DRAFT

Environmental Assessment

BLUE ORIGIN NEW GLENN CADENCE INCREASE AT SPACE LAUNCH COMPLEX 36

CAPE CANAVERAL SPACE FORCE STATION, FLORIDA

Appendix A.1.2, Part 2

September 2026

Federal Aviation Administration
Department of the Air Force
United States Coast Guard
National Aeronautics and Space Administration

Unique ID: EAXX-021-12-14Y-1773227485

Federal Aviation Administration

Photo credit Blue Origin

LIST OF APPENDICES

Acronyms and Abbreviations

Acronym	Definition
§/§§	section/sections
ACHP	Advisory Council on Historic Preservation
AHA	Aircraft Hazard Area
APE	Area of Potential Effects
ASEL	A-weighted sound exposure level
BCA	Biological and Conference Assessment
BGEPA	Bald and Golden Eagle Protection Act
Blue Origin	Blue Origin, LLC
CCP	Comprehensive Conservation Plan
CCSFS	Cape Canaveral Space Force Station
CDNL	C-weighted day-night average sound level
CFR	Code of Federal Regulations
CH_4	methane
CMP	Coastal Management Program
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COMDTINST	Commandant Instruction
CZMA	Coastal Zone Management Act
DAF	Department of the Air Force
dB	decibel(s)
dBA	A-weighted decibels
DNL	day-night average sound level
DoD	Department of Defense
DOT	Department of Transportation
DoW	Department of War
EO	Executive Order
EA	Environmental Assessment
EFH	essential fish habitat
EIS	Environmental Impact Statement
ERD	Environmental Resources Document
ERP	Environmental Resource Permit
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FDEP	Florida Department of Environmental Protection
FONSI	Finding of No Significant Impact
HAPC	habitat areas of particular concern
ILV	integrated launch vehicle
INRMP	Integrated Natural Resources Management Plan
IPaC	Information for Planning and Consultation
KSC	Kennedy Space Center
LAA	Limited Access Area
$L_{A,max}$	maximum A-weighted sound level
lbf	million pounds-force
LC	Launch Complex
LH_2	liquid hydrogen
L_{max}	maximum sound level
LNG	liquefied natural gas
LOX	liquid oxygen

Acronym	**Definition**
MBTA	Migratory Bird Treaty Act
MG	million gallons
MGD	million gallons per day
MINWR	Merritt Island National Wildlife Refuge
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MT/yr	metric tons per year
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
No.	Number
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
OSHA	Occupational Safety and Health Administration
PDC	project design criteria
PLOC	Programmatic Letter of Concurrence
PM	particulate matter
PM_{10}	particulate matter with a diameter equal to or less than 10 microns
$PM_{2.5}$	particulate matter with a diameter equal to or less than 2.5 microns
PSD	Prevention of Significant Deterioration
psf	pound per square foot
RNA	Regulated Navigation Area
SCCC	Spaceport Command and Control Center
SHPO	State Historic Preservation Officer
SJRWMD	St. Johns River Water Management District
SLC	Space Launch Complex
SLD 45	Space Launch Delta 45
SpaceX	Space Exploration Technologies Corp.
U.S.	United States
U.S.C.	United States Code
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USSF	United States Space Force
VOL	vehicle operator license

Appendix A Regulatory Consultations

A.1 Endangered Species Act Section 7 Consultation

A.1.2 National Marine Fisheries Service Programmatic Letter of Concurrence (Continued)

Bearded Seal – Beringia DPS

Critical habitat for the Beringia DPS of bearded seal encompasses marine areas in the Bering, Chukchi, and Beaufort seas (Figure 18). Small portions of critical habitat overlap Zone 2 in the Pacific portion of the action area.

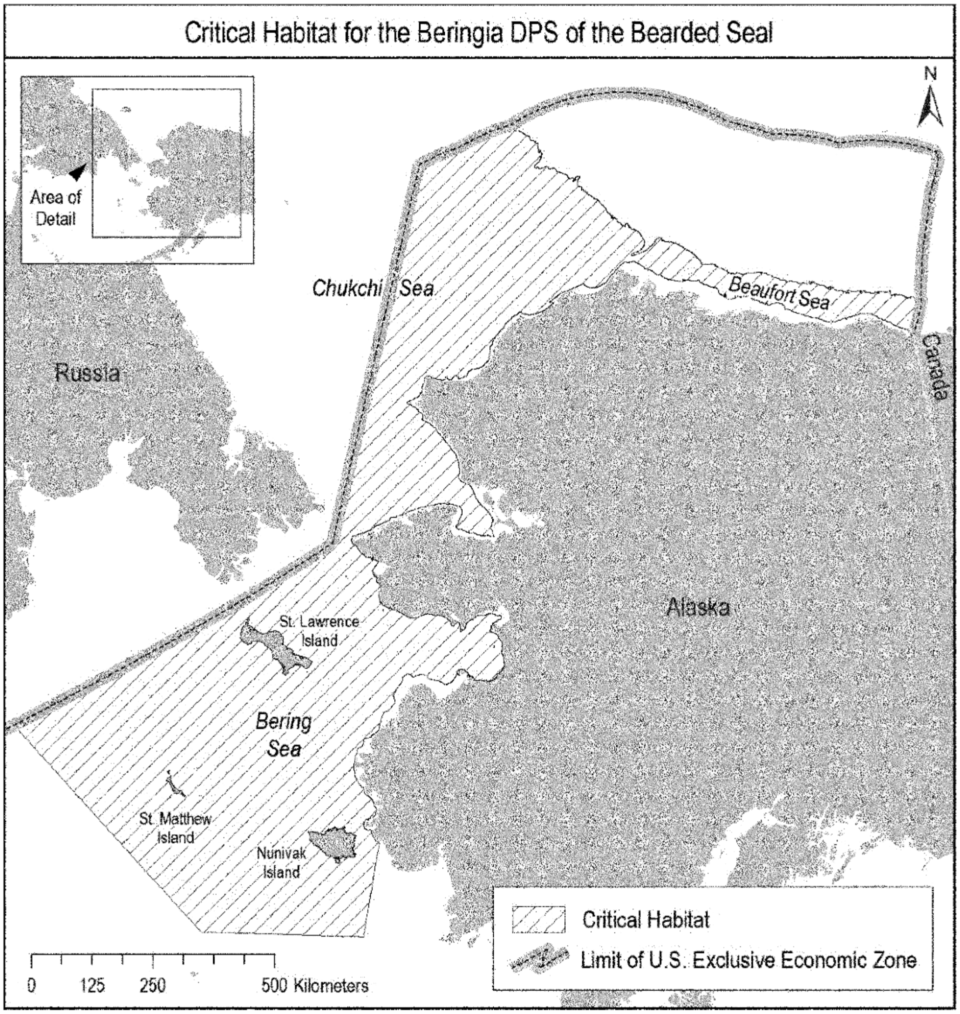

Figure 18. Critical habitat for Beringia DPS bearded seal

56

Ringed Seal – Arctic subspecies

Designated critical habitat for the Arctic subspecies of ringed seal includes marine area in the Bering, Chukchi, and Beaufort seas (Figure 19). Small portions of critical habitat overlap Zone 2 in the Pacific portion of the action area.

