022a) modeled the probability of occurrence for giant manta rays in the Gulf and Northwest Atlantic. Farmer et al. (2022a) modeled higher probabilities of occurrence nearshore compared to areas offshore. Overall, we do not expect oceanic whitetip sharks and giant manta rays to occur in high numbers or densities within the Gulf and Atlantic Ocean portions of the action area. Given the low probabilities of occurrence, relatively small ensonified areas within which measurable responses could be expected, 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 explosive events in the Gulf 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 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 (> 68°F or 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 2017c). Oceanic whitetip sharks have been caught 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 caught 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 caught as bycatch 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 measurable responses could be expected 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 8).

Oceanic whitetip shark and giant manta ray occurrence within the Hawaii and Central North Pacific portion of the action area were estimated from the NMFS Pacific Islands Regional Office's Protected Resources Division 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 occurred 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 Hawaii and Central North Pacific portion of the action area, which is over 38 million mi^2 (10 million km^2) in size. Thus, given the low estimated number of possible exposures of oceanic whitetip shark and giant manta ray in the action area, small ensonified area within which measurable responses could be expected, 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 Hawaii 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 Hawaii 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 with 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, 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 based on the Rubin et al. (2024) study. It appears 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 measurable responses could be expected 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 and thus discountable.

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 within which measurable responses could occur, and limited number of explosive events, we expect that ESA-listed fishes are extremely unlikely to be exposed to underwater acoustic effects from vehicle explosive events. Thus, effects from underwater acoustic effects from explosive events on ESA-listed fishes are discountable.

We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed Carolina DPS, Chesapeake Bay 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 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 ESA-Listed Invertebrates

The ESA-listed invertebrates that are not likely to be adversely affected by underwater acoustic effects from explosive events due to the proposed action are: black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and the proposed sunflower sea star.

Black abalone occur along the coast from Point Arena, California to Northern Baja California, Mexico in waters from the high intertidal zone to about 20 ft (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 underwater acoustic effects from explosive events, which will occur offshore in the Northeast and Tropical Pacific portion of the action area. Boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, and staghorn coral occur in coastal areas (from the coast to continental shelf edge) throughout the Caribbean (NMFS 2022). The range of these coral species does not overlap with either the Gulf or Atlantic Ocean portions of the action area where explosive events will occur. Thus, it is extremely unlikely that ESA-listed corals will be exposed to underwater acoustic effects from explosive events. The proposed sunflower sea star occurs in coastal waters from the Aleutian Islands to Baja California, and is most commonly found in waters less than 82 ft (25 m) deep, and rare in waters deeper than 394 ft (120 m; Lowry et al. 2022). Because the proposed sunflower sea star does not occur where explosive events will occur, it is extremely unlikely that proposed sunflower sea star will be exposed to underwater acoustic effects from explosive events.

In summary, given the range and distribution of ESA-listed invertebrates across the action area, we expect that ESA-listed invertebrates are extremely unlikely to be exposed to underwater acoustic effects from explosive events. Thus, underwater acoustic effects from explosive events on ESA-listed invertebrates are discountable.

We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed sunflower sea star.

4.1.3 Critical Habitat Not Likely to be Adversely Affected

This section identifies the designated or proposed critical habitat for which effects are NLAA from stressors resulting from the proposed action and are not analyzed further in this opinion. Critical habitats that are not likely to be adversely affected by the proposed action 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, North Atlantic right whale, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, 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.

Designated critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale may be affected, but is not likely to be adversely affected by the following stressors: vessel presence, vessel noise, vessel pollution, and aircraft overflight. Vessel presence may affect PBFs related to prey species of sufficient quantity and availability. Vessels may temporarily displace prey while the vessel transits through an area; however, limited and temporary vessel use is not expected to measurably affect the quantity, quality, or availability of prey. Pollution from vessels may affect the PBF: waters free of pollutants of a type and amount harmful to Main Hawaiian Islands Insular false killer whales. Given the limited use of vessels and the short amount of time action-related vessels will be in use, pollution is not expected to measurably affect the water quality, or increase the health risks in a manner that would be harmful to Main Hawaiian Islands Insular false killer whales. Vessel noise and aircraft overflight may affect PBFs: adequate space for movement and use within habitats, and sound levels that would not significantly impair false killer whales' use or occupancy. However, vessel and aircraft noise will be temporary and aircraft noise is extremely limited given that acoustic energy does not effectively cross the air-water boundary, and is not expected to measurably affect false killer whale movement, space use, or occupancy. Thus, effects from stressors from vessel and aircraft use on Main Hawaiian Islands Insular DPS of false killer whale critical habitat are too small to measure and thus insignificant.

Designated critical habitat for the Central America DPS and Mexico DPS of humpback whale may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Vessels may temporarily displace prey for the duration the vessel transits through an area; however, limited vessel use and the short amount of time action-related vessels will be in use are not expected to measurably affect the quality, abundance, or accessibility of prey. Thus, the effect from vessel presence on the Central America DPS and Mexico DPS of humpback whale critical habitat is expected to be too small to measure and thus insignificant.

Designated critical habitat for the Hawaiian monk seal may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Vessels may temporarily displace prey for the duration the vessel transits through an area; however, limited vessel use is not expected to measurably affect the quality or quantity of prey. Thus, the effect from vessel presence on the Hawaiian monk seal critical habitat is insignificant.

Designated critical habitat for the North Atlantic right whale may be affected, but is not likely to be adversely affected by the following stressors: direct impact from fallen objects, heat from launches, and heat from vehicle landings and explosive events. Falling objects, especially large objects like Starship and Super Heavy, hitting the ocean surface may temporarily affect calm conditions. However, impacts would only be in the immediate vicinity of the fallen object, and conditions would return to normal shortly after impact. Heat from launches, landings, and explosive events may affect sea surface temperatures. However, the increase in sea surface temperature would also be temporary and temperatures would return to normal shortly after the launch, landing, or explosive event. Temporary heat from these activities is not expected to affect North Atlantic right whale critical habitat conditions to an extent that would be measurable. Thus, the effects from stressors on North Atlantic right whale critical habitat are insignificant.

Designated critical habitat for the leatherback turtle may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Vessels may temporarily displace prey for the short time the vessel transits through an area; however, limited vessel use is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effect from vessel presence on the leatherback turtle critical habitat is insignificant.

Designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle may be affected, but is not likely to be adversely affected by the following stressors: direct impact by fallen objects, unrecovered debris, and vessel presence. Designated critical habitat of the Northwest Atlantic Ocean DPS of loggerhead turtle is categorized into different habitat types, each with their own set of PBFs. The habitat types that may be affected, but are not likely to be adversely affected by the proposed action include: foraging habitat, constricted migratory habitat, and *Sargassum* habitat. Breeding habitat is discussed in Sections 4.2.4 and 6. Direct impact by fallen objects may affect PBFs related to adequate cover. The area of critical habitat that Super Heavy, Starship, or associated debris could impact as it falls through the water column is relatively small (hundreds of square meters or less) compared to the area over which *Sargassum* habitat can be distributed (hundreds of thousands of square kilometers). Thus, it would be extremely unlikely that the amount of available cover in this critical habitat unit would be measurably affected by falling objects.

Unrecovered debris may affect PBFs related to passage conditions and water depth. Unrecovered debris could create obstructions to passageways or affect water depth if they land in shallow areas where the size of the debris blocks the water column. Based on the available information from FAA and SpaceX, Super Heavy and Starship may land intact and sink in a horizontal orientation (unless the vehicle landing results in debris, in which case, the debris pieces would be smaller than either Super Heavy or Starship). When Super Heavy and Starship are horizontal, the maximum height is 30 ft (9 m). Thus, the vehicles could obstruct areas or affect water depth in areas 30 ft (9 m) or shallower. However, this would be a temporary impact because the obstruction of a waterway is a clear navigational hazard (and would likely be a navigational hazard if a portion of the water column was blocked by debris), and SpaceX would be required to remove the obstruction. Super Heavy and Starship are relatively small compared to the size of critical habitat units of each species considered here, and the vehicle or debris would only temporarily obstruct a portion of the critical habitat related to passage and depth. Thus, the effects would not be expected to affect the long-term conditions of critical habitat.

Direct impact by fallen objects and vessel presence may affect PBFs related to prey availability. Vessels and falling objects may temporarily displace prey for the short time the vessel transits through an area or the object sinks through the water column; however, the duration of these stressors is brief (on the order of days or less), limited to the immediate vicinity of the vessel or object, and is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effects from stressors on the Northwest Atlantic Ocean DPS of loggerhead turtle critical habitat (foraging habitat, constricted migratory habitat, and *Sargassum* habitat) are discountable or insignificant.

Designated critical habitat for the Gulf sturgeon may be affected, but is not likely to be adversely affected by the following stressors: vessel presence and vessel pollution. Vessel presence may affect prey abundance and displace prey for the duration the vessel transits through the area; however, given the limited use of vessels and duration of activities requiring vessels, vessels are not expected to measurably affect the abundance of prey. Vessel pollution may affect the water quality PBF of Gulf sturgeon critical habitat. Pollutants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the limited use of vessels and limited number of times either vehicle can be expended in the ocean, vessel pollution is not expected to measurably affect water quality of Gulf sturgeon critical habitat. Thus, effects from stressors on Gulf sturgeon critical habitat are insignificant.

Designated critical habitat for Nassau grouper may be affected, but is not likely to be adversely affected by the following stressors: direct impact by fallen objects and vessel presence. Falling objects may directly affect benthic habitat and habitat used for shelter. However, the debris that could occur in Nassau grouper critical habitat would result from a mishap, in which case, the debris would be widely dispersed and scattered across an area significantly larger than the area of the critical habitat. The likelihood that a falling object directly hits benthic habitat would be extremely unlikely. Vessel presence may affect prey abundance by temporarily displacing prey for the short time the vessel transits through an area. However, limited and temporary vessel use is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effect from stressors on Nassau grouper critical habitat is either discountable or insignificant.

Designated critical habitat for black abalone may be affected, but is not likely to be adversely affected by the following stressor: vessel pollution. Pollution from vessels may affect the water quality PBF of black abalone critical habitat. Given the limited and temporary use of vessels, pollution is not expected to measurably affect water quality of black abalone critical habitat. Thus, the effect from vessel pollution on black abalone critical habitat is insignificant.

Designated critical habitat for boulder star coral, lobed star coral, mountainous star coral, pillar coral, and rough cactus coral may be affected, but is not likely to be adversely affected by the following stressor: direct impact by fallen objects. Falling objects may directly affect substrate; however, it is extremely unlikely that debris from a mishap will occur within coral critical habitat (see Section 4.1.1.2). Falling objects may disturb the sediment at the seafloor as they settle, and affect water quality and the amount of sediment that settles on top of the reef. If debris impacts the seafloor in proximity to ESA-listed corals, the sediment would be temporarily resuspended, and would be dispersed by currents and water movement while in the water column. Water quality would be temporarily affected, only near the fallen object, and would return to normal conditions shortly after the object has settled. It is extremely unlikely that the displaced sediment would be of adequate volume to cover the coral habitat. Thus, the effect from direct impact by fallen objects on boulder star coral, lobed star coral, mountainous star coral, pillar coral, and rough cactus coral are discountable.

Designated critical habitat for elkhorn coral and staghorn coral may be affected, but is not likely to be adversely affected by the following stressor: direct impact by falling objects. Substrate quality and availability may be affected by falling objects; however, falling objects would only be present near critical habitat if there is a mishap. In that case, the objects would be widely dispersed within an area much larger than the critical habitat area, making it extremely unlikely critical habitat would be afffected. Thus, the effect from direct impact by falling objects on elkhorn coral and staghorn coral critical habitat is discountable.

Proposed critical habitat for the Central North Pacific DPS and East Pacific DPS of green turtle may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Proposed critical habitat for the Central North Pacific DPS and East Pacific DPS of green turtle is categorized into different habitat types, each of which has their own set of PBFs. The habitat type that may be affected, but is not likely to be adversely affected by the proposed action is the benthic foraging/resting feature. Vessel use may affect the PBF related to food resources (i.e., prey), as it may temporarily displace prey for the short time the vessel transits through an area. However, limited and temporary vessel use is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effect from vessel presence on Central North Pacific DPS and East Pacific DPS of green turtle proposed critical habitat is insignificant.

Proposed critical habitat for the North Atlantic DPS of green turtle may be affected, but is not likely to be adversely affected by the following stressors: direct impact by fallen objects, unrecovered debris, and vessel presence. Proposed critical habitat for the North Atlantic DPS of green turtle is categorized into different habitat units, each of which has their own set of PBFs. The habitat units that may be affected, but are not likely to be adversely affected by the proposed action include reproductive, migratory, benthic foraging/resting, and surface-pelagic foraging/resting. Direct impact by fallen objects may affect the availability of refugia. The area of critical habitat that Super Heavy, Starship, or associated debris could affect as it falls through the water column is relatively small (hundreds of square meters or less) compared to the area of benthic foraging/resting and surface-pelagic foraging/resting habitat (hundreds of thousands of square kilometers). Thus, it would be extremely unlikely that the amount of refugia would be affected by falling objects. Unrecovered debris may affect PBFs related to unobstructed waters and water depth. Unrecovered debris could create obstructions or affect water depth if they land in shallow areas where the size of the debris blocks the water column, as described above. The vehicles could obstruct areas or affect water depth in areas 30 ft (9 m) or shallower. However, this would be a temporary impact because an obstruction of a waterway is a clear navigational hazard, and SpaceX would be required to remove any obstruction. The size of Super Heavy and Starship are relatively small compared to the area of proposed critical habitat of this DPS, and would only temporarily obstruct a portion of the proposed critical habitat. Thus, the effects would not be expected to measurably affect the conditions of proposed critical habitat. Direct impact by fallen objects may affect PBFs related to refugia and prey resources. Falling objects and vessel presence may temporarily displace prey for the duration the object moves through the water column or vessels transit through the area. This is temporary and localized, and not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, effects from stressors on North Atlantic DPS of green turtle proposed critical habitat are discountable or insignificant.

