DRAFT ENVIRONMENTAL IMPACT STATEMENT

SPACEX STARSHIP-SUPER HEAVY LAUNCH VEHICLE AT LAUNCH COMPLEX 39A

at the Kennedy Space Center, Merritt Island, Florida

Volume II, Appendix B.6, Part 3

August 2025

Federal Aviation Administration

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Appendix B Regulatory Consultations

This appendix provides regulatory consultation documentation for Endangered Species Act Section 7 consultation with the United States (U.S.) Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), Magnuson-Stevenson Fishery Conservation and Management Act consultation with the NMFS, National Historic Preservation Act (NHPA) Section 106 consultation with the Florida State Historic Preservation Officer (SHPO), U.S. Department of Transportation Act Section 4(f) consultation with officials with jurisdiction over affected properties, Coastal Zone Management Act consultation with the Florida Department of Environmental Protection, and Marine Mammal Protection Act Incidental Harassment Authorization with NMFS.

B.6 Endangered Species Act Section 7 Consultation (NMFS)

A Biological Assessment (BA) was submitted to NMFS on May 24, 2024.

On January 17, 2025, NMFS provided a Conference and Biological Opinion (CBO) on the effects of Starship-Super Heavy operations on endangered and threatened species under NMFS' jurisdiction, as well as critical habitat for those species, in the North Atlantic Ocean, Gulf of America, North Pacific Ocean, South Pacific Ocean, and Indian Ocean. The Federal Aviation Administration provided addendums to NMFS describing proposed modifications to Starship-Super Heavy operations at Launch Complex (LC)-39A, among other locations, on March 10, 2025, March 28, 2025, and April 1, 2025. The addendum submitted on April 1, 2025, supersedes the previous addendums and is included in the EIS appendix. On April 18, 2025, based on the addendum requests, NMFS provided a revised CBO on the effects of Starship-Super Heavy 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. This revised CBO replaced the original CBO submitted on January 17, 2025; thus, only the revised CBO is included in the EIS appendix.

B.6.3 Conference and Biological Opinion (April 2025)

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
Publisher:	Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Approved:	MARZIN.CATHERINE.GAELLE.1365836082 Digitally signed by MARZIN.CATHERINE.GAELLE.1365836082 Date: 2025.04.18 12:18:08 -04'00' For Kimberly Damon-Randall Director, Office of Protected Resources
Date:	4/18/25
ECO Number:	OPR-2025-00164
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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

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[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

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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

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(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.

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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).