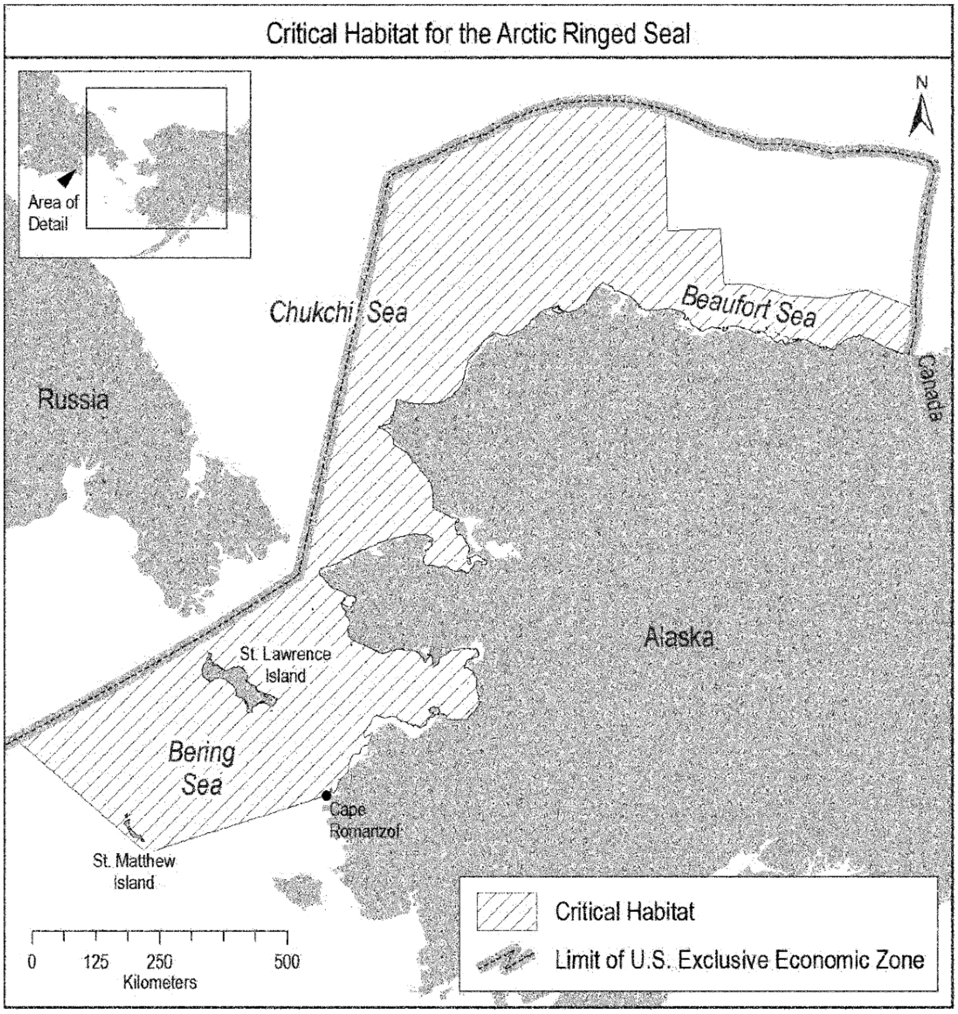

Figure 19. Critical habitat for the Arctic subspecies of ringed seal

Steller Sea Lion

Critical habitat for designated for the Steller sea lion includes specific rookeries, haul-outs, and associated areas, as well as three foraging areas. Critical habitat in Alaska includes a terrestrial

57

zone extending 3,000 ft (0.9 km) landward from each major rookery and haul-out; it also includes air zones extending 3,000 ft (0.9 km) above these terrestrial zones and aquatic zones. Aquatic zones extend 3,000 ft (0.9 km) seaward from the major rookeries and haul-outs east of 144°W. West of 144° W, where the Western DPS is located, the aquatic zone extends 20 NM (37 km) seaward from the baseline or basepoint of each major rookery and major haul-out (Figure 20). While the areas of critical habitat were excluded from the zones identified in the Action Area section above (i.e., would be subject only to vessel and aircraft transits), the Pacific Spaceport Complex Alaska on the southeastern side of Kodiak Island overlaps with Steller sea lion critical habitat.

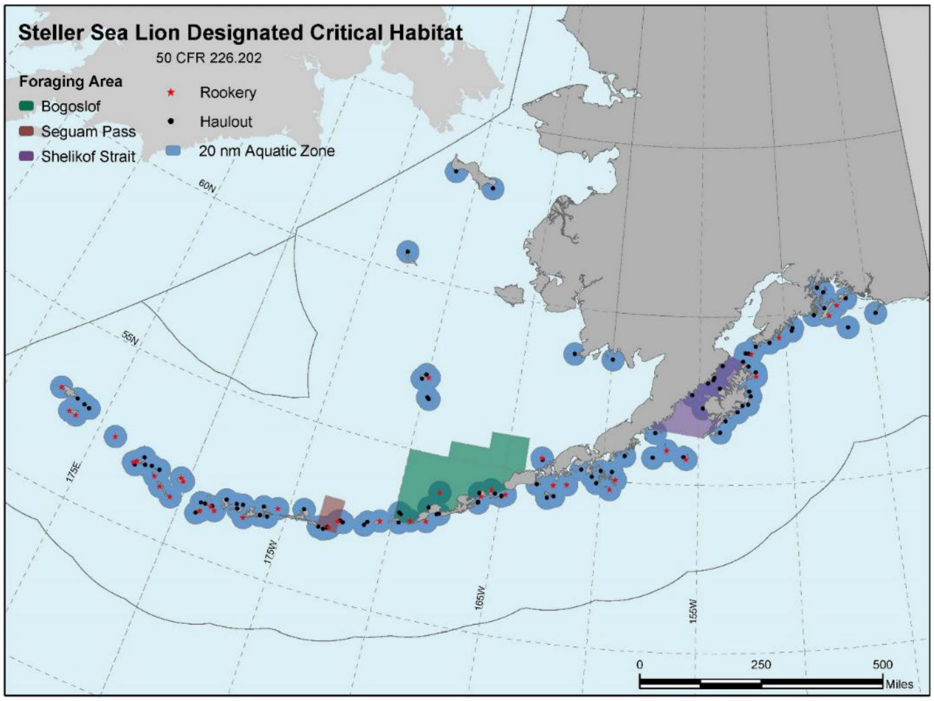

Figure 20. Steller Sea Lion Critical Habitat – Western Alaska

Green Sea Turtle – North Atlantic DPS

NMFS proposed to designate critical habitat for the North Atlantic DPS green turtle in 2023 (88 Fed. Reg. 46572; Figure 21). Proposed critical habitat includes surface-pelagic foraging/resting features that overlap with the Gulf Zone 2, Atlantic Zone 2, Atlantic explosive events area, and Bahamas/Caribbean Zone 4. Reproductive and migratory features are in the Atlantic Zone 5, where no disposals or expended stages, expended components, or debris will occur.

58

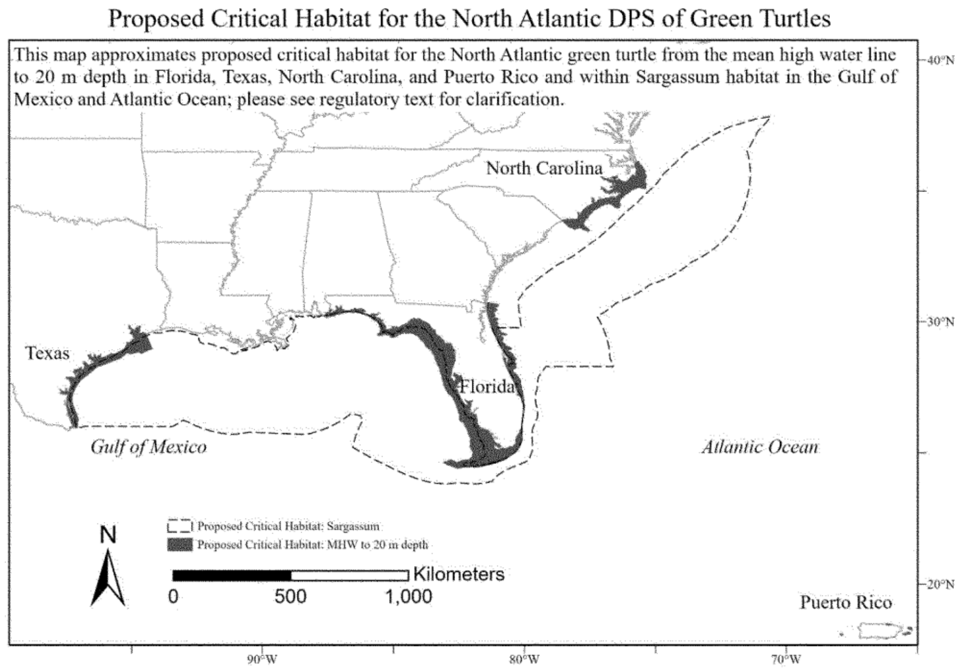

Figure 21. Overview of proposed critical habitat for the North Atlantic DPS green turtle

Green Sturgeon – Southern DPS

NMFS designated critical habitat for the threatened Southern DPS of green sturgeon (74 Fed. Reg. 52299; Figure 22). Coastal marine waters of the critical habitat overlap with the Pacific Zone 4 where barge landings may occur.