Proposed critical habitat for Rice's whale may be affected, but is not likely to be adversely affected by the following stressors: sonic booms and impulse noise, direct impact by fallen objects, vessel presence, vessel and vehicle pollution, vessel noise, aircraft overflight, in-air acoustic effects from vehicle landings and explosive events, heat from vehicle landings and explosive events, and underwater acoustic effects from explosive events. Acoustic-related stressors (sonic booms, impulse noise, vessel noise, in-air acoustic effects from vehicle landings and explosive events, and underwater acoustic effects from explosive events) may affect the PBF related to sufficiently quiet conditions for normal use and occupancy. Given the limited number of times and short duration that these activities will occur, in addition to the ineffective transmission of acoustic energy across the air-water boundary, these stressors are not expected to measurably affect acoustic conditions long-term. Direct impact by fallen objects and vessel presence may temporarily displace prey for the duration the object moves through the water column or vessels transit through an area. Given the temporary duration of those activities, these stressors are not expected to measurably affect the density, quality, abundance, or accessibility of prey. Vessel and vehicle pollution may affect the PBF related to the level of pollutants in marine water. However, given the limited vessel activity and number of times Starship and Super Heavy will be expended in a manner that facilitates pollutants entering the ocean and dispersion of pollutants in the ocean (i.e., explosive event), we expect the effects of vessel and vehicle pollution on proposed critical habitat will be so small as to be immeasurable. Heat from vehicle landings and explosive events may temporarily affect surface temperatures; however, the increase in temperature is extremely unlikely to affect the bottom temperature range specified in the PBF. Thus, effects from stressors on Rice's whale proposed critical habitat are discountable or insignificant.

We conclude the proposed action may affect, but is 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, North Atlantic right whale, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle (with the exception of breeding habitat), Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle, and Rice's whale.

4.2 Status of the Species and Critical Habitat Likely to be Adversely Affected

The remainder of this opinion examines the status of each species and critical habitat that is likely to be adversely affected by the proposed action (Kemp's ridley turtle and Northwest Atlantic Ocean DPS of loggerhead turtle in the Gulf portion of the action area, North Atlantic DPS of green turtle and Northwest Atlantic Ocean DPS of loggerhead turtle in the Atlantic Ocean portion of the action area, and designated critical habitat of Northwest Atlantic Ocean DPS loggerhead turtle – breeding critical habitat). 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, critical habitat, and recovery planning. The status of each critical habitat is described in terms of the PBFs essential to the conservation of the species; the status, function, and extent of those PBFs based on best available scientific and commercial data; and the conservation needs of the species in terms of habitat to support a recovered population.

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. This section also examines the condition of critical habitat throughout the species' range, evaluates the conservation value of the various components of the habitat (e.g., watersheds, ocean basins, and coastal and marine environments) that make up the designated area, and discusses the function of the essential PBFs that help to form that conservation value. 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 Green, Kemp's Ridley, and Loggerhead Turtles

ESA-listed sea turtles in the Gulf and Atlantic portions 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. North Atlantic DPS green, Kemp's ridley, and Northwest Atlantic Ocean DPS loggerhead turtles generally nest from late spring to late summer/early fall.

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).

4.2.2 Threats Common to Green, Kemp's Ridley, and Loggerhead Turtles

ESA-listed sea turtles in the Gulf and Atlantic Ocean portions of the action area face numerous natural and human-induced threats that shape their status and affect their ability to recover. Many of these threats are either the same or similar in nature among the North Atlantic DPS of green, Kemp's ridley, and Northwest Atlantic Ocean DPS of loggerhead turtle. The threats identified in this section apply to all three species. Information on threats specific to a particular species is discussed in the corresponding Status of the Species sections where appropriate.

ESA-listed sea turtles in the Gulf and Atlantic Ocean portions of the action area were threatened by overharvesting and poaching. Although intentional take of sea turtles and their eggs does not occur extensively within these portions 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, changing environmental trends, oceanic events such as cold-stunning, natural predation, and disease.

4.2.3 Green Turtle – North Atlantic DPS

The green turtle was first listed as endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened for all other areas under the ESA in 1978 (43 Fed. Reg. 32800). On April 6, 2016, the NMFS listed 11 DPSs of green turtles, with the North Atlantic DPS listed as threatened (81 Fed. Reg. 20057).

Life History

Adult females in the North Atlantic DPS nest from May–September. Female age at first reproduction is 20–40 years. Green turtles lay an average of three nests per season with an average of 100 eggs per nest (Seminoff et al. 2015). The remigration interval (i.e., return to natal beaches) is two to five years. Nesting is geographically widespread within the action area, and occurs along the southeastern Atlantic coast of the U.S. and the northwestern Gulf coast. Nesting primarily occurs along the central and southeast Atlantic coast of Florida. Four regions support nesting concentrations of particular interest in the North Atlantic DPS: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), U.S. (Florida), and Cuba. The largest nesting site occurs in Tortuguero, Costa Rica (Seminoff et al. 2015).

Green turtle juveniles are capable of hearing underwater sounds at frequencies of 50–1,600 Hz and experience maximum sensitivity at 200–400 Hz, although sensitivity is still possible outside of this range (Piniak et al. 2016; Lenhardt 1994; Bartol and Ketten 2006; Ridgway et al. 1969).

Population Dynamics

Accurate population estimates for sea turtles do not exist because of the difficulty in sampling turtles over their large geographic ranges and within their marine environments. Nonetheless, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends and nester abundance is provided in the most recent status review for the species (Seminoff et al. 2015). The North Atlantic DPS is the largest of the 11 green turtle DPSs, with an estimated nester abundance of over 167,000 adult females from 73 nesting sites.

Florida accounts for approximately 5% of nesting for this DPS (Seminoff et al. 2015). According to data collected from Florida's index nesting beach survey from 1989–2024, green turtle nest counts across Florida have increased from a low of 267 in the early 1990s to a high of 40,911 in 2019. Nesting decreased by half from 2019–2020, although it increased to a new record high in 2023 before dropping substantially in 2024. Green turtles generally follow a two-year reproductive cycle, which may explain fluctuating nest counts. Tortuguero, Costa Rica is the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al. 2015). A recent long-term study spanning over 50 years of nesting at Tortuguero found that while nest numbers increased steadily over 37 years from 1971–2008, the rate of increase slowed gradually from 2000–2008. After 2008, nesting trends decreased, with current nesting levels having reverted to that of the mid-1990s and the overall long-term trend has now become negative (Restrepo et al. 2023). While nesting in Florida has shown increases over the past decade, individuals across North Atlantic DPS nesting sites intermix and share developmental and foraging habitat. Therefore, threats that have affected nesting in the Tortuguero region may ultimately influence the trajectories of nesting in the Florida region.

DiMatteo et al. (2024a) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult green turtles along the U.S. Atlantic Coast of 63,674 individuals (90% Confidence Interval [CI] = 23,381–117,610 individuals).

Threats

In addition to general threats common to all three sea turtle species considered, green turtles are especially susceptible to natural mortality from fibropapillomatosis (FP) disease (Blackburn et al. 2021; Foley et al. 2005; Manes et al. 2022; Shaver et al. 2019; Tristan et al. 2010). The prevalence of FP has reached epidemic proportions in some parts of the North Atlantic DPS of green turtle, including Florida, although the long-term impacts to North Atlantic DPS green turtles is unknown (Seminoff et al. 2015). FP 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). When these 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. Although the exact cause of FP is unknown, it is believed to be related to an infectious agent, such as a virus, and/or environmental conditions such as habitat degradation and pollution (Foley et al. 2005).

Critical Habitat

Green turtle designated and proposed 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 and U.S. Fish and Wildlife Service (USWFS) identified actions needed to recover the U.S. Atlantic population of green turtles. These threats are discussed in further detail in the environmental baseline of this consultation. See the NMFS and USFWS 1991 recovery plan for the U.S. Atlantic population of green turtles for complete down-listing/delisting criteria for each of the following major actions (NMFS and USFWS 1991). The following items were identified as priorities to recover U.S. Atlantic green turtles:

1. Provide long-term protection to important nesting beaches.
2. Ensure at least 60% hatch success on major nesting beaches.
3. Implement effective lighting ordinances or lighting plans on nesting beaches.
4. Determine distribution and seasonal movements for all life stages in the marine environment.
5. Minimize mortality from commercial fisheries.
6. Reduce threat to population and foraging habitat from marine pollution.

4.2.4 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 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, primarily in Tamaulipas, Mexico but also in Veracruz, Mexico and Padre Island National Sea Shore, Texas.

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).

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 2015a).

A small nesting population has emerged in the U.S., primarily in Texas, rising from six nests in 1996 to 42 in 2004, to a record high of 353 nests in 2017 (National Park Service data). It is worth noting that nesting in Texas has somewhat paralleled the trends observed in Mexico, characterized by a significant decline in 2010, followed by a second decline in 2013–2014, but with a rebound in 2015, the record high in 2017, and then a decrease back down to 190 nests in 2019, rebounding to 262 nests in 2020, and back down to 195 nests in 2021, and then rebounding again to 284 nests in 2022 (National Park Service data; (NMFS and USFWS 2015a). Gallaway et al. (2013) estimated the female population size for age 2 and older in 2012 to be 188,713 (standard deviation; SD = 32,529). If females comprise 76% of the population, the total population of Kemp's ridley turtles greater than two years in age was estimated to have been 248,307 in 2012 (Gallaway et al. 2013).

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. 2005a); 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 2015a). The species' limited range as well as low global abundance makes it particularly vulnerable to new and continued threats. The significant nesting declines observed in 2010 and 2013–2014 potentially indicate a serious population-level impact, and the ongoing recovery trajectory is unclear. DiMatteo et al. (2024a) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 individuals (90% CI = 2,620–19,443 individuals).

Threats

In addition to general threats common to all three sea turtle species considered, fishery interactions and strandings appear to be the main threats to Kemp's ridley turtles. Since 2010, NMFS has documented (via the Sea Turtle Stranding and Salvage Network data) more Kemp's ridley turtle strandings in the Northern Gulf of America, compared to other sea turtle species. While a definitive cause for these strandings has not been identified, necropsy results indicate a significant number of stranded were forcibly submerged, which is commonly associated with fishery interactions (B. Stacy, NMFS, pers. comm. to M. Barnette, NMFS Protected Resources Division, March 2012). Given the nesting trends and habitat utilization of Kemp's ridley turtles, it is likely that fishery interactions in the Northern Gulf of America may continue to be an issue of concern for the species, and one that may potentially slow the rate of recovery for Kemp's ridley turtles. Kemp's ridley turtles are also especially vulnerable to 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. While the Kemp's ridley turtle population shows signs of increasing abundance, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness. Therefore, the species' resilience to future perturbation is considered low.

Critical Habitat

Critical habitat has not been designated for this species.

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.

4.2.5 Loggerhead Turtle – Northwest Atlantic Ocean DPS

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

Life History

Adult female loggerhead turtles generally nest between April–September. They nest one to seven times in a season, with an internesting interval of approximately 14 days. Clutch sizes range from 95–130 eggs (NMFS and USFWS 2023b). Loggerhead turtles reach sexual maturity between 29–49 years of age, although this varies widely among populations (Chasco et al. 2020; Frazer and Ehrhart 1985; NMFS 2001). Mean age at first reproduction for female loggerhead turtles is 30 years. The average remigration interval is 2.7 years. Within the action area, Northwest Atlantic Ocean DPS loggerhead turtle nesting generally occurs along the Atlantic and Gulf coasts from North Carolina to Alabama and Florida, respectively, although additional nesting occurs along the entire north and western Gulf coast.

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, with the lowest threshold recorded at 98 dB re 1µPa at 100 Hz (Martin et al. 2012). 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.

Population Dynamics

The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead turtles from Texas through Virginia and Quintana Roo, Mexico, is over 110,000 (NMFS and USFWS 2023b). 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 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 2011c). 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 2011c). 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 turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023b). Ceriani et al. (2019) estimated the total number of adult females nesting in Florida to be 51,319 individuals (95% CI = 16,639–99,739 individuals), based on nest count data from 2014–2018. Over 90% of loggerhead sea turtle nesting in the U.S. occurs in Florida (Ceriani et al. 2021). Most recently, DiMatteo et al. (2024a) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). 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 2023a). 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 five 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).

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. An annual increase of 1.3% nesting females was observed between 1983–2019 (Bolten et al. 2019). 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. Loggerhead nesting in Georgia, South Carolina, and North Carolina all broke records in 2015 and then topped those records again in 2016. Nesting in 2017 and 2018 declined relative to 2016, back to levels seen in 2013 to 2015, but then bounced back in 2019, breaking records for each of the three states and the overall recovery unit. Nesting in 2020 and 2021 declined from the 2019 records, but still remained high, representing the third and fourth highest total numbers for the Northern Recovery Unit since 2008. In 2022, Georgia loggerhead nesting broke the record at 4,071, while South Carolina and North Carolina nesting were both at the second-highest level recorded.

The Peninsular Florida Recovery Unit, defined as loggerheads originating from nesting beaches along the Gulf coast from the Georgia-Florida border to the northern shore of Tampa Bay, Florida, is the largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle. An average of 64,513 nests per year were documented 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. Loggerhead nesting in 2016 reached a new record on Florida's core index beaches (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). While nest numbers subsequently declined from the 2016 high, the 2007–2021 period represents a period of increase, with a maximum number of nests in 2023 (70,945 nests). The statewide estimated total for 2022 was 116,765 nests and 18,293 of those from Florida's Gulf coast (FWRI nesting database). Experts are concerned that there have not been significant increases in the number of nesters in over 30 years (1989–2018; less than the 1% recovery criterion), which suggests that the Peninsular Florida Recovery Unit is not recovering (Bolten et al. 2019).

The Dry Tortugas, Northern 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 loggerhead turtles originating from nesting beaches on 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 168–270 (mean of 246) nests per year, or about 60 nesting females (NMFS and USFWS 2007b). There was no detectable trend during this period (NMFS and USFWS 2008a).

The Northern Gulf of Mexico Recovery Unit, defined as loggerheads originating from nesting beaches from Texas through the Florida panhandle, has 100–999 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 America 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. Experts have not observed the amount of increase in the number of nests needed to meet recovery criterion (3% annual increase; Bolten et al. 2019).

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).

Threats

In addition to general threats common to all three species of sea turtle considered, loggerheads may be particularly affected by organochlorine contaminants; they have the highest organochlorine concentrations and metal loads (D'Ilio et al. 2011) in sampled tissues among the sea turtle species. Modeling suggests an increase of 3.6°F (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 5.4°F (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).

Critical Habitat

Northwest Atlantic Ocean DPS loggerhead turtle critical habitat is categorized into different habitat types, each with their own set of PBFs. Foraging habitat, constricted migratory habitat, and *Sargassum* habitat were found to be NLAA (Section 4.1.3) and are not considered further in the opinion. The remaining habitat type that is likely to be adversely affected by the proposed action is breeding habitat.