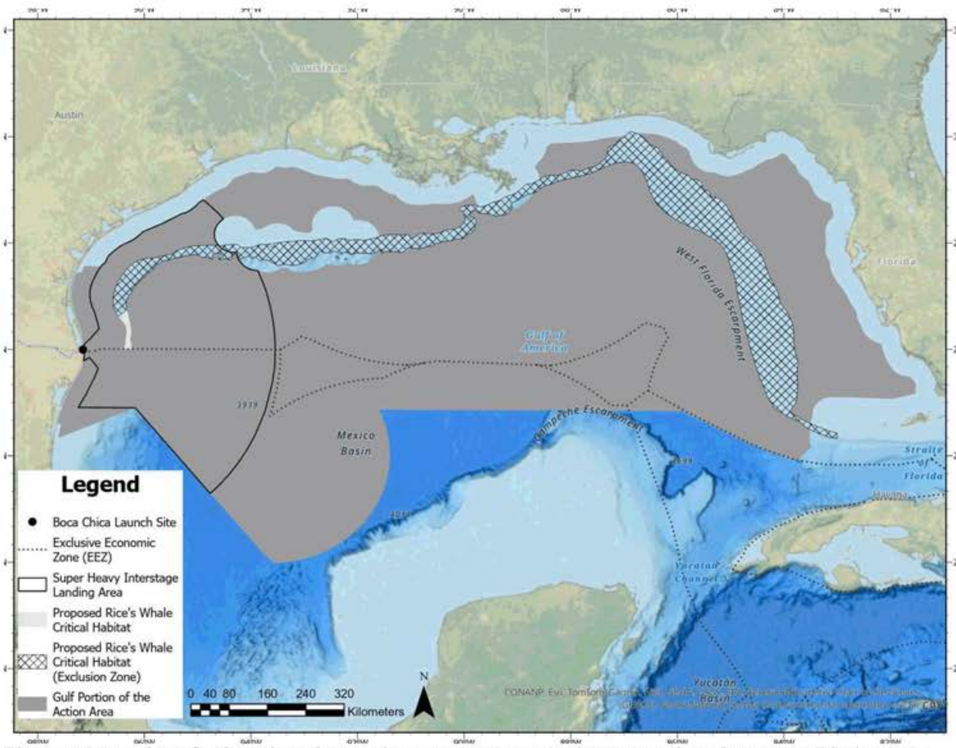

Figure 1. Map of the Gulf portion of the action area (dark grey) with the portion of proposed Rice's whale critical habitat that will be excluded (hatched) and portion of proposed Rice's whale critical habitat that will be included (light grey) in the area where Starship and Super Heavy may land, and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

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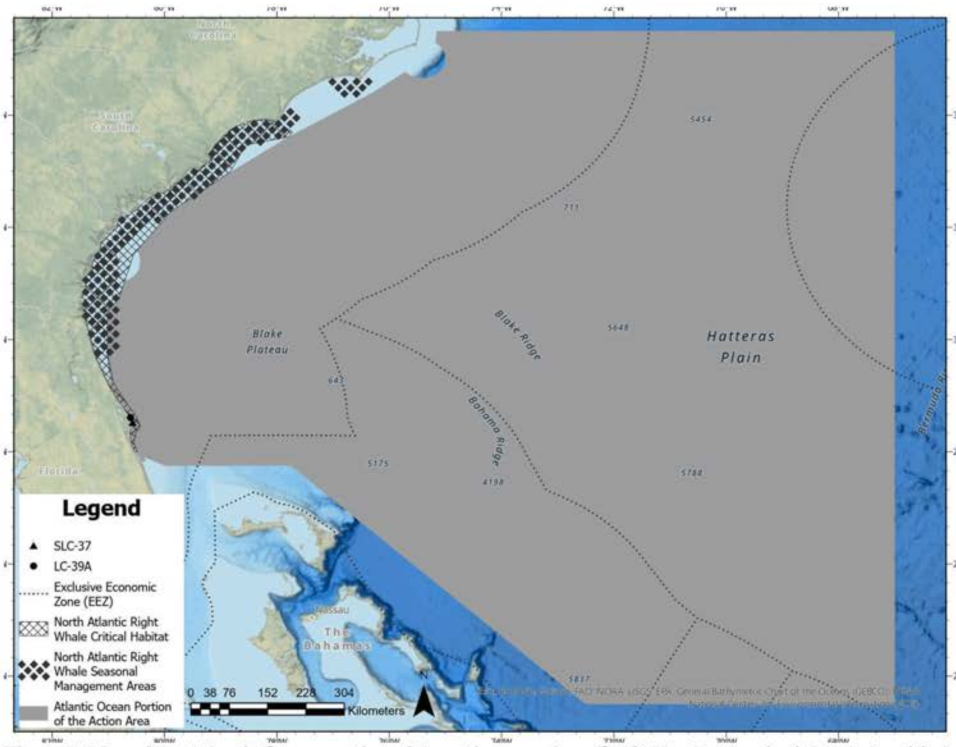

Figure 2. Map of the Atlantic Ocean portion of the action area (non-Gulf), North Atlantic right whale critical habitat (hatched) and Seasonal Management Area (diamonds) shown to illustrate overlap with the Atlantic Ocean portion of the action area.