59

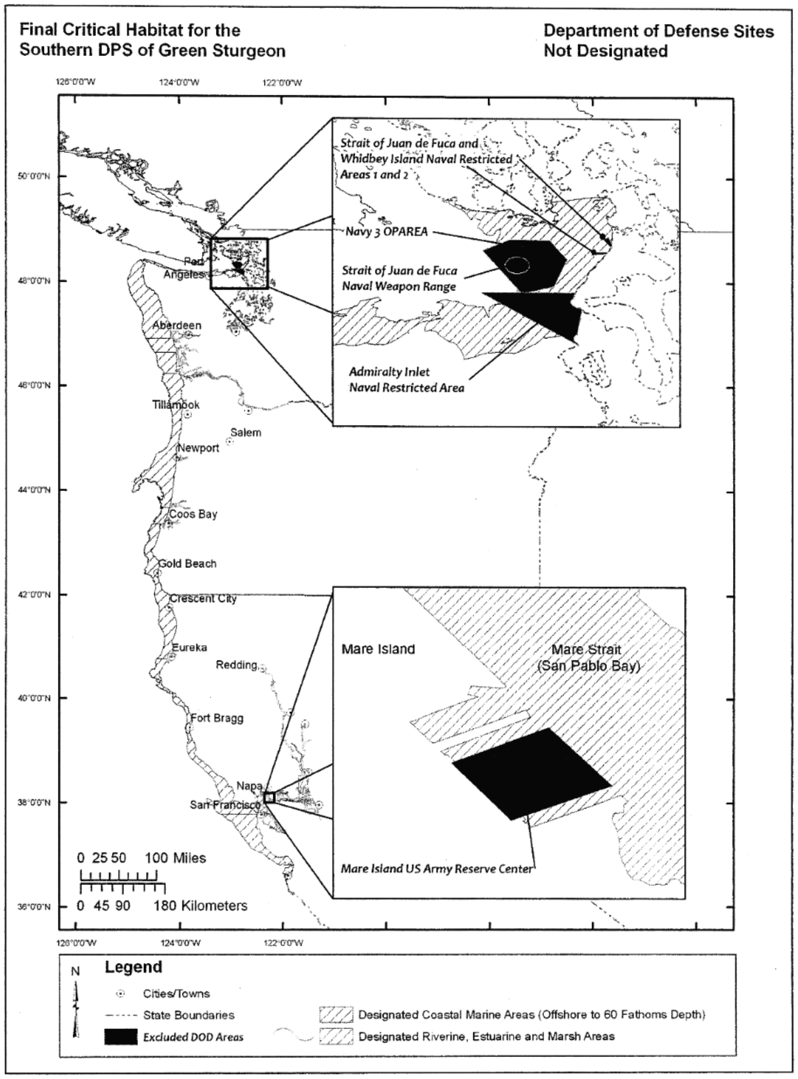

Figure 22. Critical Habitat for the Southern DPS Green Sturgeon

Leatherback Sea Turtle

NMFS designated critical habitat for the leatherback sea turtle (77 Fed. Reg. 4170; Figure 23). Leatherback sea turtle critical habitat in the Pacific overlaps with the Pacific Zone 4, where barge landings may occur.

60

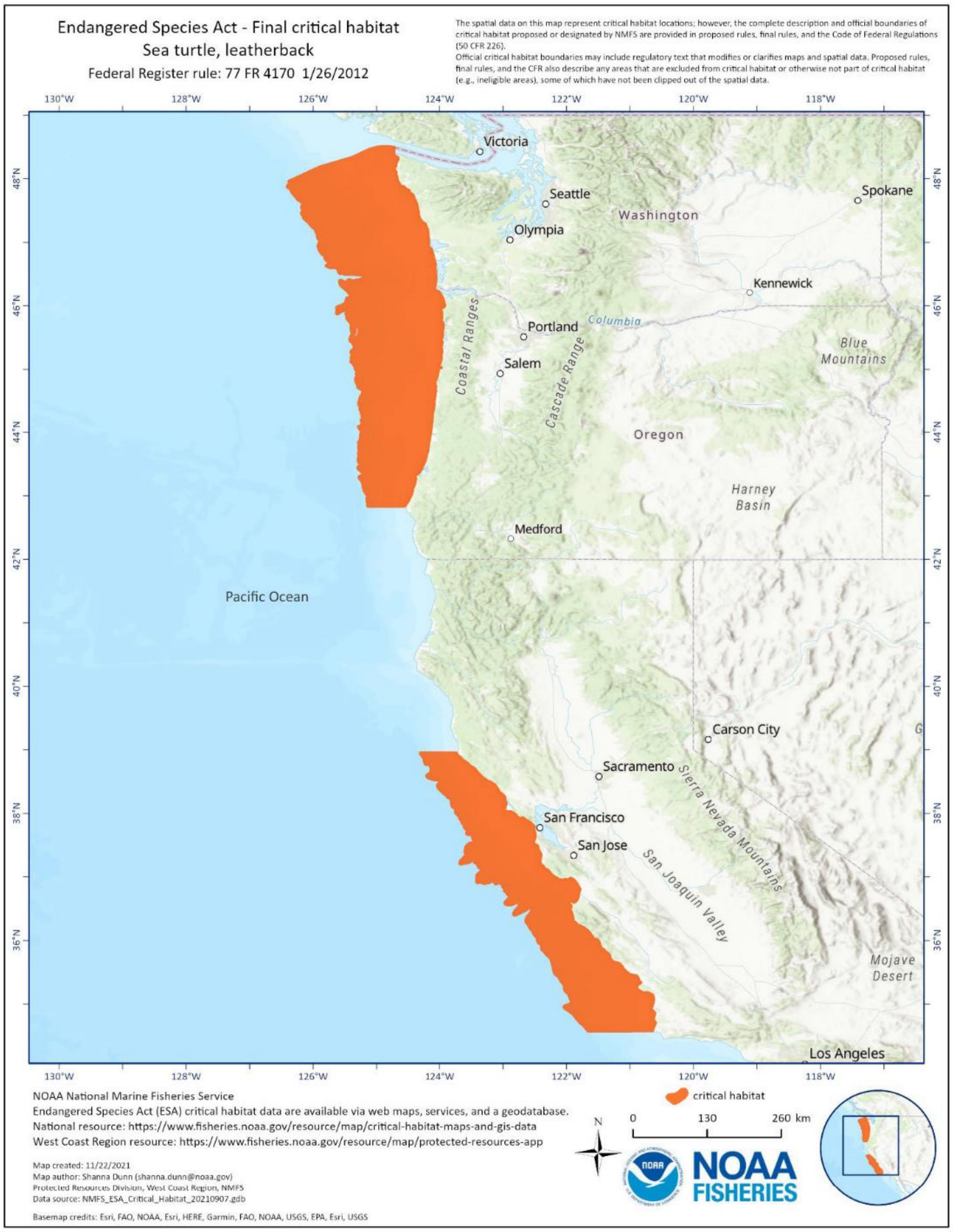

Figure 23. Leatherback Sea Turtle Critical Habitat

Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS

NMFS designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead sea turtle includes overlapping areas of nearshore reproductive habitat, constricted migratory habitat, breeding habitat, and *Sargassum* habitat (Figure 24). Constricted migratory habitat is in Atlantic Zone 5 where no disposals or expended stages, components, or debris will occur. Winter habitat is in Atlantic Zone 5a where no disposal or expended stages, components, or debris will occur between November through April. Breeding habitat is in Atlantic Zone 5b where no disposals or expended stages, components, or debris will occur between April through November. *Sargassum* habitat overlaps the Atlantic Zone 2 and explosive events area.