Breeding habitat is defined as concentrated breeding sites, and are "core" areas where data indicate adult males congregate to gain access to receptive females during the breeding season. Loggerhead turtle breeding season off Florida occurs between April–September. NMFS designated two units of breeding habitat: (1) within the Southern Florida migration corridor from the shore out to the 656 ft (200 m) depth contour along the stretch of the corridor between the Marquesas Keys and the Martin County/Palm Beach County line; and (2) in nearshore waters just south of Cape Canaveral, Florida.

Physical and Biological Features

The PBFs of breeding habitat include:

1. High densities of reproductive male and female loggerheads;
1. Proximity to primary Florida migratory corridor; and
2. Proximity to Florida nesting grounds.

Only the first PBF, high densities of reproductive male and female loggerheads, may be affected by the proposed action.

Status, Function, and Extent of Physical and Biological Features

Breeding critical habitat may be affected by fishing activities that disrupt the use of habitat, and, thus, affect densities of reproductive loggerheads, dredging and disposal of sediments that affect densities of reproductive loggerheads, oil spills and response activities that affect densities of reproductive loggerheads, alternative offshore energy development that affects densities of reproductive loggerheads, and changing environmental trends that can affect currents and water temperatures, and affect densities of reproductive loggerheads (note this is not an exhaustive list of activities that may affect breeding critical habitat). Because of these activities, there may be relatively small numbers of loggerhead turtle lethal or sub-lethal take. For example, the number of Northwest Atlantic Ocean DPS loggerhead turtles that may be killed from U.S. Navy training and testing activities is four; and the number that may be taken (non-lethal take) by the same activities is 138 over a five-year period. The number of Northwest Atlantic Ocean DPS loggerhead turtles that may be killed from renewable energy development off Virginia is 249 over a 30-year period, and the number that may be taken (non-lethal take) from those activities is 1,214 over a two-year construction period. The number of Northwest Atlantic Ocean DPS loggerhead turtles that may be killed in the Commercial Anchored Gill Net Fisheries off North Carolina is 20 over a 10-year period.

The most recent population abundance estimate, DiMatteo et al. (2024a), modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). This is an underestimate of the Northwest Atlantic Ocean DPS's abundance due to limitations in detecting smaller (i.e., younger) turtles during surveys and geographic limitations of the model (i.e., the model does not estimate abundance across the entire range of the DPS). While there has been no indication that the DPS is increasing (NMFS and USFWS 2023a), the number of loggerhead turtles that may be killed or otherwise taken by past activities is relatively small compared to the population abundance overall. As such, the status and function of breeding critical habitat, particularly the high densities of reproductive male and female loggerheads, does not appear to be significantly affected by past activities.

Conservation Needs

Breeding critical habitat is essential to the conservation of Northwest Atlantic Ocean DPS loggerhead turtles because these areas host a high density of breeding individuals, and, thus, are important locations for breeding activities and the propagation of the species. Designation of breeding critical habitat relates directly to the recovery plan for this DPS, which includes recovery objectives that collectively describe the conditions necessary to ensure each recovery unit meets its recovery criteria alleviating threats to the species so that protections afforded under the ESA are no longer necessary.

Recovery criteria for each recovery unit includes specific measures for the number of nests and the number of nesting females (for more information, see the Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle Second Revision): (1) Northern Recovery Unit – a 2% or greater annual rate of increase over a generation time of 50 years, resulting in a total annual number of nests of 14,000 or greater; (2) Peninsular Florida Recovery Unit – a 1% annual rate of increase over a generation time of 50 years, resulting in a total annual number of nests of 106,100 or greater; (3) Dry Tortugas Recovery Unit – an annual rate of increase over a generation time of 50 years is 3% or greater, resulting in a total annual number of nests of 1,100 or greater; (4) Northern Gulf of Mexico Recovery Unit – an annual rate of increase over a generation time of 50 years is 3% or greater, resulting in a total annual number of nests of 4,000 or greater; and (5) Greater Caribbean Recovery Unit – a total annual number of nests at a minimum of three nesting assemblages, averaging greater than 100 nests annually, has increased over a generation time of 50 years.

A number of recovery objectives are directly or indirectly related to ensuring high densities of reproductive male and female loggerheads in breeding critical habitat, including, but not limited to: 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; 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; and manage sufficient feeding, migratory, and interesting marine habitats to ensure successful growth and reproduction (see Recovery Planning, below).

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 Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle Second Revision for complete down-listing/delisting criteria for each of the following recovery objectives (NMFS 2008b):

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.

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).

In this section, we discuss the environmental baseline within the Gulf and Atlantic Ocean portions of the action area, as it applies to species that are likely to be adversely affected by the proposed action. This allows us to assess the prior experience and state (or condition) of the endangered and threatened species and designated critical habitat that will be exposed to effects from the proposed action. The environmental baseline is important to consider because in some life history stages or areas within their ranges, listed individuals or critical habitat features will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other life history stages or areas. These localized stress responses, or stressed baseline conditions, may increase the severity of the adverse effects expected from the proposed action.

5.1 Environmental Trends

Temperature profiles have been collected in the Gulf since the 1920s. The Gulf of America region has experienced a warming rate of approximately 0.347°F (0.193°C) per decade since 1970, and has warmed at least 1.8°F (1.0°C) in the past approximately 50 years (Wang et al. 2023). The rate at which the Gulf of America is warming is twice that for the global ocean (0.155°F or 0.086°C per decade), but only slightly higher than the warming trend in the subtropical northern Atlantic Ocean (0.329°F or 0.183°C per decade; Wang et al. 2023). Overall, the Atlantic Ocean region appears to be warming faster than all other ocean basins except the polar oceans, and is projected to continue to experience substantial warming in the upper 6,562 ft (2,000 m) of the ocean even under conservative emissions scenarios (Cheng et al. 2022). On average, the general warming trend in the North Atlantic Ocean over the last 80 years is 0.056±0.0011°F (0.031±0.0006 °C) per decade in the upper 6,562 ft (2,000 m) of the ocean (Polyakov et al. 2009). One consequence of warming waters in the Gulf of America is exacerbation of hypoxic conditions in the "dead zone" caused by excessive nutrient pollution into and freshwater discharge from the Mississippi River basin, due to changes in oxygen solubility, water stratification, and primary productivity (Altieri and Gedan 2015; Bianchi et al. 2010; Laurent et al. 2018). Changes to the marine biophysical environment are also affecting the growth and movement dynamics of pelagic *Sargassum* in the Gulf of America; *Sargassum* is designated as critical habitat for juvenile green turtles and loggerhead turtles (Marsh et al. 2023; Sanchez-Rubio et al. 2018).

Recent peer-reviewed research has provided additional evidence that long-term warming has led to changes in ocean circulation which have altered the migration timing of marine species (Langan et al. 2021). In the Gulf of America, fish and invertebrate species shifted to regions with deeper waters, rather than exhibiting a pole-ward shift like other continental shelf species assemblages in North America (Pinsky et al. 2013). Along the Texas coast over a 35-year period, researchers observed 32 species exhibiting range shifts, either expanding or contracting their expected distribution due to changing environmental factors (Fujiwara et al. 2019). 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 an environmentally-driven shift in their main prey source. Loggerhead 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. Key marine predators are predicted to experience a 35% change in core habitat area in the Pacific Ocean, with both losses and gains in habitat due to changing environmental conditions (Hazen et al. 2012) and we anticipate similar effects in the Atlantic, including the Gulf of America.

For sea turtle prey species such as mollusks, which form calcium carbonate shells, one of the greatest threats contributing to their extinction risk is ocean acidification driven by global changing environmental conditions. Ocean acidification occurs as carbon dioxide concentrations increase in the atmosphere, more carbon dioxide is absorbed by the oceans, causing lower pH and reduced availability of calcium carbonate. Because of the increase in carbon dioxide and other greenhouse gases in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans and is predicted to increase considerably between now and 2100 (IPCC 2014; IPCC 2023b). Predicted rates of ocean acidification will have adverse impacts on species richness especially for strongly calcifying species, such as echinoderms and mollusks (Scherer et al. 2022) that provide food resources for sea turtle species. Changes in the marine ecosystem caused by changing environmental trends can also influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, and forage fish), ultimately affecting primary foraging areas of ESA-listed sea turtles. For migrating sea turtles, if either prey availability or habitat suitability is disrupted by changing ocean temperatures regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

Sea turtles are especially sensitive to temperature-related changes in their life history and habitat. Notably, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 77–95°F (25–35°C; Ackerman 1997). Increases in global temperature could skew future sex ratios toward higher numbers of females (NMFS and

USFWS 2007aa; NMFS and USFWS 2007bb; NMFS and USFWS 2013aa; NMFS and USFWS 2013bb; NMFS and USFWS 2015a). For example, modeling suggests an increase of 3.6°F (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 5.4°F (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).

In addition to increased ocean warming and changes in species' distribution, changing environmental trends are linked to increased extreme weather events including, but not limited to, hurricanes, cyclones, tropical storms, heat waves, and droughts (IPCC 2023a). Research from IPCC (2023a) 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 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).

This review highlights evidence of significant changes in environmental conditions in the Gulf and Atlantic Ocean that may affect ESA-listed species and their habitats. While it is difficult to accurately predict the consequences of these changing environmental conditions 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. This is discussed further in the Integration and Synthesis (Section 8).

5.2 Sound

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), and military activities, which are summarized in the subsequent environmental baseline subsections. 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.

NMFS has established criteria to predict varying levels of responses of marine species to anthropogenic sound, based upon the best available science (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance-other-acoustic-tools). Responses to sound exposure may include lethal or nonlethal injury, permanent or temporary hearing impairment, behavioral harassment and stress, or no apparent response. Ambient noise consists of sound sources such as vocalizing animals, wind, and waves; however, anthropogenic activities such as vessels, geophysical exploration, and the construction, operational, and decommissioning of offshore structures, can contribute to, and increase, sound levels. Several policies on managing anthropogenic sound in the marine environment provide guidance for research permits involving sound-producing activities. For example, NOAA is working cooperatively with the ship building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels.

Globally, commercial shipping's contribution to ambient noise in the ocean increased by as much as 12 dB between approximately the 1960s and 2005 (Hildebrand 2009a). 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. While commercial shipping vessels contribute a large portion of oceanic anthropogenic noise, other sources of maritime traffic can be present in large numbers and affect the marine environment particularly in nearshore and inland marine areas. These include recreational boats, whale-watching boats, research vessels, and ships associated with oil and gas activities.

The Gulf of America soundscape is being studied long-term by NOAA's Sound Reference Station Network (https://www.pmel.noaa.gov/acoustics/noaanps-ocean-noise-reference-station-network). This network uses static Passive Acoustic Monitoring (PAM) hydrophone (underwater sound recorder) units to monitor trends and changes in the ambient sound field in U.S. Federal waters. In addition to this network, there have been several other hydrophone units in the northern Gulf of America. A study by Wiggins et al. (2016) placed two high-frequency acoustic recording packages (HARPs) in 328–820 ft (100–250 m) water depths and three HARPs in approximately 3,280 ft (1,000 m) water depth to compare low-frequency sound pressure spectrum levels over three years. NOAA's Southeast Fisheries Science Center (SEFSC), University of California San Diego's Scripps Institution of Oceanography (SIO), and partners initiated a comprehensive, long-term, multi-scale passive acoustic monitoring program (LISTEN Gulf of Mexico [GoMex]; https://www.fisheries.noaa.gov/science-data/passive-acoustic-research-southeast-fisheries-science-center) throughout the U.S. and Gulf waters to expand upon the initial Wiggins et al. (2016) study. Through this program, scientists are collecting data to assess contributions of ambient noise sources to the Gulf soundscape. This collaborative study deploys moored HARPs, continuously recording over the 10 Hz–100 kHz band, from 2020–2025 (Figure 7). Additionally, the study leverages 10 years of historic HARP recordings at five long-term sites, collected by SIO as part of the DWH damage assessment to enhance the assessment of trends in cetacean density and noise (Rafter et al. 2022). Here, we include the preliminary results from the first year of the HARP recordings at sites collected under the LISTEN GoMex project from 2020–2021.

The low-frequency ambient soundscape, between 10–1,000 Hz, was dominated by sounds from anthropogenic activities, notably seismic exploration at deep sites and shipping at shallow sites. Seismic survey signals dominated the ambient soundscape below 100 Hz throughout the historic time series and at the new 2020–2021 sites, with the same surveys detected simultaneously at distant sites throughout the Gulf. Sound levels are most elevated in the airgun frequency band (10–100 Hz) at recording sites within or near active oil and gas lease blocks, and more moderately at sites further away, but with deep water where signals propagate effectively. During quieter periods between seismic surveys, moderately elevated sound levels in the 30–90 Hz frequency band are often evident, representing noise from vessel traffic.

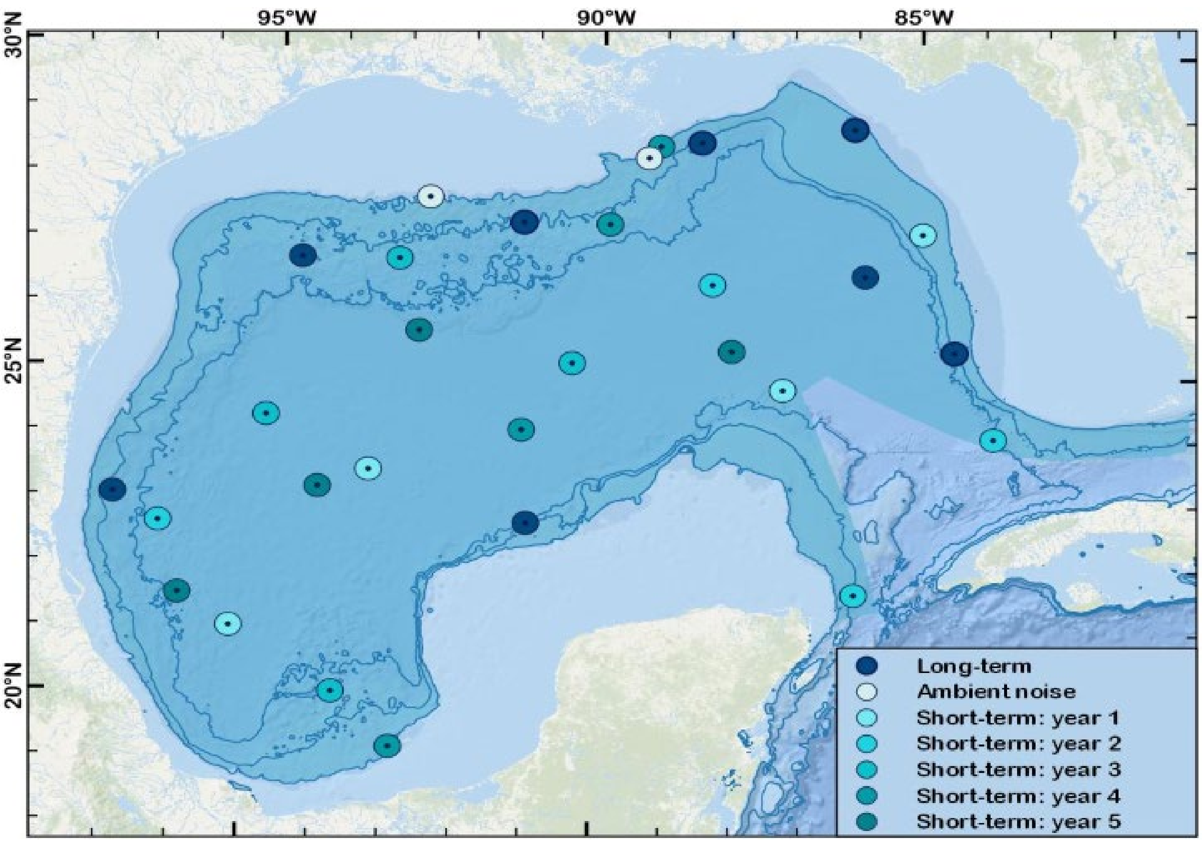


Figure 7. Location of long-term passive acoustic recording sites for the five-year LISTEN GoMex project. Figure from NMFS/Melissa Soldevilla.