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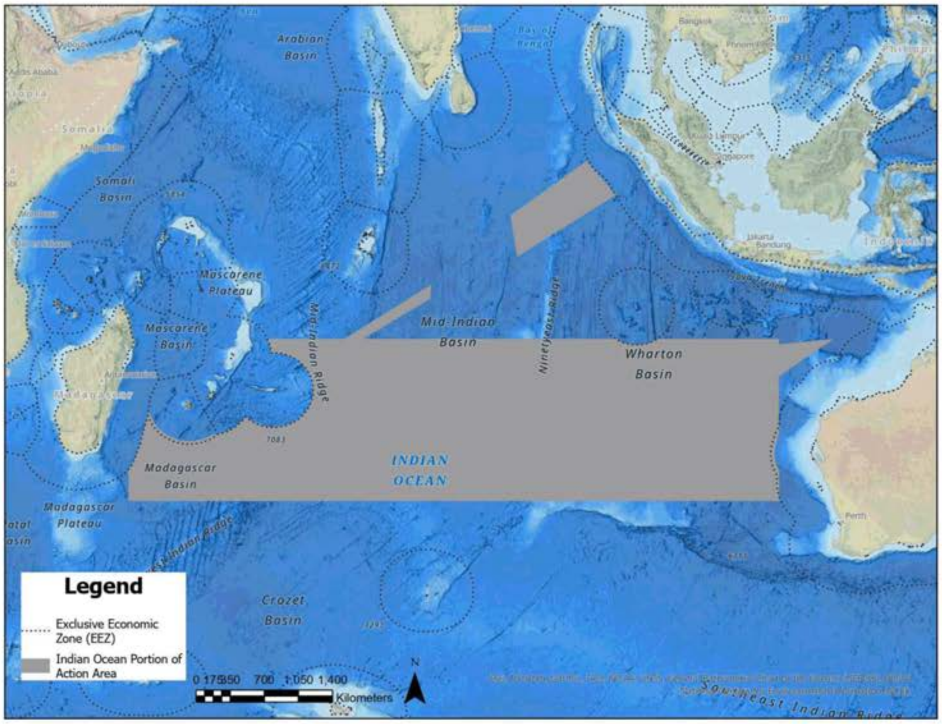

Figure 3. Map of the Indian Ocean portion of the action area.

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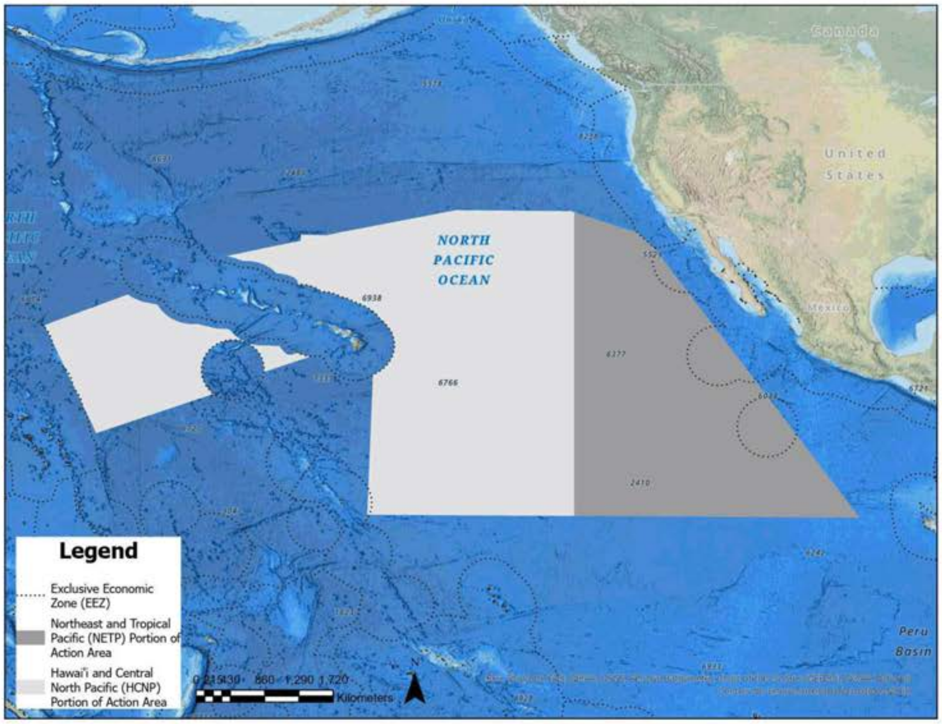

Figure 4. Map of the Hawaii and Central North Pacific portion of the action area (light grey) and Northeast and Tropical Pacific portion of the action area (dark grey).