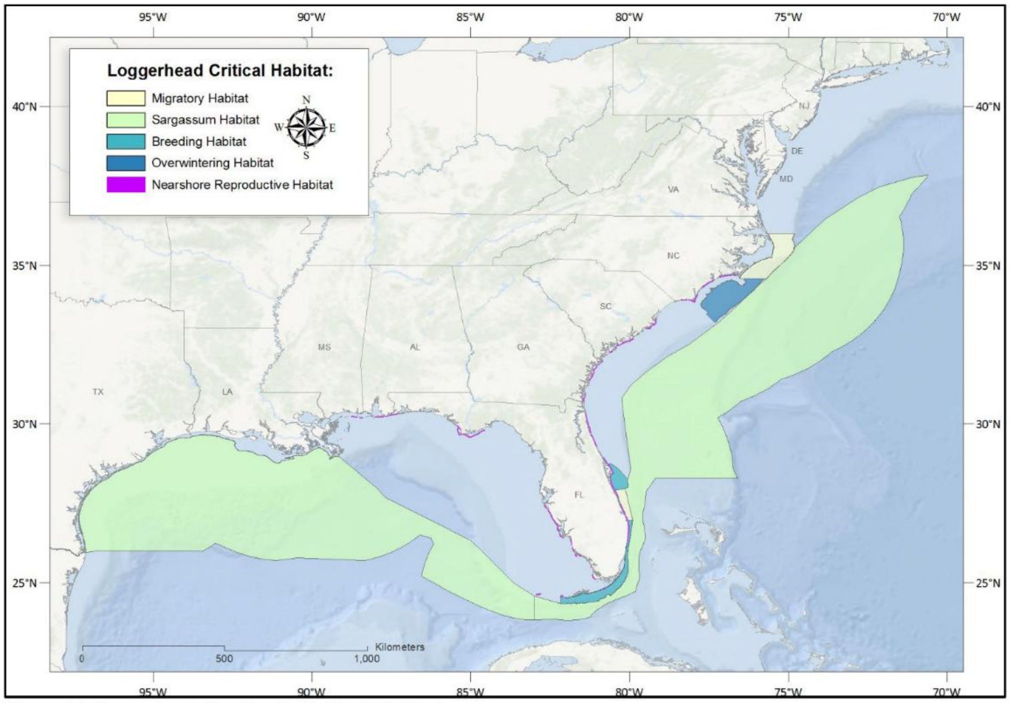

Figure 24. Loggerhead Sea Turtle Critical Habitat

Nassau Grouper

NMFS designated critical habitat for the Nassau grouper off Florida, Puerto Rico, Navassa, and the U.S. Virgin Islands. Only critical habitat designated off Navassa (Figure 25) will overlap the Bahamas/Caribbean Zone 4 where barge landings may occur.

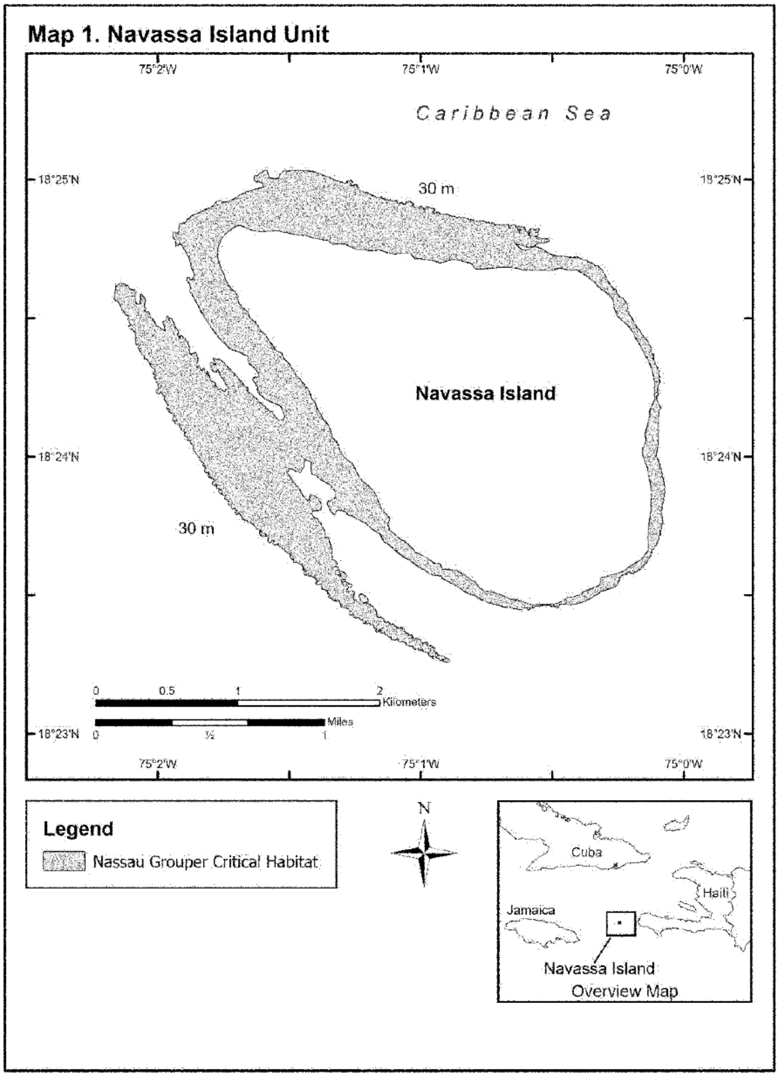

Figure 25. Nassau grouper critical habitat off Navassa Island

Caribbean Corals

NMFS designated critical habitat for the boulder star coral, lobed star coral, mountainous star coral, pillar coral, and rough cactus coral (88 Fed. Reg. 54026). Critical habitat occurs off Florida, Puerto Rico, the U.S. Virgin Islands, Navassa Island, and in the Flower Garden Banks National Marine Sanctuary in the Gulf of America. Only critical habitat designated off Navassa

63

(Figure 26, Figure 27, Figure 28, Figure 29, Figure 30) will overlap the Bahamas/Caribbean Zone 4 where barge landings may occur.