The PAM data also demonstrate spatially and temporally variable patterns in noise concentration. The spatial distribution of monthly median octave bands at each site over the 2020–2021 period highlights some of the noise sources described in (Rafter et al. 2022): The 31.5 Hz octave band represents noise from shipping traffic; the 500 Hz octave band represents noise from weather; and the 31.5 Hz octave band are generally higher in the western Gulf than the eastern Gulf, which is expected given the distribution of airgun energy in the northwestern Gulf. April, May, and December have particularly high 31.5 Hz octave band levels across western sites, and in September, those levels were especially high at the central Gulf sites. These correspond with locations of seismic survey activity. Unsurprisingly, ship noise dominated the ambient soundscapes at the two shipping lane sites, where the highest number of ship detections and longest time with ship noise present occurred (Rafter et al. 2022). At the three monitoring sites with high levels of shipping traffic, daily average sound levels were consistently near, or higher than 100 dB re 1 µPa in both the 63 and 125 Hz one-third octave bands. In comparison, sound levels were approximately 20 dB lower year-round in Hawaii and approximately 10–20 dB lower in the Alaskan Arctic (depending on season).

5.3 Fisheries Bycatch and Interactions

Commercial and recreational fisheries can result in substantial detrimental impacts on populations of ESA-listed sea turtles. Although directed fishing for the species covered in this opinion is prohibited under the ESA, many listed species are still captured as "bycatch" in fishing operations targeting other species. Bycatch occurs when fishing operations interact with sea turtles that are not the target species for commercial harvest. Sea turtles are also susceptible to entanglement in fishing gear that is actively deployed, as well as derelict or "ghost fishing" gear that has been abandoned in the pelagic environment.

5.3.1 Federal Fisheries

Commercial and recreational fisheries managed by NMFS under the Magnuson-Stevens Act (MSA) in the Gulf and Atlantic Ocean have interacted with sea turtles throughout the past. Commercial fisheries bycatch represents a significant threat to sea turtles throughout the Gulf and Atlantic Ocean portions of the action area, as sea turtles are highly vulnerable to incidental capture in many fisheries gears including tangle nets, trawls and longlines.

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, Southeastern Shrimp Trawl Fisheries, and ten fisheries in the Atlantic (including Atlantic Bluefish, Jonah Crab, Spiny Dogfish, and Summer Flounder Fisheries). NMFS has issued an ITS for the take of sea turtles in each of these fisheries (NMFS 2011a; NMFS 2012a; NMFS 2014a; NMFS 2015b). A summary of each consultation is provided below, but more detailed information can be found in the respective biological opinions (NMFS 2011a; NMFS 2011b; NMFS 2012b; NMFS 2015a; NMFS 2021a).

Coastal Migratory Pelagics Fishery

In 2015, NMFS completed a section 7 consultation on the continued authorization of the coastal migratory pelagics fishery in the Gulf and South Atlantic (NMFS 2015a). In the Gulf of America and South Atlantic, hook-and-line, gillnet, and cast net gears are used commercially, while the recreational sector uses hook-and-line gear. The biological opinion concluded that green, Kemp's ridley, and loggerhead turtles may be adversely affected by operation of the fishery.

However, the proposed action was not expected to jeopardize the continued existence of any of these species. An ITS was provided for consecutive three-year periods authorizing 31 takes (nine of which could be lethal) for green turtles, 27 takes (seven of which could be lethal) for loggerhead turtles, and eight takes (two of which could be lethal) for Kemp's ridley turtles.

Highly Migratory Species Atlantic Shark and Smoothhound Fisheries

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

The most recent ESA section 7 consultation on the continued operation of Atlantic shark and smoothhound fisheries and Amendments 3 and 4 to the Consolidated HMS FMP was completed on December 12, 2012 (NMFS 2012b). The consultation concluded the proposed action was not likely to jeopardize the continued existence of sea turtles. An ITS was provided for consecutive three-year periods authorizing 57 takes (33 of which could be lethal) for green turtles, 126 takes (78 of which could be lethal) for loggerhead turtles, and 36 takes (21 of which could be lethal) for Kemp's ridley turtles.

Gulf Reef Fish Fishery

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

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

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

On October 13, 2009, NMFS Southeast Regional Office completed an opinion that analyzed the expected effects of the continued operation of the Gulf reef fish fishery under the changes proposed in Amendment 31 (NMFS-SEFSC 2009). The opinion concluded that sea turtle takes would be substantially reduced compared to the fishery as it was previously prosecuted, and that operation of the fishery would not jeopardize the continued existence of any sea turtle species. Amendment 31 was implemented on May 26, 2010. In August 2011, consultation was reinitiated to address the DWH oil spill and potential changes to the environmental baseline. Reinitiation of consultation was not related to any material change in the fishery itself, violations of any terms and conditions of the 2009 opinion, or an exceedance of the ITS. The resulting September 30, 2011, opinion concluded the continued operation of the Gulf reef fish fishery is not likely to jeopardize the continued existence of any listed sea turtles (NMFS 2011a). An ITS was provided for consecutive three-year periods authorizing 116 takes (75 of which could be lethal) for green turtles, 1,044–1,065 takes (572–585 of which could be lethal) for loggerhead turtles, and 108 takes (41 of which could be lethal) for Kemp's ridley turtles.

Southeastern Shrimp Trawl Fisheries

The high activity of shrimp trawl fishing fleets in the Gulf poses risks of bycatch to listed sea turtles (NMFS 2014a). The shrimp trawl fishery FMP was amended March 9, 2020, increasing the allowable amount of fishing effort in several zones off the coasts of Mississippi, Louisiana, and Texas (Council 2019). The consultation history for this fishery is closely tied to the lengthy regulatory history governing the use of turtle excluder devices (TEDs) and a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. The level of annual mortality described in NRC (1990b) is believed to have continued until 1992–1994, when U.S. law required all shrimp trawlers in the Atlantic and Gulf to use TEDs, allowing at least some sea turtles to escape nets before drowning (NMFS 2002).[4] TEDs

[4] TEDs were mandatory on all shrimping vessels. However, certain shrimpers (e.g., fishers using skimmer trawls or targeting bait shrimp) could operate without TEDs if they agreed to follow specific tow-time restrictions.

approved for use have had to demonstrate 97% effectiveness in excluding sea turtles from trawls in controlled testing. These regulations have been refined over the years to ensure that TED effectiveness is maximized through proper placement and installation, configuration (e.g.*,* width of bar spacing), flotation, and more widespread use.

Despite the apparent success of TEDs for some species of sea turtles (e.g., Kemp's ridley turtles), TEDs were later discovered to not adequately protect all species and size classes of sea turtles. Analyses by Epperly and Teas (2002b) indicated that the minimum requirements for the escape opening dimension in TEDs in use at that time were too small for some sea turtles and that as many as 47% of the loggerheads stranding annually along the Atlantic and Gulf were too large to fit the existing openings. On December 2, 2002, NMFS completed an opinion on shrimp trawling in the southeastern United States (NMFS 2002) under proposed revisions to the TED regulations requiring larger escape openings (68 FR 8456 2003). This opinion determined that the shrimp trawl fishery under the revised TED regulations would not jeopardize the continued existence of any sea turtle species. The determination was based in part on the opinion's analysis that shows the revised TED regulations are expected to reduce shrimp trawl related mortality by 94% for loggerheads. In February 2003, NMFS implemented the revisions to the TED regulations.

Although mitigation measures have greatly reduced the impact on sea turtle populations, the shrimp trawl fishery is still responsible for large numbers of turtle mortalities each year. The Gulf fleet accounts for a large percentage of the sea turtle bycatch in this fishery. In 2010, the Gulf shrimp trawl fishery had an estimated bycatch mortality of 5,166 turtles (including 778 loggerhead, 486 green, and 3,884 Kemp's ridley turtles). By comparison, the southeast Atlantic fishery had an estimated bycatch mortality of 1,033 turtles (including 673 loggerhead, 28 green, and 324 Kemp's ridley turtles) in 2010 (NMFS 2014c).

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

More recent studies demonstrate continued take from the fisheries. From 2011–2016, mandatory fisheries observer data for the southeastern shrimp trawl fishery found that otter and skimmer shrimp trawls captured 158 listed sea turtles (Scott-Denton et al. 2020). Data from 2002, 2009, 2014, and 2015 in NOAA's National Bycatch Report Database System indicated that the shrimp trawl was likely to capture 709 sea turtles annually as bycatch (Savoca et al. 2020).

On April 26, 2021, NMFS completed reinitiation on the consultation that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the MSA (NMFS-SERO 2021). Reinitiation of the 2014 consultation (NMFS 2014a) was triggered by three factors: 1) the listing of new species under the ESA (e.g., green sea turtle DPSs in 2016); 2) new bycatch information developed to better analyze the effects of the shrimp fisheries on sea turtle populations; and 3) the December 2019 Final Rule requiring TEDs for a portion of the skimmer trawl fisheries. The reinitiated biological opinion for the reinitiated consultation concluded that the proposed action was not likely to jeopardize the continued existence of any listed species, including sea turtle species. The ITS was revised for consecutive five-year periods authorizing 24,214 takes (1,700 of which could be lethal) for green turtles, 72,670 takes (2,150 of which could be lethal) for loggerhead turtles, and 84,495 takes (8,505 of which could be lethal) for Kemp's ridley turtles (NMFS SERO 2021).

Ten Fisheries in the Atlantic

In 2021, NMFS completed a section 7 consultation on the continued authorization of the American Lobster, Atlantic Bluefish, Atlantic Deep-Sea Red Crab, Mackerel/Squid/Butterfish, Monkfish, Northeast Multispecies, Northeast Skate Complex, Spiny Dogfish, Summer Flounder/Scup/Black Sea Bass Fisheries and the new authorization of the Jonah Crab Fishery (NMFS 2021b). In the Gulf of America and South Atlantic, sink gillnets, hook and line, bottom trawls, and pot/traps are the predominant gears used. The biological opinion concluded that green, Kemp's ridley, and loggerhead turtles may be adversely affected by operation of the fishery. However, the proposed action was determined not to jeopardize the continued existence of any of these species. An ITS was provided for authorizing annual takes of 8.4 North Atlantic DPS green turtles (4.8 of which could be lethal), 399 Northwest Atlantic Ocean DPS loggerhead turtles (257.8 of which could be lethal), and 58.4 Kemp's ridley turtles (42.8 of which could be lethal).

5.3.2 State Fisheries

Several coastal state fisheries are known to incidentally take listed species, and available information on these fisheries is documented through different agencies (NMFS 2014d). State commercial and recreational fisheries use gear types including trawling, pot fisheries, gillnets, pound net and weir, seines, channel nets, and vertical line, all of which are known to incidentally take sea turtles. 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

(NMFS 2014d). The 2001 HMS biological opinion (discussed in the Federal Fisheries Section above) provides a summary of sea turtles taken in state fisheries throughout the action area.

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

5.4 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 sea turtles in the Gulf portion of the action area. As of 2022, Gulf 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. 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 (Murawski et al. 2020).

The Bureau of Ocean and Energy Management (BOEM) administers the Outer Continental Shelf Lands Act (OCSLA) and authorizes the exploration and development of wells in Gulf leases. The sale of OCS leases in the Gulf of America and the resulting exploration and development of these leases for oil and natural gas resources has affected the status of ESA-listed species in the action area. As discussed above (Section 5.2), seismic exploration is an integral part of oil and gas discovery, development, and production in the Gulf of America. Year-round noise generated by oil and gas vessels and airguns used for seismic surveys has permanently changed the marine soundscape in the Gulf of America.

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 effluents and emissions. BOEM requires that oil and gas structures be removed from the seafloor within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al. 1997). An underwater explosion is composed of an initial shock wave, followed by a succession of oscillating bubble pulses. A shock wave is a compression wave that expands radially out from the detonation point of an explosion. The direct shock wave results in the peak shock pressure (compression) and the reflected wave at the air-water surface produces negative pressure (expansion). Explosions are described by metrics such as amplitude, energy and time-space characteristics of the pressure wave (Popper et al. 2014a). Explosive detonations and their impacts on ESA-listed species are discussed in more detail this opinion (see Sections 2.4 and 6).

5.4.1 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 America. 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 (NCCOS 2019). The summary presented here includes examples of recent events, but may not encompass all incidents. For more information, the Bureau of Safety and Environmental Enforcement (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 America 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 (gal; 52,996 liters [L]) of light crude oil, with recorded impacts to green 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 gal (4,163,953 L) at risk of spill and an observed slick over 40 mi (64 km) 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 Gulf (BSEE 2017). According to BSEE (2017) from 2000–2015, four of the 117 loss of well control events were categorized as a total loss. 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 into 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 America 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 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 changing environmental trends, which increases the risk of oil spills and the introduction of harmful debris into species' habitat (GAO 2024).