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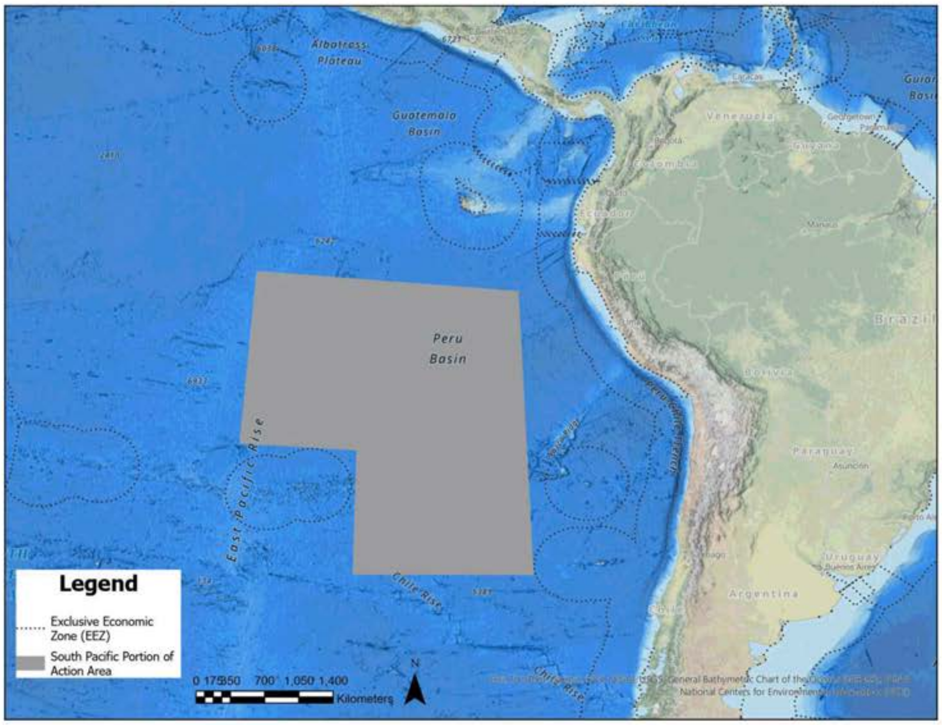

Figure 5. Map of the South Pacific portion of the action area.

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

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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.

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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

[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

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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.

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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.

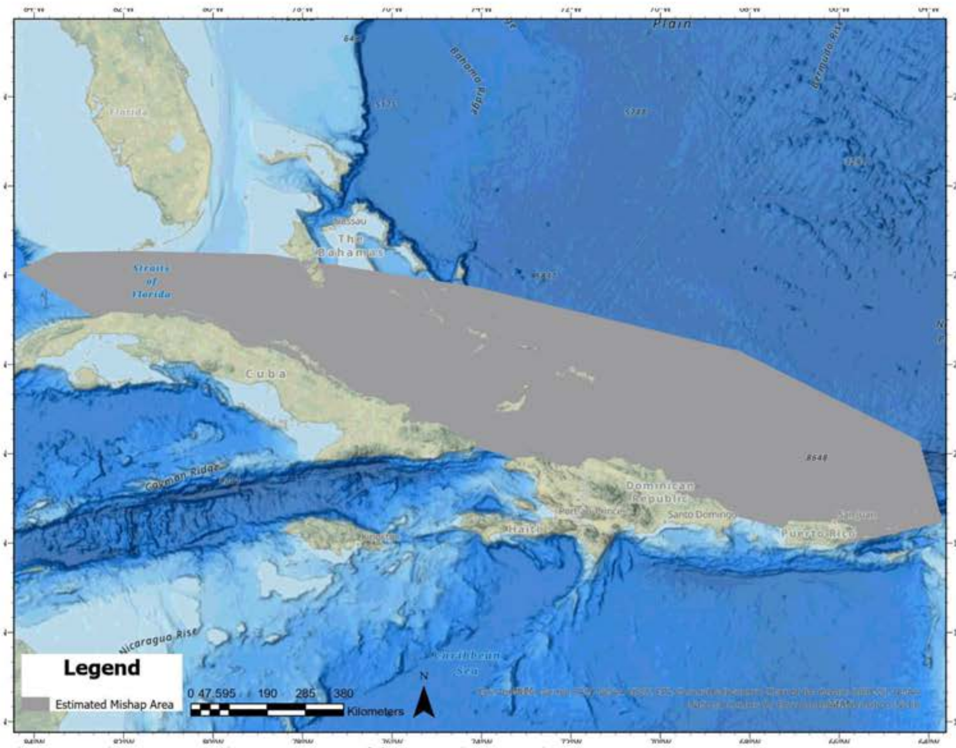

Figure 6. Mishap area estimated by NMFS included in the action area.

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

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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

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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

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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	-- --	-- --

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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

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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:

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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:

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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:

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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

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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

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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

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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

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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

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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.