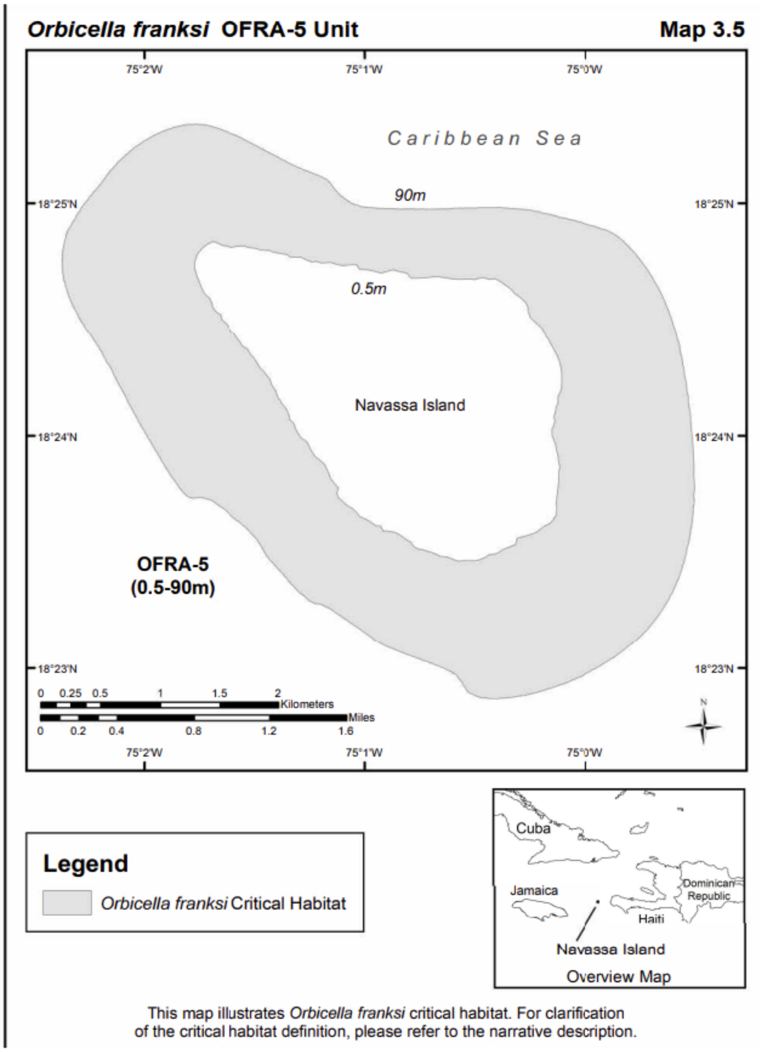

Figure 26. Boulder star coral critical habitat off Navassa Island

64

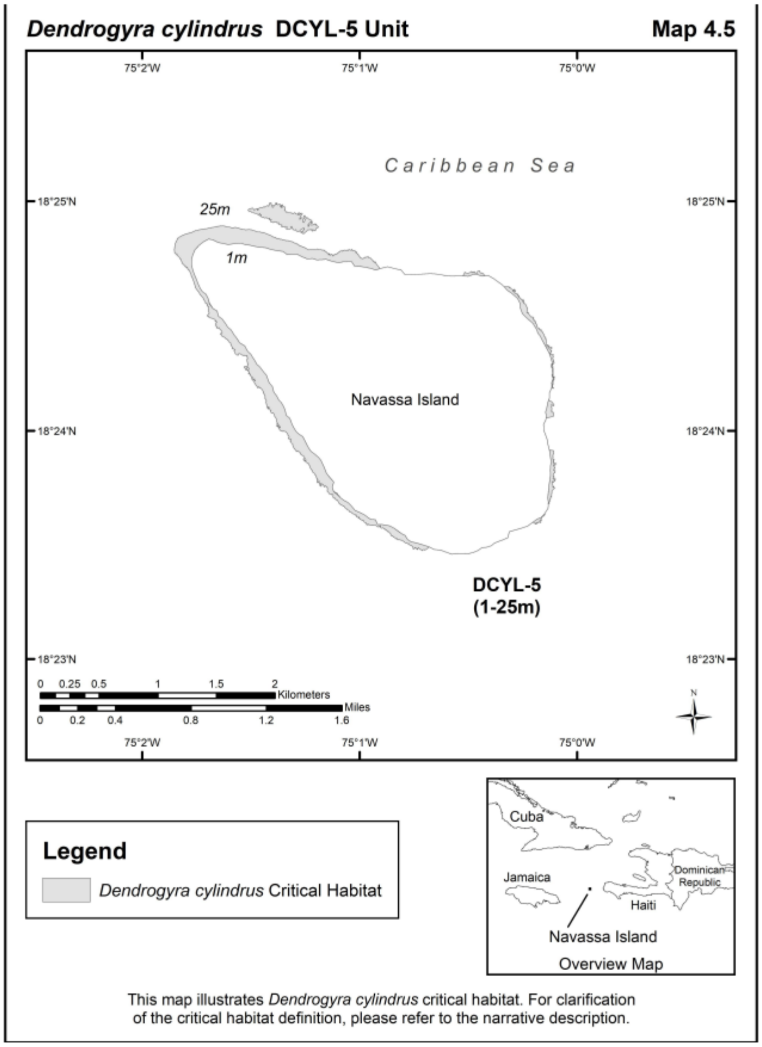

Figure 27. Pillar coral critical habitat off Navassa Island

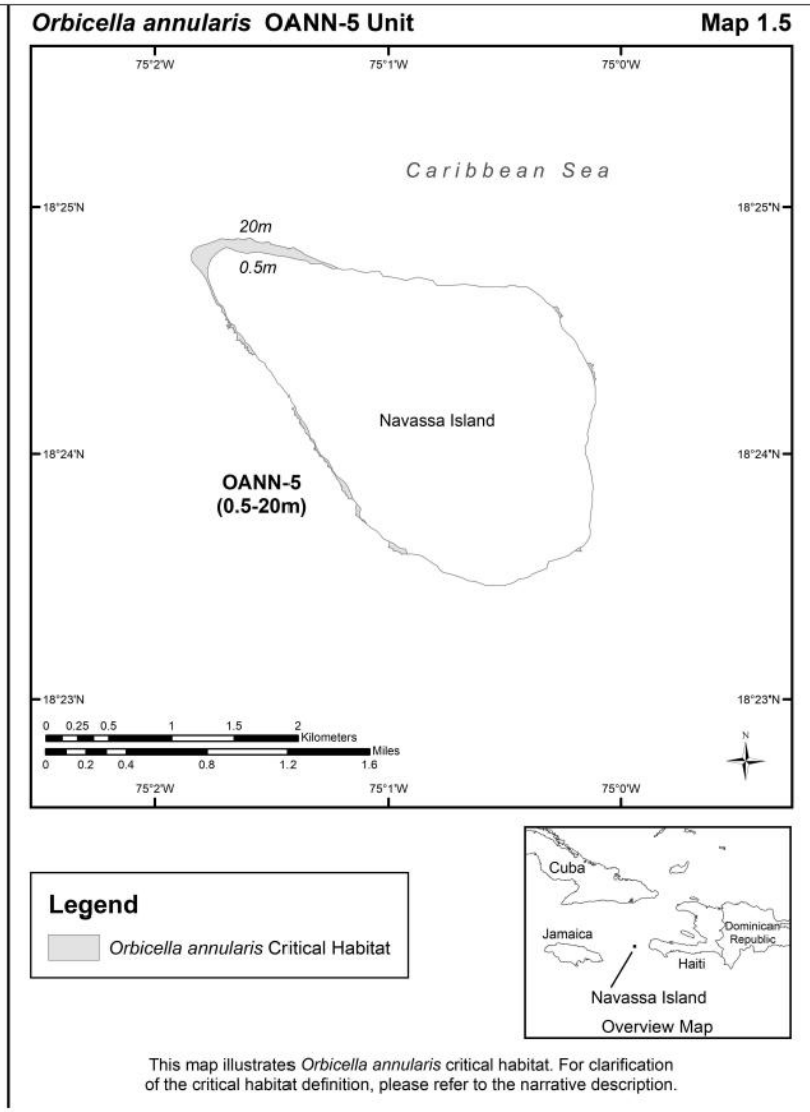

Figure 28. Lobed star coral critical habitat off Navassa Island

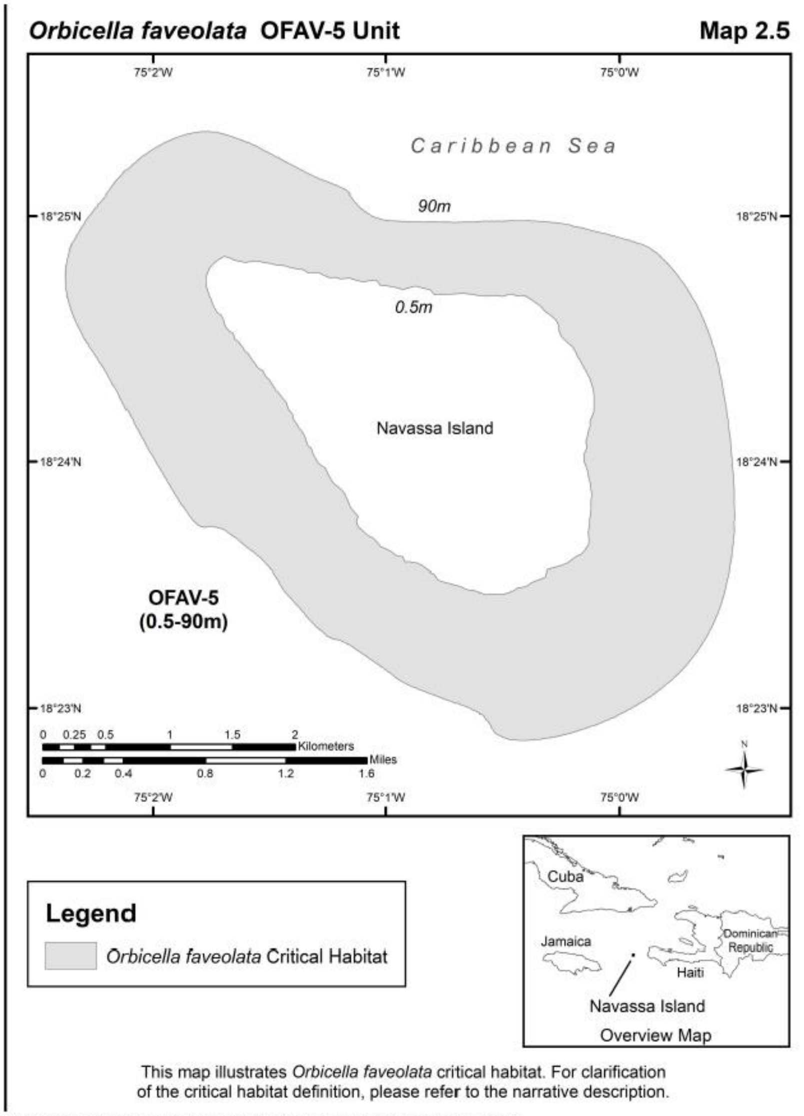

Figure 29. Mountainous star coral critical habitat off Navassa Island

67

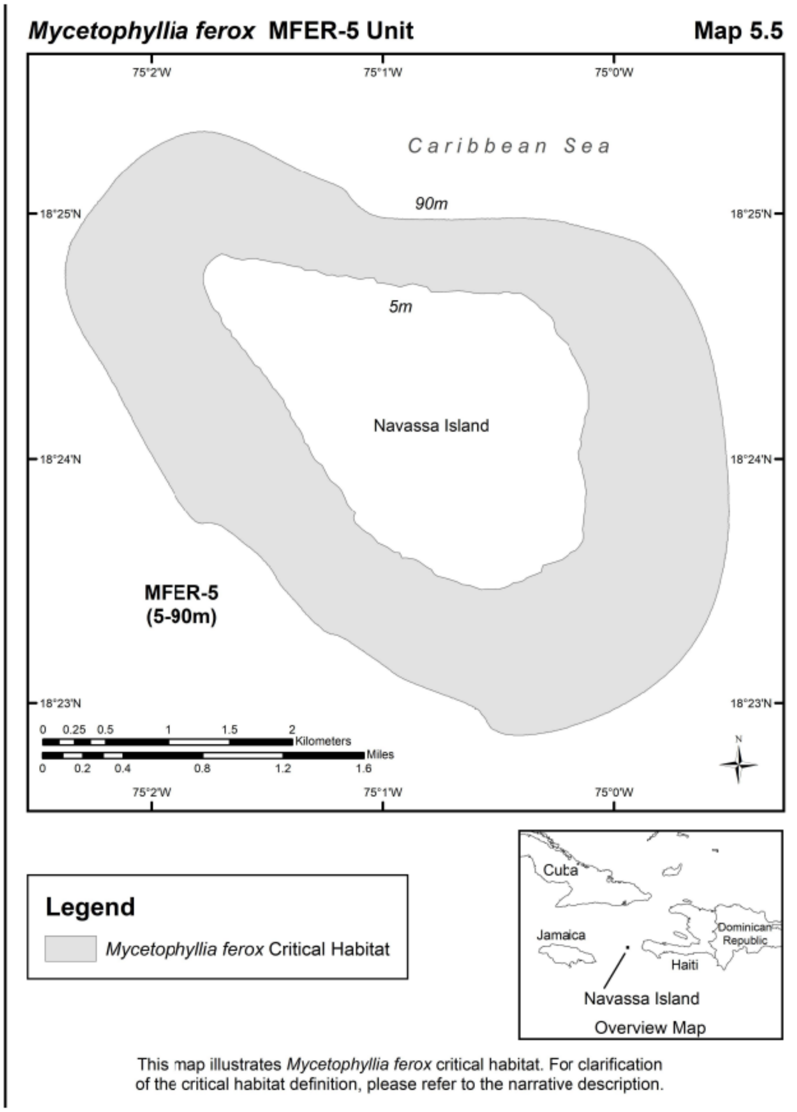

Figure 30. Rough cactus coral critical habitat off Navassa Island

EFFECTS ANALYSIS

Once we have determined the action may affect ESA-listed or proposed species or their designated or proposed critical habitat, the next step is to consider whether the action is NLAA

68

for each listed species and critical habitat in the action area. We accomplish this by evaluating individual stressors in the proposed action for each listed species and critical habitat. An action warrants a NLAA finding when its effects are wholly beneficial, discountable, or insignificant. Wholly beneficial effects are contemporaneous positive effects without any adverse effects to the species or habitat. 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 too small to be measured, would be undetectable, or an impact to the conservation value of a PBF would be too small to be measured or undetectable.

To assist in reaching an NLAA conclusion, we perform a two-step assessment that considers all of the stressors caused by the action and all of the ESA-listed species and critical habitats in the action area. 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. Given the physical, chemical, or biological extent of the stressor, we evaluate the anticipated response of a species or critical habitat to that exposure to understand whether the response would be meaningful or biologically measurable. Again, if we conclude that the response of a species or critical habitat to a stressor caused by the proposed action or activity is insignificant, we must also conclude it is NLAA. When the evaluation of all stressors, species, and critical habitats relevant to the action result in all effects being NLAA, we can concur with the Action agency's determination.

The following subsections identify the potential stressors and analyze the potential effects of the proposed space launch and reentry operations on the ESA-listed species and critical habitat in the action area.

Potential Stressors to ESA-Listed Species