5.4.2 Deepwater Horizon Spill

The largest spill within the Gulf portion of the action area occurred on April 20, 2010. The semi-submersible drilling rig DWH experienced an explosion and fire while working on an exploratory well approximately 50 mi (80 km) offshore of Louisiana. The rig subsequently sank and oil and natural gas began leaking into the surrounding waters of the Gulf of America. Oil flowed for 86 days, until the well was capped on July 15, 2010. By then, 134 million bbl of oil were spilled into the Gulf. In addition, approximately 1.84 million gal (6.97 million L) of chemical dispersant were 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 adverse effects on listed species and changed the baseline for the Gulf ecosystem. Effects of the spill went beyond the footprint visually detected using satellite imagery shown in Figure 8. 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 8 below displays visible and toxic (brown), invisible and toxic (yellow), and non-toxic (blue) oil concentrations.

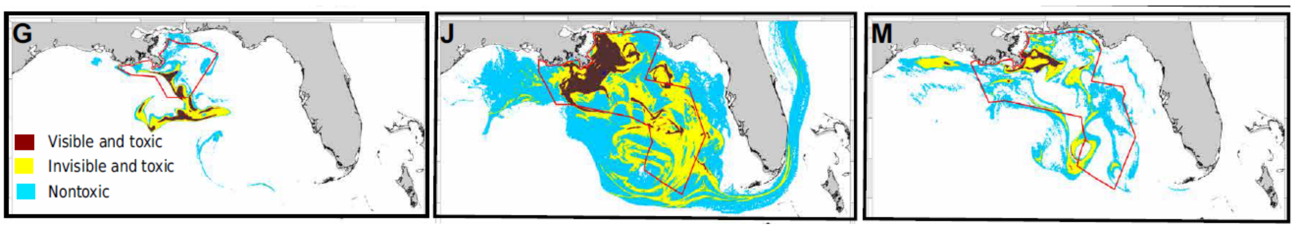
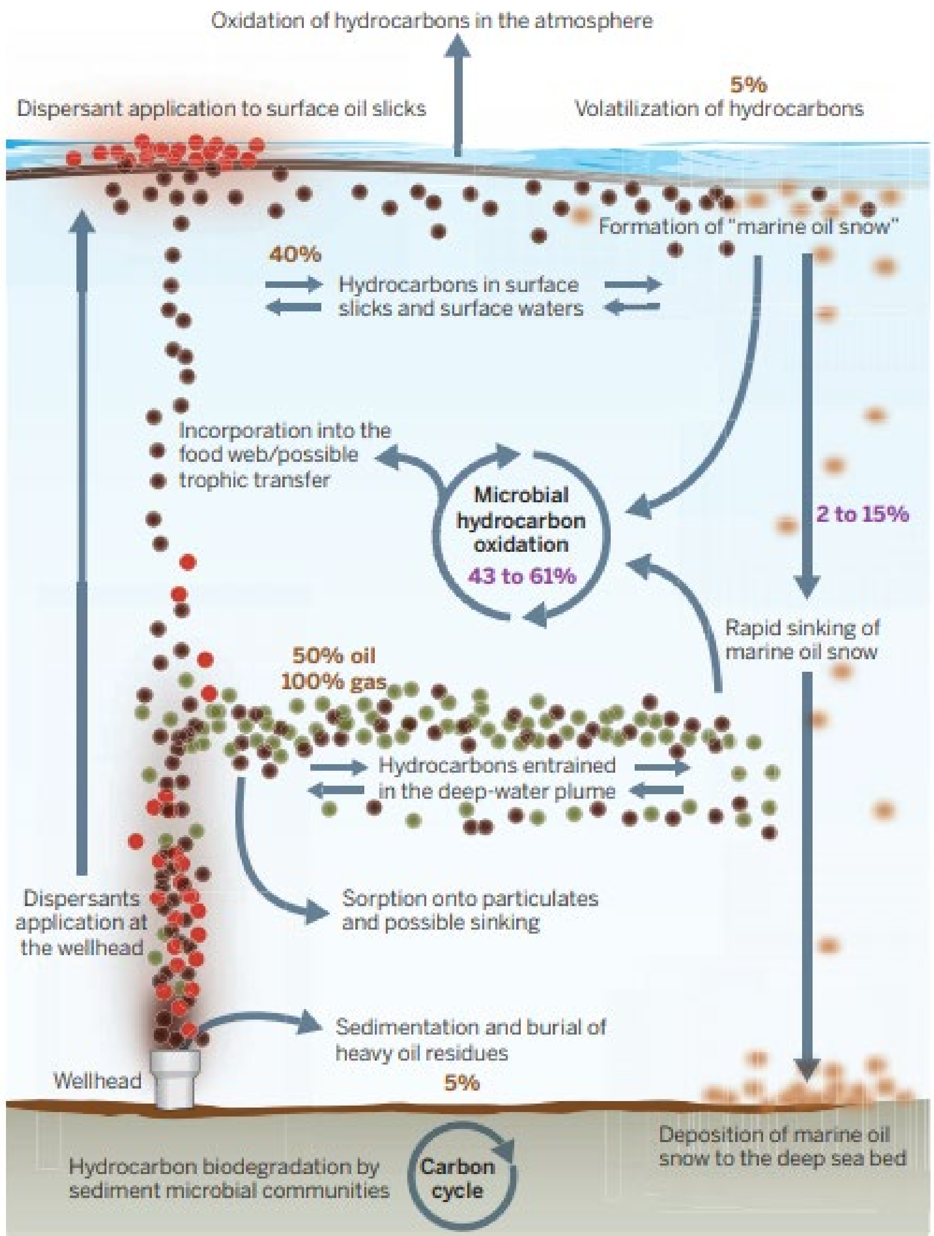


Figure 8. Figure from Berenshtein et al. (2020a) showing spatiotemporal dynamics of the DWH spill for dates showing cumulative oil concentrations in panels G (15 May 2010), J (18 June 2010), and M (2 July 2010).

The investigation conducted under the National Resource Damage Assessment regulations of 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 several ESA-listed species, including Kemp's ridley, green, and loggerhead sea turtles and habitats of these species (Trustees 2016b). The findings of this assessment provide details regarding impacts to the environmental baseline of listed species and critical habitats in the Gulf, summarized below, 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) also resulted in adverse effects to 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 the status of 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 America resulting in new baseline conditions (BOEM 2016; Trustees 2016a). A review of current literature by Patterson et al. (2023) found 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 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 (Figure 9). 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.



Where did the oil and gas go? The percentages given in brown in the figure reflect the approximate distribution of oil (brown circles) and gas (green circles) during the Deepwater Horizon well blowout (*2–4*); dispersant addition is noted by red circles. Available data (purple percentages) suggest that the long-term fate is known for only 45 to 76% of the discharged hydrocarbons (*7–9*). Some of the unaccounted-for oil may have been deposited in coastal marshes or beaches (not shown on the figure). Vertical and horizontal aspects are not to scale.

Figure 9. Diagram showing offshore distribution of oil and gas during DWH (Joye 2015)

The DWH oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of America. *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 America 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 2016a).

Subsequent to the Programmatic Damage Assessment and Restoration Plan (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 loggerhead, Kemp's ridley, and green turtles were excavated prior to emergence and eggs were translocated from Florida and Alabama beaches in the northern Gulf of America 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 America were released in the Atlantic Ocean and not the Gulf of America. Therefore, the hatchlings imprinted on the area of their release beach. Sea turtles are thought to 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 America to nest; therefore, the damage assessment determined that the 14,796 hatchlings will be lost to the Gulf of America breeding populations because of the DWH oil spill. It is estimated that nearly 35,000 hatchling sea turtles (loggerhead, Kemp's ridley, 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 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 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 ridley turtles nest in the Gulf and belong to the same population (NMFS et al. 2011b). The total population abundance of Kemp's ridley turtles could be calculated based on numbers of hatchlings because all individuals are reasonably expected to inhabit the northern Gulf of America 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.

Loggerhead turtles made up 12.7% (60,800 animals) of the total sea turtle exposures (478,900). A total of 14,300 loggerhead turtles died as a result of exposure to DWH oil. Unlike Kemp's ridley turtles, the majority of nesting for the Northwest Atlantic Ocean DPS of loggerhead turtles occurs on the Atlantic coast, and thus nesting was impacted to a lesser degree in this species. It is likely that impacts to the Northern Gulf of Mexico Recovery Unit of the Northwest Atlantic Ocean DPS of loggerhead 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.

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

5.5 Vessel Operations

The Gulf and Atlantic Ocean are highly active regions for maritime vessel activity, including shipping, transit, fishing, and offshore operations, all of which have baseline impacts to listed species and their habitats. Propeller and collision injuries and mortalities from private and commercial vessels are a significant threat to ESA-listed sea turtles. Potential sources of adverse effects from federal vessel operations in the action area include operations of the U.S. DoD, BOEM, BSEE, Federal Energy Regulatory Commission (FERC), U.S. Coast Guard (USCG), NOAA, and U.S. Army Corps of Engineers (USACE).

Sea turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to vessel strikes, which can result in serious injury and death (Hazel et al. 2007b). Sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases (Hazel et al. 2007b). Green sea turtles cannot consistently avoid being struck by vessels moving at relatively moderate speeds (i.e., greater 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).

Many recovered sea turtles display injuries that appear to result from interactions with vessels and their associated propulsion systems (Work et al. 2010). This is particularly true in nearshore areas with high vessel traffic along the U.S. Atlantic and Gulf of America coasts. From 1997 to 2005, nearly 15% of all stranded loggerheads in the U.S. Atlantic and Gulf of America were documented as having sustained some type of propeller or collision injury; although it is not known what proportion of these injuries were before or after death. In one study conducted in Virginia, Barco et al. (2016) found that all 15 dead loggerhead turtles encountered with signs of acute vessel interaction were normal and healthy prior to the vessel interaction. The incidence of propeller wounds of stranded sea turtles from the U.S. Atlantic and Gulf of America doubled from about 10% in the late 1980s to about 20% in 2004. Singel et al. (2007) reported a tripling of boat strike injuries in Florida from the 1980s to 2005. Over this time period, in Florida alone, over 4,000 (approximately 500 live and 3,500 dead) sea turtle strandings were documented with propeller wounds, which represented 30% of all sea turtle strandings for the state (Singel et al. 2007). 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 71% of stranded green turtles and 61% of Kemp’s ridley turtles studied had documented vessel strike injuries (Stacy et al. 2020). These studies suggest that the threat of vessel strikes to sea turtles may be increasing over time as vessel traffic continues to increase in the south and southeastern U.S.

The Sea Turtle Stranding and Salvage Network reports a large number of vessel interactions (propeller injury) with sea turtles off coastal states such as New Jersey and Florida, where there are high levels of vessel traffic. The Virginia Aquarium & Marine Science Center Strandings Program reported an average of 62.3 sea turtle strandings per year in Virginia waters due to boat strikes from 2009–2014 (Barco 2015). The large majority of these (about 87%) were dead strandings. By sea turtle species, 73.3% of Virginia vessel strike strandings from 2009–2014 were loggerhead, 20.3% Kemp’s ridley, and 3.5% green turtles (Barco 2015).

5.6 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 America 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 America. In 2003, NMFS completed a regional biological opinion on USACE hopper dredging in the Gulf of America that included impacts to sea turtles via maintenance dredging. NMFS determined that Gulf of America 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 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, or destroy or adversely modify critical habitat of any listed species.

5.7 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, the Federal Emergency Management Agency (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 were 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.

5.8 Research Permits

The ESA allows for the issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research (section 10(a)(1)(a)). In addition, section 6 of the ESA allows NMFS to enter into cooperative agreements with states to assist in recovery actions of listed species. The number of authorized directed and incidental takes by research permits varies widely depending on the research and species involved but may involve the taking of hundreds of sea turtles annually. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). The proposal must be reviewed for compliance with section 7 of the ESA because issuance is a Federal activity.

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.

Currently, there are 24 active sea turtle research permits issued for work in the Atlantic and Gulf of America under the NMFS Sea Turtle Research and Enhancement Permitting Program and covered by the sea turtle research permit programmatic biological opinion (NMFS 2017a). The sea turtle research programmatic established mortality banks for each species, which represent the maximum total number of mortalities that could be authorized and used over a 10-year period (2018–2027). Only two sea turtle lethal takes (one Kemp's ridley and one loggerhead turtle) have been reported since 2018 when the programmatic opinion took effect.

5.9 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 America 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 America. The western Gulf of America has four warning areas used for military operations. The areas total approximately 21 million acres or 58% of the Gulf of America. In addition, six blocks in the western Gulf of America are used by the Navy for mine warfare testing and training. The central Gulf of America has five designated military warning areas that are used for military operations.

The central Gulf of America has five designated military warning areas used for military operations. These areas total approximately 11.3 million acres (ac; 45,729 km^2). Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million ac (2,023 km^2) in the Gulf of America. The total 11.8 million ac (47,753 km^2) is about 25% of the area of the Gulf of America.

Formal consultations on overall U.S. Navy activities in the Atlantic have been completed by NMFS, for 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 Letter of Authorization 2012–2014: U.S. Navy active sonar training along the Atlantic Coast and Gulf of America (December 19, 2011); Activities in the Gulf 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 U.S. Navy activities to affect sea turtles, those effects were not expected to affect 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). We concluded the action is not likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of critical habitat. The AFTT Phase III opinion includes an ITS with exempted take for ESA-listed sea turtles (for details see https://repository.library.noaa.gov/view/noaa/31540). Through the section 7 consultation process with NMFS, the U.S. Navy has developed and implemented monitoring and conservation measures to reduce the potential effects of explosives, sonar, and vessel strikes on ESA-listed resources, including sea turtles, in the Atlantic Ocean and Gulf of America.

NMFS completed consultations on Eglin Air Force Base testing and training activities in the Gulf of America. These consultations concluded that adverse effects to sea turtles are likely to occur, but the action is not likely to jeopardize their continued existence or result in the destruction or adverse modification of critical habitat. These opinions included an ITS for these actions: Eglin Gulf Test and Training Range (NMFS 2004b), the Precision Strike Weapons Tests (NMFS 2005b), the Santa Rosa Island Mission Utilization Plan (NMFS 2005c), Naval Explosive Ordnance Disposal School (NMFS 2004a), Eglin Maritime Strike Operations Tactics Development and Evaluation (NMFS 2013), and Ongoing Eglin Gulf Testing and Training Activities (NMFS 2017b; NMFS 2023c).