Direct or indirect modifications to the land, water, or air caused by an action are identified as stressors. Here we identify all of the stressors resulting from the proposed action, as well as the sources of those stressors. Some stressors may have multiple sources. Likewise, multiple sources may combine to create a stressor that would not exist if only one of the sources were present. Potential stressors to ESA-listed or proposed species and designated or proposed critical habitats from the proposed activities include the following:

- Direct impact by falling objects (e.g., from stages, components, or debris landing or being expended in the ocean);
- Entanglement (e.g., in unrecovered parachutes and parafoils);
- Unrecovered debris (e.g., from expended stages or components, launch);
- Pollution (e.g., from vessels, propellant from expended stages, launch and reentry emissions)
- In-air sound (e.g., sonic booms, landings, explosive events, launches);
- Impulsive underwater sound (e.g., sonic booms, landings, explosive events);

- Noise and visual disturbance (e.g., from vessels and aircraft);
- Vessel strike;
- Increased sea surface temperature (explosive events, launch); and
- Vibration from launches.

Effects to the ESA-listed species from these stressors are discussed in the following subsections, followed by effects to the PBFs of designated or proposed critical habitat. There are many uncertainties regarding potential effects to ESA-listed species and critical habitat from launch and reentry operations due to a variety of reasons, including but not limited to: lack of resources dedicated to observing and monitoring for potential effects; lack of historical data about impacts to ESA resources given the rapid expansion of the commercial space industry; many operations occur out at sea and encompass large areas with no feasible way to monitor for potential effects; lack of knowledge of specific areas where certain operations may or may not occur; and potential effects and the magnitude of those effects may vary depending on the project, mission, and goals of the launch operators (i.e., the companies), which is largely unknown until a license or permit application is received. The following effects analysis draws upon the best scientific and commercial data available at the time of this consultation, including annual reports submitted by action agencies, other information provided by the action agencies, and effects considered by similar activities.