5.10 Aquaculture

Marine aquaculture systems are diverse, ranging from highly controlled land-based systems to open water cages that release wastes directly to the environment. Species produced in the marine environment are also diverse, and include seaweeds, bivalve mollusks, echinoderms, crustaceans, and finfish (Langan 2004). Globally, aquaculture supplies more than 50% of all seafood produced for human consumption, and that percentage will likely continue to rise (NOAA Marine Aquaculture; https://www.fisheries.noaa.gov/topic/aquaculture). Marine aquaculture is expected to expand in the U. S. Exclusive Economic Zone (EEZ) due to increased demand for domestically grown seafood, coupled with improved technological capacity to farm in the open ocean. The National Offshore Aquaculture Act of 2005 (S. 1195) promotes offshore aquaculture development within the EEZ and established a permitting process that encourages private investment in aquaculture operations, demonstrations, and research. Although the marine aquaculture industry has been expanding in the U.S., development is highly variable among states (e.g., Virginia and Maine have productive and valuable industries, while Georgia and New York, have relatively minimal development; Lester et al. 2024).

Aquaculture is an emerging industry in the Gulf of America, 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 America 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 protected 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 America (Figure 10). 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. The model 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).

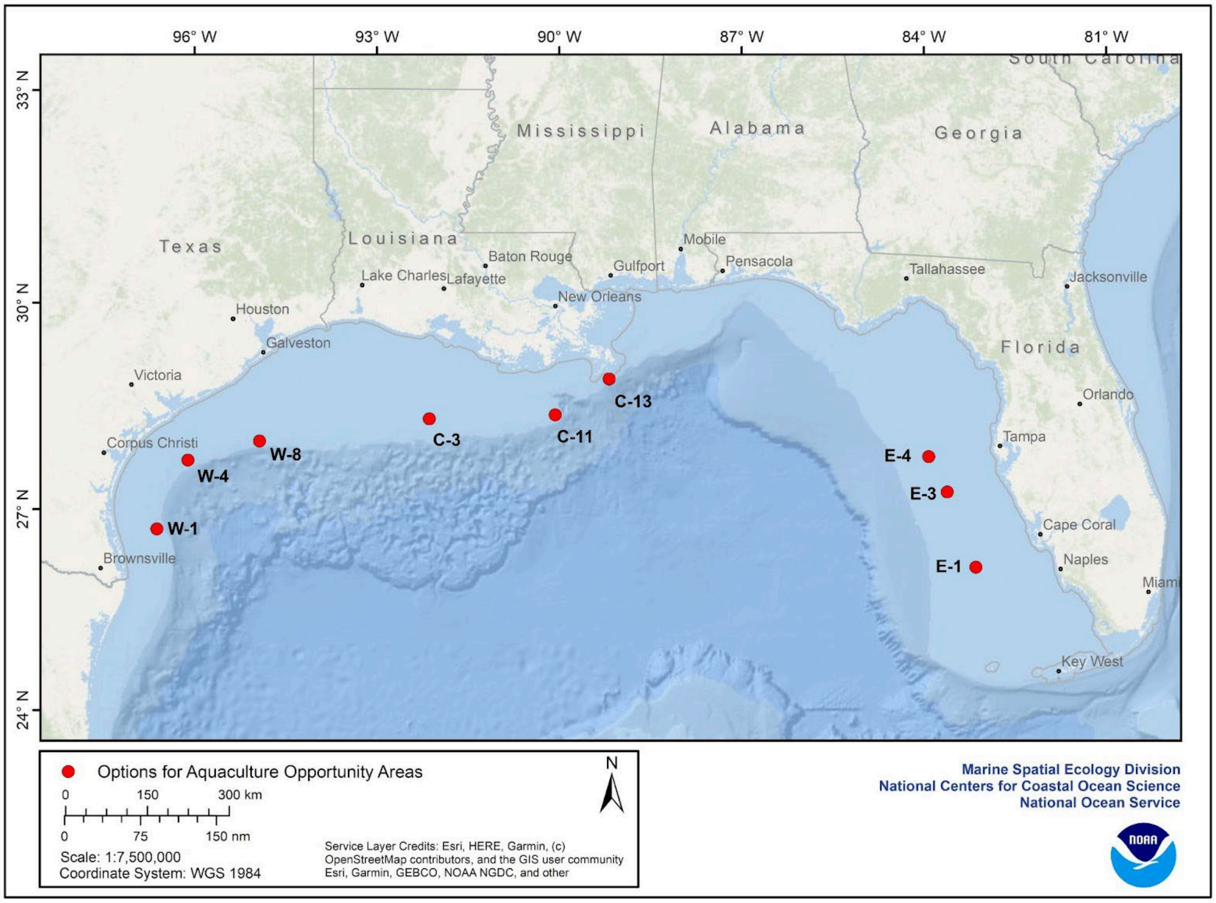


Figure 10. Nine potential locations for AOAs in federal waters of the Gulf of America (Source: NCCOS 2023)

Potential impacts to ESA-listed species can occur at all stages of aquaculture development, operation, and decommissioning, and can include attraction to farms or displacement from important habitats, resulting in changes to distribution, behaviors, or social structures (Clement 2013; Price et al. 2017). Aquaculture has the potential to affect protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic and noise, impacts to habitat and benthic organisms, and water quality (Clement 2013a; Lloyd 2003; Price et al. 2017; Price and Morris 2013). Current data suggest that interactions and entanglements of ESA-listed marine mammals and sea turtles with aquaculture gear are rare (Price et al. 2017). This may be because worldwide the number and density of aquaculture farms are low, and thus there is a low probability of interactions, or because they pose little risk to ESA-listed marine mammals or sea turtles. There are limited data on sea turtle interactions, and very few reports of marine mammal interactions with aquaculture gear. It is not always possible to determine if the gear animals become entangled in originates from aquaculture or commercial fisheries (Price et al. 2017). Some aquaculture gear has the potential for behavioral effects on marine mammals. For example, aquaculture gear may act as a "fish aggregating device" which may attract marine mammals seeking prey for food, and subsequent marine mammal depredation may occur (Callier et al. 2018). Aquaculture gear may also block migration routes (MPI 2013) or at least cause animals to have to circumnavigate the aquaculture gear.

5.11 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. Since lionfish were first captured in the northern Gulf of America in 2010 and 2011, they have rapidly dispersed throughout the northern Gulf of America, 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, and 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 loggerhead and Kemp's ridley turtles in the Gulf portion of the action area. Although it is not possible to predict which aquatic nuisance species will arrive and thrive in the Gulf portion of the action area, 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.

5.12 Nutrient Loading and Hypoxia

Industrial and municipal activities can result in the discharge of large quantities of nutrients into coastal waters. Excessive nutrient enrichment results in eutrophication, a condition associated with degraded water quality, algal blooms (including harmful algal blooms), oxygen depletion, loss of seagrass and coral reef habitat, and in some instances the formation of hypoxic "dead zones" (USCOP 2004). Hypoxia (low dissolved oxygen concentration) occurs when waters become overloaded with nutrients such as nitrogen and phosphorus, which enter oceans from agricultural runoff, sewage treatment plants, bilge water, atmospheric deposition, and other sources. An overabundance of nutrients can stimulate algal blooms resulting in a rapid expansion of microscopic algae (phytoplankton). When excess nutrients are consumed, the algal population dies off and the remains are consumed by bacteria. Bacterial consumption decreases the dissolved oxygen level in the water which may result in mortality of fish and crustaceans, reduced benthic and demersal organism abundance, reduced biomass and species richness, and abandonment of habitat to sufficiently oxygenated areas (Craig et al. 2001; Rabalais et al. 2002). Higher trophic-level species (e.g., sea turtles) may be impacted by the reduction of available prey because of hypoxic conditions.

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 America, 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 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 America has been approximately 6,200 mi^2 (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 8,500 mi^2 (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 determined the midsummer extent of the hypoxic zone was 6,330 mi^2 (16,400 km^2) in 2021, and 3,270 mi^2 (8,480 km^2) in 2022 (US-HTF 2023). For 2024, NOAA measured a hypoxic zone in the Gulf of America of 6,507 mi^2 (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 will likely exacerbate hypoxic conditions along the Gulf of America continental shelf, resulting in greater exposure to prolonged and severe 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 changing environmental trends can trigger the development of marine algal toxins. Marine algal toxins are produced by unicellular algae that are often present at low concentrations but may proliferate to form dense concentrations under certain environmental conditions (National Academies of Sciences and Medicine 2016). When high cell concentrations form, the toxins they produce can harm marine life, which is referred to as a harmful algal bloom (HAB). 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, the dinoflagellates *Karenia brevis, Alexandrium,* and *Dinophysis*, and the diatom *Pseudo-nitzschia* in the Gulf of America (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 portion of the action area, such as Ciguatoxin-producing *Gambierdiscus* dinoflagellates into the northern Gulf of America (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 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). Capper et al. (2013) found that sea turtles were exposed to multiple HAB toxins (okadaic acid, brevetoxins, saxitoxins, and likely others) in Florida. Results from Vilas et al. (2023) suggest that severe red tide fisheries impacts have occurred on the West Florida Shelf, located in the eastern Gulf of America, at the ecosystem, community, and population levels in terms of biomass, catch, and productivity. Blooms of the toxic dinoflagellate *K. brevis* occur frequently on the west coast of Florida, killing fish and other marine life. The 2018 *K. brevis* harmful algal bloom experienced along the west coast of Florida was the worst red tide occurrence there since 2005 (Liu et al. 2022).

5.13 Marine Debris

Marine debris is an ecological threat 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 5.3–14 million t (4.8–12.7 million MT) 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 concentrate in ocean gyres and convergence zones, notably in regions with *Sargassum* habitat where 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). Changing environmental trends are 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. In a review of global studies evaluating debris ingestion, researchers found that the probability of green and leatherback turtles ingesting debris has increased significantly between 1985– 2012, and herbivorous or jellyfish-consuming species are at greatest risk of both lethal and sublethal effects (Schuyler et al. 2014). 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 providing a source of toxic chemicals (Laist 1987; Laist 1997). Weakened animals are more susceptible to predators and disease and are 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, 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 entangled in marine debris, namely fishing gear, as discussed in Section 5.3.

5.14 Other Marine Pollution

Chemical-based pollution from a variety of sources may also affect listed species in the action area. These sources include atmospheric loading of pollutants such as polychlorinated biphenyls (PCBs), stormwater from coastal or river communities, and discharges from ships and industries. In addition to legacy contaminants such as PCBs, heavy metals, and pesticides, several classes of contaminants of emerging concern also introduce risks to listed species. NOAA's National Status and Trends Mussel Watch Program monitors 85 long-term sites in coastal waters in the Gulf of America, and, in 2017, detected elevated concentrations of the following contaminants of emerging concern across the coastline: brominated flame retardants, pesticides such as highly toxic organophosphates, pharmaceutical compounds, and per- and poly-fluoroalkyl substances (PFAS; Swam et al. 2023). PFAS are a class of chemicals that are highly persistent, bioaccumulative, and have been linked to liver damage, cancer, and immune suppression in humans and aquatic vertebrate study species. Sources of marine pollution are often difficult to attribute to specific federal, state, local or private actions.

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. 2015b; 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. 2015a; 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 portion of the action area and adjacent waters. Two studies 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. PFAS compounds have been detected in the plasma of loggerhead and Kemp's ridley turtles; adverse impacts could have endocrine and reproductive implications for turtle species (Khan et al. 2023). No information on detrimental threshold concentrations is available and little is known about the consequences of exposure of sea turtles to organochlorine compounds. More research is needed to better understand the short- and long-term health and fecundity effects of these chemical pollutants and heavy metal accumulation in sea turtles.

5.15 Other Launch and Reentry Operations

The FAA, National Aeronautics and Space Administration (commonly known as NASA), and the U.S. Space Force (USSF) are involved in space operations such as licensing and regulating U.S. commercial launch and reentry activity and launch sites, leasing launch facilities, and overseeing the preparation and launching of DoD missile launch activities, and government and commercial satellites. As part of these operations, a number of vehicles are launched from facilities across the U.S. each year, and may end up in the ocean.

Space activities may affect marine protected species including sea turtles, that inhabit or transit through areas where launch and reentry operations occur. These operations often involve the deployment of weather balloons, vessel and aircraft surveillance, and expending or landing a vehicle or component of the vehicle (parachutes, fairings) in the ocean, which can affect sea turtles, their prey, and their habitat.

The programmatic letter of concurrence for launch and reentry vehicle operations in the marine environment (OPR-2021-02908) sets maximum annual limits on commercial space operations in the Gulf and Atlantic Ocean. In the Gulf, maximum annual limits include five launches involving stages that are expended (not recovered) in the ocean, five launches involving attempted recovery of stages in the ocean, and ten spacecraft reentries and landings in the ocean. In the Atlantic Ocean, maximum annual limits include 30 launches involving stages and fairings that are expended in the ocean, 70 launches involving attempted recovery of stages and fairings in the ocean, 10 spacecraft reentries and landings in the ocean, and one launch abort test. At this time, it is unclear the extent to which the rapid expansion of the space industry and continuing disposal of stages and debris in the ocean will affect ESA-listed species and their critical habitat. FAA, NASA, and USSF are in the process of reinitiating the consultation to include all ongoing and future commercial space operations.

5.16 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 affects 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 green, Kemp's ridley, and loggerhead turtles to be the status and trends of those species. As noted in Section 4.2, some of the species considered in this consultation are experiencing increases in population abundance, some are declining, and, for others, their status remains unknown. Taken together, this indicates that the environmental baseline is affecting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the environmental baseline. Therefore, while the environmental baseline may slow their recovery, recovery is not prevented. For the species that may be declining in abundance, it is possible the suite of conditions described in the environmental baseline section is preventing their recovery. However, it is also possible 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.

5.17 Conservation and Recovery Actions

NMFS has implemented a series of regulations aimed at reducing the potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for the Atlantic HMS, South Atlantic snapper-grouper, and Gulf reef fish fisheries, and TED requirements for the Southeast shrimp trawl fishery. In addition to regulations, outreach programs have been established and data on sea turtle interactions with recreational fisheries has been collected through the Marine Recreational Information Program. These measures are summarized below.

5.17.1 Federal Actions

To advance the conservation and recovery of ESA-listed sea turtles, each sea turtle recovery plan, developed jointly by NMFS and the USFWS, identifies and highlights the need to maintain an active stranding network. As a result, the Sea Turtle Stranding and Salvage Network (the Network) was formally established by NMFS in 1980 to document stranding of sea turtles along the coastal areas from Maine to Texas and in portions of the U.S. Caribbean. The Network is a cooperative effort comprised of federal, state, and permitted private partners working to inform causes of morbidity and mortality in sea turtles by responding to and documenting sea turtles, found either dead or alive (but compromised), in a manner sufficient to inform conservation management and recovery.