Direct Impact by Falling Objects

Radiosondes, stages, fairings, and debris falling and landing in the action area have the potential to affect ESA-listed species. The primary concern is direct impact from these objects striking an ESA-listed species. An object striking an ESA-listed species may result in injury or mortality to the individual struck. The following subsections assess the effects to ESA-listed species from this stressor in each zone.

Zone 1

Zone 1 excludes all countries' EEZs (which includes coastal areas where species generally occur in higher densities), Important Marine Mammal Areas (IMMA) relevant to ESA-listed species, Important Shark and Ray Areas relevant to ESA-listed species, and the species ranges for ESA-listed species whose ranges are restricted to a specific region (i.e., species that do not have a cosmopolitan distribution). Given these exclusions, ESA-listed species are expected to be rare throughout Zone 1. Thus, the likelihood that an ESA-listed species will be in the exact location at the exact time that an object falls and lands in the action area is extremely unlikely, and thus, the effects are discountable.

Pacific – Zone 2

Zone 2 in the Pacific portion of the action area excludes all designated critical habitat (except for very small portions of the Central America DPS and Mexico DPS humpback whale critical habitats), National Marine Sanctuaries, Isla Guadalupe (where a majority of Guadalupe fur seals occur and where over 99% of Guadalupe fur seal pups are born; McCue et al. 2021), the Revillagigedo Archipelago where humpback whale breeding aggregations, including the Mexico DPS, occur December–April (e.g., Jacobsen et al. (In Press)), and the Alaskan continental shelf (where a majority of Arctic listed seals occur; Cameron et al. 2010; Harwood et al. 2012; NMFS 2020; Von Duyke et al. 2020). Thus, Zone 2 excludes most areas where listed species are expected to occur in higher numbers.

The best available density data in this zone does not provide density data across the entire zone and covers areas not in the action area. It also does not provide mean densities, which would be the more appropriate statistic because activities could occur anywhere throughout the zone and at any time of year. Therefore, based on what data is available, we separate our analysis of the Pacific Zone 2 into two areas for analysis: offshore (beyond the EEZ) and nearshore (within the EEZ).

In the offshore area, ESA-listed marine mammal and sea turtle species for which there are available density data include the blue, fin, humpback, sei, and sperm whale, Guadalupe fur seal, and green, loggerhead, and leatherback turtle. Densities for those species are low and near zero in the offshore area (U.S. Department of the Navy 2024b). Density data for other ESA-listed marine mammals, sea turtles, and protected fishes that may occur in the offshore area were not available. However, it is expected that those densities will be lower than those for the aforementioned species because the offshore area does not include aggregation or spawning areas. Thus, the likelihood that an ESA-listed species will be in the exact location at the exact time that an object falls and lands in the offshore area is extremely unlikely.

In the nearshore area, we focused on an area off Southern California and Baja California where all past operations have occurred and are expected to continue. This also includes the area where the ATO-approved Dragon landing areas occur. Based on the available data, we use density to estimate species exposure. Areas of high density are small relative to the U.S. EEZ and generally occur close to shore (Zone 4) where only barge landings and vessel transit will occur. The density for marine mammals was 0.195 humpback whales per square kilometers (km^2) within approximately 27 NM (50 km) from shore off San Francisco, California and the density for sea turtles was 0.24 loggerhead sea turtles per km^2 west of the Channel Islands (U.S. Department of the Navy 2024b). All other species densities were lower than the densities for humpback whales and loggerhead sea turtles.

Based on current available information, we expect operations to continue in the Southern California and Baja California area at a rate of approximately 100 launches per year (Department of the Air Force 2025). Thus, we can estimate the probability of a direct impact by estimating the species exposure to being struck by a falling object. Under this programmatic, the largest object that could fall and land in the Southern California and Baja California area is a launch vehicle. The 100 launches are all expected to use Falcon 9 or Falcon Heavy, both of which are reusable launch vehicles. Falcon (referring to both Falcon 9 and Falcon Heavy) has a failure rate of approximately 1% over 400 launches since June 2010. Based on Department of the Air Force (2025), there may be a combined 10 expended Falcon 9 or Falcon Heavy center core first stage boosters each year. Falcon Heavy essentially consists of three reusable Falcon 9 boosters, so the Falcon Heavy center core is simply a Falcon 9. Falcon 9 is approximately 229.6 ft (70 m) in length and 12 ft (3.7 m) in diameter. Thus, we estimate that the largest object that could land in this area is approximately 25,967.1 square feet (ft^2) or 2,412.4 square meters (m^2; 0.002412 km^2). Exposure to a direct impact from launch vehicle landings can be calculated as the product

71

of the species density, area of a launch vehicle, and 10 landings per year. This results in a maximum species exposure of 0.006 (Table 5).

Spacecraft (Dragon and new capsule) and fairings are also expected to fall and land in that area. Dragon is 26.7 ft (8.1 m) in length and 13 ft (4 m) in diameter. Thus, we estimate that the largest object that could land in this area is approximately 3,543.95 ft^2 or 329.24 m^2 (0.000329 km^2). Spacecraft may land in this area up to 70 times a year. Exposure to a direct impact from spacecraft landings can be calculated as the product of the species density, area of a reentry vehicle, and the number of landings per year. This results in a maximum species exposure of 0.006 (Table 5). Fairings of Falcon 9 are 43 ft (13.1 m) in length and 17.1 ft (5.2 m) in diameter. Thus, we estimate the size of a single fairing half to be approximately 735.3 ft^2 or 68.3 m^2 (0.0000683 km^2). Assuming each launch carries a payload, both fairing halves will fall and land in the ocean during each launch, resulting in 200 fairing halves landing in the ocean each year. Exposure to a direct impact from a fairing can be calculated as the product of the species density, area of a fairing, and the number of fairing landings per year. This results in a maximum species exposure of 0.004 (Table 5).

Table 5. Estimated maximum species exposure to falling objects off Southern California and Baja California within Pacific Zone 2

	Marine Mammals	Sea Turtles
Density (animals/ km^2)	0.195	0.24
Launch Vehicle Area (km^2)	0.002412	0.002412
Reentry vehicle area (km^2)	0.0032924	0.0032924
Fairing half area (km^2)	0.0000683	0.0000683
Number of launch vehicle landings	1	1
Number of reentry vehicle landings	70	70
Number of fairing half landings	220	220
Estimated Exposure – Launch Vehicle	0.0047	0.0058
Estimated Exposure – Reentry Vehicle	0.0045	0.0055
Estimated Exposure – Fairings	0.0027	0.0036

km^2 = square kilometers

Density data for marine mammals, sea turtles, and protected fishes were not available; however, it is expected that those densities will be lower than those for the humpback whales and loggerhead sea turtles because this area does not include aggregation or spawning areas. Additionally, because fishes are able to detect particle motion and are highly mobile, listed fishes are likely able to detect an object landing in the water and evade the oncoming object. Chambered nautilus may also occur in the Pacific Zone 2; however, their densities are also not expected to exceed those for marine mammals and sea turtles. Further, chambered nautilus distribution is irregular and patchy (Miller 2018). Other components, debris, and radiosondes that may land in this area will be smaller than Dragon or would not land in as high numbers as the fairings, and therefore would result in an even smaller number of species exposures. Thus, the likelihood that an ESA-listed species will be in the exact location at the exact time that an object falls and lands in the nearshore area is extremely unlikely, and thus, the effects are discountable.

Pacific – Zone 3a

In Zone 3a, the Revillagigedo Archipelago, space launch and reentry operations are limited to vessel transit only from December 1–April 30. This seasonal restriction reduces potential adverse effects to humpback whales, including the Mexico DPS, which aggregate in the area to breed (e.g., Jacobsen et al. (In Press)). Thus, except for humpback whales, the effects analysis is similar to that of the Zone 2 Pacific area. Regarding humpback whales, due to the seasonal restriction on operations, it is extremely unlikely that an object will strike an ESA-listed humpback whale. Thus, the effects are discountable.