NMFS also formally established the Southeast Atlantic Coast Sea Turtle Disentanglement Network (STDN), an important component of the National Sea Turtle Stranding and Salvage Network. The STDN works to reduce serious injuries and mortalities caused by entanglements and is active throughout the action area responding to reports of entanglements. Where possible, sea turtles are disentangled and may be brought to rehabilitation facilities for treatment and recovery, helping to reduce death from entanglement.

Reducing Threats from Pelagic Longline and Other Hook-and-Line Fisheries

On July 6, 2004, NMFS published a Final Rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality.

NMFS published the Final Rule to implement sea turtle release gear requirements and sea turtle careful release protocols in the Gulf reef fish (August 9, 2006; 71 FR 45428) and South Atlantic snapper-grouper fisheries (November 8, 2011; Lopez-Pujol and Ren 2009). These measures require owners and operators of vessels with federal commercial or charter vessel/headboat permits for Gulf reef fish and South Atlantic snapper-grouper to comply with sea turtle release protocols and have specific sea turtle release gear aboard vessels.

Revised Use of Turtle Excluder Devices in Trawl Fisheries

NMFS has also implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. In particular, NMFS has required the use of TEDs in southeast U.S. shrimp trawls since 1989, and in summer flounder trawls in the mid-Atlantic area (south of Cape Charles, Virginia) since 1992. It is estimated that TEDs exclude 97% of the sea turtles caught in such trawls. The regulations have been refined over the years to ensure that TED effectiveness is maximized through more widespread use, and proper placement, installation, configuration (e.g., width of bar spacing), and floatation. The NMFS continues to work towards development of new, more effective gear specific to fishery needs.

Placement of Fisheries Observers to Monitor Sea Turtle Captures

On August 3, 2007, NMFS published a Final Rule that required selected fishing vessels to carry observers on board to collect data on sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle captures, and to determine whether additional measures to address prohibited sea turtle captures may be necessary (72 FR 43176). This Rule also extended the number of days NMFS observers could be placed aboard vessels, from 30 to 180 days, in response to a determination by the Assistant Administrator that the unauthorized take of sea turtles may be likely to jeopardize their continued existence under existing regulations.

5.17.2 State Actions

Under section 6 of the ESA, state agencies may voluntarily enter into cooperative research and conservation agreements with NMFS to assist in recovery actions of listed species. NMFS currently has an agreement with all states along the Gulf of America and Atlantic Ocean in the action area. Prior to issuance of these agreements, the proposals were reviewed for compliance with section 7 of the ESA.

5.17.3 Other Conservation Efforts

Sea Turtle Handling and Resuscitation Techniques

NMFS published a Final Rule (66 FR 67495) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the Final Rule. These measures help to prevent mortality of hardshell turtles (such as ESA-listed sea turtles) caught in fishing or scientific research gear.

Outreach and Education, Sea Turtle Entanglement, and Rehabilitation

A Final Rule (70 FR 42508), published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the USCG, or any other federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment, if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA (50 CFR §223.206(b)).

NMFS has also been active in public outreach efforts to educate fishers regarding sea turtle handling and resuscitation techniques. As well as making this information widely available to all fishers, NMFS recently conducted a number of workshops with Atlantic HMS pelagic longline fishers to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts and hopes to reach all fishers participating in the Atlantic HMS pelagic longline fishery.

Recovery Plans and Reviews

The Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle Second Revision was completed in 2008 (NMFS 2008b). The recovery plan for the U.S. Atlantic population of green turtles was published in 1991 (NMFS and USFWS 1991), and the Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles was published 2011 (NMFS et al. 2011a). Recovery teams comprised of sea turtle experts that were convened and are currently working towards revising these plans based upon the latest and best available science. Five-year status reviews were completed in 2015 for green (Seminoff et al. 2015) and Kemp's ridley turtles (NMFS and USFWS 2015). The five-year status review of the Northwest Atlantic Ocean DPS of loggerhead turtle status was conducted in 2023 (NMFS and USFWS 2023). These reviews comply with the ESA mandate for periodic status evaluation of listed species to ensure that their threatened or endangered listing status remains accurate.

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 determined to be LAA is the underwater acoustic effects from explosive events in the Gulf and Atlantic Ocean portions of the action area. The following analysis separately assesses the exposure of listed sea turtles and then critical habitat, followed by separate assessments of the responses of listed species and critical habitat to that exposure. To conclude this section, we summarize the combination of exposure and response for each species and each critical habitat.

6.1 Exposure

In this section, we consider the exposure to the various stressors that could cause an effect to ESA-listed species and designated critical habitat 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 then determine to which populations those exposed individuals belong. Similarly, we describe the location, duration, and frequency of those stressors to understand the alterations to the conservation value of designated critical habitat. We also describe the duration, frequency, and intensity of stressors to quantify the number or extent of exposures that are reasonably certain to occur.

6.1.1 ESA-Listed Sea Turtle Exposure

The ESA-listed sea turtles likely to be adversely affected by underwater acoustic effects from explosive events in the Gulf and Atlantic Ocean portions of the action area are the North Atlantic DPS of green turtle, 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 exposed to underwater sound from the explosive events, FAA adopted SpaceX's methodology summarized in Sections 4.1.2.1 and 4.1.2.2. Sea turtle densities were obtained from Garrison et al. (2023b) for the Gulf portion of the action area and DiMatteo et al. (2024) for the Atlantic Ocean portion of the action area. NMFS acoustic thresholds for sea turtles corresponding to different levels of hearing threshold shifts (226 and 232 dB re 1µPa, respectively) were applied to estimate the ensonified areas, and the number of individuals of each species exposed to and potentially responding to the underwater sound from a maximum of 20 Super Heavy and 20 Starship explosions in each portion of the action area (Table 16 and Table 17). We note that the U.S. Navy has developed updated thresholds for sea turtles (U.S. Department of the Navy 2024). The U.S. Navy's updated thresholds for sea turtles are extrapolated from Salas et al. (2023), Salas et al. (2024a), and Salas et al. (2024b), all of which observed hearing shifts in response to noise in freshwater turtles (see below). While Salas et al. (2023), Salas et al. (2024a), and Salas et al. (2024b) represent the best available information on hearing shift in freshwater turtles, at the time of this consultation, NMFS has not adopted the U.S. Navy's sea turtle thresholds for non-Navy actions. Table 18 summarizes the total number of individuals exposed to underwater acoustic effects from explosive events by species. Note that estimated exposures may not match the exact product of the density and ensonified area due to rounding.

Table 16. Exposure estimates for ESA-listed sea turtles in the Gulf portion of the action area for up to 20 Super Heavy and 20 Starship explosive events

Species	Threshold (dB re 1µPa)*	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Maximum Monthly Mean Density (individuals per km^2)	Exposure for 20 Super Heavy Explosive Events	Exposure for 20 Starship Explosive Events
Kemp's Ridley Turtle	226	0.093	0.046	0.753	1.4067	0.6973
	232	0.024	0.012	0.753	0.3539	0.1747
Loggerhead Turtle – Northwest Atlantic Ocean DPS	226	0.093	0.046	0.8336	1.5572	0.7720
	232	0.024	0.012	0.8336	0.3918	0.1934

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

Table 17. Exposure estimates for ESA-listed sea turtles in the Atlantic Ocean portion of the action area for up to 20 Super Heavy and 20 Starship explosive events

Species	Threshold (dB re 1µPa)*	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Maximum Monthly Mean Density (individuals per km^2)	Exposure for 20 Super Heavy Explosive Events	Exposure for 20 Starship Explosive Events
Green Turtle – North Atlantic DPS	226	0.093	0.046	0.05322	0.0994	0.0493
Loggerhead Turtle – Northwest Atlantic Ocean DPS	226	0.093	0.046	0.30404	0.5680	0.2815
	232	0.024	0.012	0.30404	0.1429	0.0705

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

Table 18. Total number of individuals exposed to underwater acoustic effects from explosive events in the Gulf and Atlantic Ocean portions of the action area

Species	Threshold (dB re 1µPa)*	Exposure for 20 Super Heavy Explosive Events	Exposure for 20 Starship Explosive Events	Total Estimated Individuals Exposed	Total Individuals Exposed
Green Turtle – North Atlantic DPS	226	0.0994	0.0493	0.15	1
Kemp's Ridley Turtle	226	1.4067	0.6973	2.10	3
	232	0.3539	0.1747	0.53	1
Loggerhead Turtle – Northwest Atlantic Ocean DPS	226	2.125	1.053	3.18	4
	232	0.535	0.264	0.8	1

* Note SPL_{peak} thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal

Green, 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 40 explosive events (20 Super Heavy and 20 Starship) could occur at any time of year for the duration of the proposed action, we expect that animals will be foraging, mating, nesting, hatching, or transiting in the Gulf and Atlantic Ocean portions of the action area.

North Atlantic DPS Green Turtle – The estimated exposure is one individual in the Atlantic Ocean portion of the action area. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult green turtles along the U.S. Atlantic Coast of 63,674 individuals (90% CI = 23,381–117,610 individuals). Given this population estimate, the estimated exposure of one individual is approximately 0.00002% of the population.

Kemp's Ridley Turtle – The estimated exposure is four individuals in the Gulf portion of the action area. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 individuals (90% CI = 2,620–19,443 individuals). Given this population estimate, the estimated exposure of four individuals is approximately 0.0004% of the population. This estimate is likely higher than the actual exposures because the population abundance estimate does not include turtles smaller than 16 in (40 cm) or turtles from the population's entire range.

Northwest Atlantic Ocean DPS Loggerhead Turtle – The estimated exposure of the population is five individuals in the Gulf and Atlantic Ocean portions of the action area. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). Based on this population estimate, the estimated exposure of five individuals is approximately 0.00003% of the population. This estimate is likely higher than the actual exposures because the population abundance estimate does not include turtles smaller than 16 in (40 cm) or turtles from the population's entire range.

6.1.2 Designated Critical Habitat Exposure

The designated critical habitat that is likely to be adversely affected by the proposed action is the breeding habitat of the Northwest Atlantic Ocean DPS of loggerhead turtle. NMFS designated two units of breeding habitat: (1) within the Southern Florida migration corridor from the shore out to the 656 ft (200 m) depth contour along the stretch of the corridor between the Marquesas Keys and the Martin County/Palm Beach County line, and (2) in nearshore waters just south of Cape Canaveral, Florida.

Only breeding habitat around Cape Canaveral, Florida overlaps with the Atlantic Ocean portion of the action area where there will be explosive events.

6.2 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 species and the PBFs of critical habitat may display because of exposure to those stressors from explosive events. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. We address the expected range of responses because of the types of exposure of the PBFs of critical habitat. When addressing critical habitat, we consider impairments to the function of the PBFs, the amount of time it may take for those PBFs to return to their present function, the extent of the critical habitat that is likely to be affected by the action, and whether the remaining critical habitat is sufficient to support the conservation of ESA-listed species.

6.2.1 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)).

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

Hearing Loss and Threshold Shifts

Sea turtles are susceptible to noise-induced hearing loss, or noise-induced threshold shifts (i.e., a loss of hearing sensitivity), and auditory injury when exposed to high levels of sound within their limited hearing range (most sensitive from 100– 400 Hz and limited over 1 kHz). Types of noise-induced threshold shifts include temporary threshold shift (TTS) or a permanent threshold shift (PTS). TTS is a temporary, reversible increase in hearing threshold at a specified frequency or portion of an animal's hearing range above a previously established reference level. PTS is a permanent, irreversible increase in hearing threshold at a specified frequency of portion of an animal's hearing range above a previously established reference level. Sea turtles may also be susceptible to auditory injury, which is sometimes referred to as PTS. However, the term auditory injury acknowledges that auditory injury, such as the loss of cochlear neuron synapses or auditory neuropathy, may occur even if hearing thresholds return to previously established reference levels. In other words, auditory injury includes PTS, but can occur without resulting in PTS (U.S. Department of the Navy 2024). Auditory injury has not been directly observed in sea turtles; however, it has been observed in other animals such as mice and guinea pigs (Kujawa and Liberman 2006; Kujawa and Liberman 2009; Lin et al. 2011). We note that NMFS has not adopted the U.S. Navy's updated TTS and auditory injury thresholds for sea turtles (see Section 6.1.1). The following discussion summarizes the best available information on hearing shifts in sea turtles.

Although no studies have directly measured underwater TTS or auditory injury in ESA-listed sea turtles, recent studies examined underwater TTS in freshwater turtles using broadband sound (analogous to sound from an explosion). Salas et al. (2023) exposed red-eared sliders (*Trachemys scripta elegans*) to sound exposure levels (a measure of the acoustic energy of a sound over a specified time period) between 155–193 decibels referenced to a pressure of one microPascal-squared second (dB re 1 μPa^2-s), and auditory sensitivity was measured at 400 Hz using auditory evoked potential methods. The mean predicted TTS onset was 160 dB re 1 μPa^2-s. In another study using Eastern painted turtles (*Chrysemys picta picta*), Salas et al. (2024) reported similar results, with TTS onset occurring at 154 dB re 1 μPa^2 s at 600 Hz and 158 dB re 1 μPa^2 s at 400 Hz.

Explosions create a sound that is broadband in frequency, and includes low frequencies that overlap sea turtle hearing ranges (Hildebrand 2009a). 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 affect 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 affect 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 is 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 long-term fitness impacts to 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, 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 sea turtle behavioral responses 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 40 explosive events in each portion of the action area, explosive events will not happen in succession and are extremely unlikely to occur in the same location) 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, such as reproduction, would not be likely with exposure to 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.

Super Heavy and Starship explosive events transmit acoustic energy into the water, creating a wave of pressure that can result in TTS or PTS in ESA-listed loggerhead turtles, including potentially reproductive males and females, which may affect reproduction. There may be up to 80 explosive events within the range of Northwest Atlantic Ocean DPS loggerhead turtle (20 Super Heavy explosive events and 20 Starship explosive events, in the Gulf and the Atlantic Ocean portions of the action area), which could result in TTS or PTS to five loggerhead turtles. In the area of Cape Canaveral, Florida, Ceriani et al. (2019) estimated an annual average number of loggerhead nests between 1989–2018 at 31,144 nests (range: 19,416–43,583 nests) and 27,819 nests (range: 16,646–39,140 nests) based on data from the Florida Statewide Nesting Beach Survey program and the Florida Index Nesting Beach Survey program, respectively. Should all five expected loggerhead exposures be turtles of reproductive age, we anticipate a short-term effect to reproduction on the part of individuals exposed to the sound from an explosive event if it occurs during breeding season.

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. 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.

6.2.2 Critical Habitat Response – Northwest Atlantic Ocean DPS Loggerhead Turtle

Super Heavy and Starship explosive events transmit acoustic energy into the water, creating a wave of pressure that can affect the PBF for breeding critical habitat. Explosive events within the unit of breeding critical habitat that may be affected by the proposed action (Cape Canaveral, Florida), would affect the PBF of concentrating reproductive individuals. The sound levels during an explosive event would impair normal functions, such as breeding, at levels causing TTS or PTS, and cause behavioral responses such as startle responses, causing individuals to leave the area. Thus, the PBF for breeding habitat would be impaired because the habitat would, at least temporarily, not concentrate reproductive individuals.

6.3 Summary of Effects

In this section, we combine the exposure analysis and response analysis to produce estimates of the amount and extent of take anticipated because of the stressors caused by 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 and designated critical habitat that will be adversely affected by the proposed action.

6.3.1 Green Turtle – North Atlantic DPS

We expect one North Atlantic DPS green turtle to be exposed to underwater sound from Super Heavy and Starship explosive events within the 226 dB re 1µPa ensonified area in the Atlantic Ocean portion of the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect North Atlantic DPS green turtles' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness or have population-level effects.

6.3.2 Kemp's Ridley Turtle

We expect up to three Kemp's ridley turtles to be exposed to underwater sound from Super Heavy and Starship explosive events within the 226 dB re 1µPa ensonified area in the Gulf portion of the action area and exhibit responses in the form of TTS or behavioral and physiological stress. We also expect one Kemp's ridley turtle to be exposed to underwater sound from Super Heavy and Starship explosive events within the 232 dB re 1µPa ensonified area in the Gulf portion of the action area and exhibit responses in the form of PTS.

TTS or behavioral and physiological stress may affect Kemp's ridley turtles' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness. PTS could permanently impair a sea turtle's hearing and result in a reduction in fitness through some decrease in survivorship or reproduction, but we do not expect population-level effects.

6.3.3 Loggerhead Turtle – Northwest Atlantic Ocean DPS

We expect up to four Northwest Atlantic Ocean DPS loggerhead turtles to be exposed to underwater sound from Super Heavy and Starship explosive events within the 226 dB re 1µPa ensonified area in the Gulf and Atlantic Ocean portions of the action area and exhibit responses in the form of TTS or behavioral and physiological stress. We also expect one Northwest Atlantic Ocean DPS loggerhead turtle to be exposed to underwater sound from Super Heavy and Starship explosive events within the 232 dB re 1µPa ensonified area in the Gulf and Atlantic Ocean portions of the action area and exhibit responses in the form of PTS.

TTS or behavioral and physiological stress may affect Northwest Atlantic Ocean DPS loggerhead turtles' normal behavior patterns but is not expected to result in a long-term reduction in individual fitness. PTS could permanently impair a sea turtle's hearing and result in a reduction in fitness through some decrease in survivorship or reproduction, but we do not expect population-level effects.

6.3.4 Critical Habitat – Northwest Atlantic Ocean DPS of Loggerhead Turtle

We examined underwater acoustic effects from explosive events on the designated breeding critical habitat for Northwest Atlantic Ocean DPS of loggerhead turtle. The PBF of breeding habitat that may be adversely affected is the suitability of the habitat to allow for high densities of reproductive male and female loggerheads. In our analysis of underwater acoustic effects from explosive events to breeding habitat, we determined sound levels would temporarily alter habitat conditions such that individuals would not be concentrated within the area with sound levels above sea turtle hearing thresholds, impairing critical habitat function for the designated breeding critical habitat unit for Northwest Atlantic Ocean DPS of loggerhead turtle.

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, a future increase is considered reasonably certain to occur. Given current trends in global population growth, threats associated with changing environmental trends, pollution, fisheries, bycatch, aquaculture, vessel strikes, and sound are likely to continue to increase in the future, although any increase in effects may be somewhat countered by an increase in conservation and management, should these occur.

8. INTEGRATION AND SYNTHESIS

This opinion includes a jeopardy analysis for the ESA-listed threatened and endangered species and a destruction of adverse modification analysis for designated critical habitat that are likely to be adversely affected by the action. Section 7(a)(2) of the ESA 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. The jeopardy analysis, therefore, relies upon the regulatory definitions of *jeopardize the continued existence of* and *destruction or adverse modification*.

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).

Destruction or adverse modification means "a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02). *Conservation*, used in that definition, means "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary" (16 U.S.C. §1532(3)).

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 and critical habitat (Section 4), to formulate the agency's biological opinion as to whether the action agency can insure its proposed action is not likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat as a whole for the conservation of the species.

8.1 Jeopardy Analysis

The jeopardy analysis assesses the proposed action's effects on ESA-listed North Atlantic DPS green, Kemp's ridley, and Northwest Atlantic Ocean DPS loggerhead turtle survival and recovery. The following sections summarize the relevant information in this opinion for each individual species considered.

8.1.1 Green Turtle – North Atlantic DPS

The North Atlantic DPS is the largest of the 11 green turtle DPSs, with an estimated nester abundance of over 167,000 adult females from 73 nesting sites (Seminoff et al. 2015). Florida accounts for approximately 5% of nesting for this DPS. According to data collected from Florida's index nesting beach survey from 1989–2024, green turtle nest counts across Florida have increased from a low of 267 in the early 1990s to a high of 40,911 in 2019. Nesting decreased by half from 2019–2020, although it increased to a new record high in 2023 before dropping substantially in 2024. Similar fluctuations were observed at Tortuguero, Costa Rica, which is the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al. 2015). Current nesting levels at Tortuguero, Costa Rica have reverted to that of the mid-1990s and the overall long-term trend has now become negative (Restrepo et al. 2023). Green turtles generally follow a two-year reproductive cycle, which may explain fluctuating nest counts; however, threats that have affected nesting in the Tortuguero region may ultimately influence the trajectories of nesting in the Florida region. DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult green turtles along the U.S. Atlantic Coast of 63,674 individuals (90% CI = 23,381–117,610 individuals). We are not aware of any current range-wide in-water estimates for the DPS.

North Atlantic DPS green turtles will experience TTS or behavioral and physiological stress responses throughout the Atlantic Ocean portion of the action area from Super Heavy and Starship explosive events. We anticipate one instance of TTS or behavioral and physiological stress is reasonably certain to occur over 40 total explosive events in the Atlantic Ocean portion of the action area.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary and sea turtles do not rely heavily on acoustic cues. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, one TTS or behavioral and physiological stress exposure will not have measurable impacts to the population to which that individual belongs and the effects of the stressors resulting from explosive events as part of the proposed action will not affect the survival of North Atlantic DPS green turtles in the wild.

The 1991 Recovery Plan for the U.S. Atlantic population of green turtles identified the major actions needed to recover this DPS (NMFS and USFWS 1991). Demographic criteria for delisting the species includes a level of nesting in Florida that has increased to an average of 5,000 nests per year for at least six years. There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that explosives can affect green turtles and cause negative impacts including, but not limited to, injury and mortality. While we anticipate North Atlantic DPS green turtles will be harassed by underwater sound during explosive events, this will not impede the potential for recovery of North Atlantic DPS green turtles. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not appreciably diminish the ability of green 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, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of North Atlantic DPS green sea turtles in the wild.

8.1.2 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 a mean annual in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 individuals (90% CI = 2,620–19,443 individuals).

Kemp's ridley turtles will experience TTS, PTS, and behavioral and physiological stress responses throughout the Gulf portion of the action area from Super Heavy and Starship explosive events. We anticipate three instances of TTS or behavioral and physiological stress, and one instance of PTS are reasonably certain to occur over the 40 total anticipated explosive events in the Gulf portion of the action area.

As discussed in Section 6.2.1, 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 one individual, leading to a slight reduction in numbers. This reduction in numbers, as well as the effects of TTS or behavioral and physiological stress responses in three other individuals, will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in three individuals and PTS in one individual 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 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 six-year period distributed among nesting beaches in Mexico and the U.S.; and 2) ensure average annual recruitment of hatchlings over a six-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 anticipate Kemp's ridley turtles will be adversely affected by underwater sound from explosive events, this will not impede the recovery objectives for Kemp's ridley turtles. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not appreciably diminish the ability of Kemp's ridley 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, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of Kemp's ridley sea turtles in the wild.

8.1.3 Loggerhead Turtle – Northwest Atlantic Ocean DPS

The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead 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 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). An 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) recovery 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 a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). 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 and Atlantic Ocean portions of the action area from Super Heavy and Starship explosive events. We anticipate four instances of TTS or behavioral and physiological stress, and one instance of PTS are reasonably certain to occur over 80 total explosive events across the Gulf and Atlantic Ocean portions of the action area.

As discussed in Section 6.2.1, 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 one individual, leading to a slight reduction in numbers. This reduction in numbers, as well as the effects of TTS or behavioral and physiological stress responses in four other individuals, will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in four individuals and PTS in one individual 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 Northwest Atlantic Ocean DPS loggerhead 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 adversely affected by exposure to underwater sound from explosive events, this will not impede recovery 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 appreciably diminish the ability of loggerhead 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, 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.

8.2 Destruction/Adverse Modification Analysis

Recovery of the Northwest Atlantic Ocean DPS of loggerhead turtle cannot occur without protecting the PBF that supports breeding critical habitat. Super Heavy and Starship explosive events will adversely affect Northwest Atlantic Ocean DPS loggerhead turtle critical habitat. Thus, our destruction or adverse modification analysis determines whether or not the proposed action is likely to appreciably diminish the value of critical habitat as a whole for the conservation of a listed species, in the context of the status of the critical habitat (Section 4), effects of the action (Section 6), the environmental baseline (Section 5), and cumulative effects (Section 7).

The PBF for breeding critical habitat considered in this consultation is high densities of reproductive male and female loggerhead turtles. Our effects analysis determined that explosive events are likely to adversely affect the PBF because underwater sound from explosive events will, at least temporarily, diminish habitat quality because individuals will not concentrate in areas where sound levels are sufficient to cause PTS, TTS, or behavioral and physiological stress responses. Because explosive events will not be continuous or regular in a particular portion of the breeding critical habitat unit, stressors from these explosive events will not appreciably diminish the conservation value of critical habitat as a whole. We determine that the proposed action would not result in the destruction or adverse modification of critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle.

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 North Atlantic DPS of green turtle, Kemp's ridley turtle, or Northwest Atlantic Ocean DPS of loggerhead turtle, or destroy or adversely modify designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle.

NMFS also determined the proposed action may affect, but is 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, Chesapeake Bay DPS, and South Atlantic DPS, giant manta ray, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, scalloped hammerhead shark – 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, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed sunflower sea star 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, North Atlantic right whale, leatherback turtle, North Atlantic DPS of green turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, 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. "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 19. Anticipated number and type of ESA takes of sea turtles for up to 20 Super Heavy explosive events

Species	TTS/ significant behavioral response	PTS
Green Turtle – North Atlantic DPS	1	--
Kemp's Ridley Turtle	3	1
Loggerhead Turtle – Northwest Atlantic Ocean DPS	4	1

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 continue to coordinate with NMFS to minimize effects to ESA-listed green, Kemp's ridley, and loggerhead turtles 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 green, Kemp's ridley, and loggerhead turtles from explosive events at nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2025-00164 – [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 provision and review of Starship-Super Heavy fate reports and annual reports, regular review of ESA section 7 reinitiation triggers (described in Section 12), and potential development of 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 nature and extent of potential effects, and ranges to effects (e.g., ensonified areas), 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 green, Kemp's ridley, and loggerhead 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 landings and explosive events. Sound source verification will help to improve the accuracy of predictions of the underwater acoustic impacts of similar activities in the future.
2. During any nighttime vessel operations in any portion of the action area, we recommend vessel speeds do not exceed 10 kt 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, expended stages), 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.
6. We recommend FAA utilize the Whale Alert app to report and identify where whale "safety zones" occur, so that vessel operators and observers can help reduce vessel strikes. For instance, recently, two North Atlantic right whales were observed off the Florida Gulf coast. NMFS did not declare a Dynamic Management Area because these whales were not observed off the U.S. East Coast; however, the endangered whales were reported on the Whale Alert app.
7. We recommend FAA analyze the underwater acoustic effects from explosive events in shallow water, should vehicle explosions occur there with greater frequency than is understood at the time of this consultation (see also Section 12), because sound propagates differently in shallow water compared to deep water.
8. We recommend FAA minimize the number of weather balloons released per launch and explore alternatives to the release of weather balloons, to reduce marine 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 Environmental Consultation Organizer (ECO) number for this consultation (OPR-2025-00164) in the subject line.

12. Reinitiation of Consultation

This concludes formal consultation on FAA's proposed action to modify and issue a vehicle operator license authorizing SpaceX to conduct up to 145 launches annually of their Starship-Super Heavy launch vehicle including operations in the North Atlantic Ocean, Gulf, 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.

Examples of information that could change our effects analysis, or new information that will better inform our effects analysis, and may require reinitiation include, but are not limited to:

- Issuance of a new license or extension of the current license's expiration date;
- A new launch site is proposed to become operational;
- Information on trajectories (e.g., from a new launch site, or to a another landing area), which will inform where a potential mishap may occur;
- Data regarding the likelihood or the number of times a specific trajectory is/will be used, which will better inform the assumptions on where a mishap or landing may occur;
- Data regarding landing locations of each vehicle (e.g., locations and how many times a vehicle lands in the vicinity of those locations, how often a landing area will be used compared to other landing areas, the likelihood that a vehicle will land in specific areas [e.g., nearer to launch sites] more than other areas [e.g., further offshore]), which will better inform the assumption that there is an equal probability a landing occurs anywhere within a portion of the action area, and subsequently the species densities and estimated exposure;
- Information on the ports and routes used by surveillance/recovery vessels and floating platforms/ocean-going barges/drone ships;
- Changes to the launch vehicle or flight plan that affect the performance of the launch vehicle or affect progress towards achieving a fully reusable vehicle, which will inform the likelihood of mishaps; and
- Potential impacts to listed species or critical habitat that occur after the vehicle has sunk (e.g., does propellant leak out at the seafloor or over time, how does the vehicle erode over time).

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