Gulf – Zone 2

Zone 2 in the Gulf portion of the action area excludes National Marine Sanctuaries, the Rice's whale core distribution area, and all designated and proposed critical habitats except for green turtle North Atlantic DPS proposed and loggerhead sea turtle Northwest Atlantic Ocean DPS *Sargassum* critical habitat. The excluded critical habitats include: Rice's whale proposed critical habitat, Gulf sturgeon critical habitat, smalltooth sawfish critical habitat, green turtle North Atlantic DPS proposed critical habitat (reproductive and migratory habitats), loggerhead sea turtle Northwest Atlantic Ocean DPS critical habitat (nearshore reproductive, breeding, and winter habitat), Nassau grouper critical habitat, and rough cactus, staghorn, pillar, elkhorn, boulder star, lobed star, and mountainous star coral critical habitat. Thus, Zone 2 excludes some areas where listed species are expected to occur in higher numbers.

Based on the best available density data, the highest species densities (Rice's whale, sperm whale, and green, Kemp's ridley, leatherback, and loggerhead sea turtles) in the Gulf Zone 2 occur closer to shore and are small relative to Zone 2 (Roberts et al. 2023; Garrison et al. 2023a; Garrison et al. 2023b). Because operations could occur anywhere within the Gulf Zone 2, we used the highest monthly mean (i.e., average) species density to estimate species exposure to a direct strike from a falling object. The highest monthly mean density for marine mammals was 0.0056 sperm whales per km^2 and the highest monthly mean density for sea turtles was 0.866 Kemp's ridley turtles per km^2. Under this programmatic, the largest object that could land in this area is a reentry vehicle. We approximate the size of a reentry vehicle using the reentry vehicle envelope specifications. Under this programmatic, the maximum length of a reentry vehicle will be 30 ft (9.1 m), and the maximum diameter of a reentry vehicle will be 15 ft (4.57 m). Thus, we estimate that the largest object that could land in this area is approximately 5,301.43 ft^2 or 492.52 m^2 (0.0004925 km^2). The number of animals that could be exposed to a direct impact from a falling object can be estimated by multiplying the area of the object, by the highest monthly mean species density (as a proxy for all species considered in this consultation), by the number of times the object may fall into the ocean. Using the highest monthly mean species density, largest object, and the number of reentries (22), the maximum number of species exposures that could be exposed per year to a direct impact is 0.009.

Density data for protected fishes were not available; however, it is expected that those densities will be lower than that for marine mammals and sea turtles because Zone 2 does not include

73

aggregation and spawning areas. Additionally, because fishes are able to detect particle motion and are highly mobile, listed fishes are likely able to detect an object landing in the water and evade the oncoming object. Other components, debris, and radiosondes that may land in this area will be smaller than a reentry vehicle and therefore would result in an even smaller number of species exposures. Therefore, the likelihood that an ESA-listed species will be in the exact location at the exact time that an object falls and lands in the Gulf Zone 2 is extremely unlikely, and thus, the effects are discountable.

Atlantic – Zone 2

Zone 2 in the Atlantic portion of the action area excludes National Marine Sanctuaries, IMMAs for North Atlantic right whales, and all designated and proposed critical habitats except for green turtle North Atlantic DPS proposed and loggerhead sea turtle Northwest Atlantic Ocean DPS *Sargassum* critical habitat (North Atlantic right whale critical habitat, green turtle North Atlantic DPS proposed critical habitat [reproductive and migratory habitats], loggerhead sea turtle Northwest Atlantic Ocean DPS critical habitat [nearshore reproductive, breeding, and winter habitat], Nassau grouper critical habitat, and mountainous star coral critical habitat). Thus, Zone 2 excludes some areas where listed species are expected to occur in higher numbers.

Based on the best available density data, the highest species densities (blue, fin, North Atlantic right, sei, and sperm whale, and green, Kemp's ridley, leatherback, and loggerhead sea turtles) in the Atlantic Zone 2 occur closer to shore and are small relative to Zone 2 (Roberts et al. 2023; Roberts et al. 2016; Roberts et al. 2024; DiMatteo et al. 2024). A majority of those areas of high density do not overlap where stages and fairings have landed or been expended in the past – based on annual reports, stages and fairings have generally landed approximately 200 mi (321.9 km) from shore. However, because there are small portions that overlap, we used the highest monthly mean species density to estimate species exposure to a direct strike from a falling object. The highest monthly mean density for marine mammals was 0.0068 sperm whales per km^2.

The highest monthly mean density for sea turtles was 0.1269 loggerhead sea turtles per km^2. However, there was a substantial difference in densities nearshore (off Florida, Georgia, and South Carolina) compared to other areas of Zone 2. In the nearshore area, densities were much higher than the highest monthly mean density (the highest monthly mean density in the nearshore area was 1.553 loggerhead sea turtles per km^2 compared to 0.1269 loggerhead sea turtles per km^2) and therefore would contribute to higher than discountable exposures. However, that nearshore area represents only approximately 7% of the Atlantic Zone 2 area. Further, based on annual reports, a vast majority of falling objects occurred more than approximately 200 mi (321.9 km) from shore. Only less than approximately 2% of falling objects occurred in the nearshore area. In the Zone 2 area excluding the nearshore area, sea turtle densities are low; the highest monthly mean density was 0.067 loggerhead sea turtles per km^2.

Based on the differing densities and areas where falling objects have occurred in the past, we analyze three exposure scenarios: 1) for marine mammals, using the highest monthly mean density of 0.0068 perm whales per km^2 and the maximum number of operations that may occur in the Zone 2 area; 2) for nearshore sea turtles, using the highest monthly mean density of 1.553 loggerhead sea turtles per km^2 and approximately 2% of the maximum number of operations that may occur in the Zone 2 area; and 3) for offshore sea turtles, using the highest monthly mean density of 0.067 loggerhead sea turtles per km^2 and the maximum number of operations that may occur in the Zone 2 area. All other species densities were lower than the densities for sperm whales and loggerhead sea turtles.

Under this programmatic, the largest object that could land in this area is a launch vehicle. Under the launch vehicle envelope specifications, a launch vehicle may be up to 450 ft (137.2 m) in length and 23 ft (7 m) in diameter. Thus, we estimate that the largest object that could land in this area is approximately 186,963.87 ft^2 or 17,369.5 m^2 (0.0173695 km^2). The number of times a launch vehicle may fall and land in the Atlantic Zone 2 is 601 times per year; however, based on annual reports, a majority (approximately 90%) of launches use Falcon 9 which is reusable and lands on a droneship or barge. As previously mentioned, Falcon has a failure rate of approximately 1%. Therefore, the number of times a launch vehicle is likely to fall and land in the water is approximately 65 times per year. The number of animals that could be exposed to a direct impact from a falling launch vehicle can be estimated by multiplying the area of the object, by the highest monthly mean species density (as a proxy for all species considered in this consultation), by the number of times the object may fall into the ocean. Using the highest monthly mean species density (loggerhead sea turtles), largest object, and the number of operations, the maximum number of species exposures per year is 0.076 (Table 6).

Spacecraft and fairings are also expected to fall and land in this area. Using the same method of analysis in other Zone 2 areas, we can estimate species exposure to a direct hit by a landing spacecraft and fairings. There may be up to 10 spacecraft landings and 1,200 fairing halves landings in the Atlantic Zone 2 per year. A reentry vehicle (spacecraft) under this programmatic is estimated to be approximately 5,301.43 ft^2 or 492.52 m^2 (0.0004925 km^2). Thus, exposure to a direct impact from spacecraft landings can be calculated as the product of the species density, area of a reentry vehicle, and 10 landings per year. This results in a maximum species exposure of 0.0003 (Table 6). The size of a single fairing half under this programmatic is 75 ft (22.9 m) in length and 30 ft (9.1 m) in diameter. The area of a single fairing half is thus estimated to be approximately 2,250 ft^2 or 209.03 m^2 (0.000209 km^2). Thus, exposure to a direct impact from a fairing can be calculated as the product of the species density, area of a fairing, and 1,200 fairing landings per year. This results in a maximum species exposure of 0.017 (Table 6).

Table 6. Estimated maximum species exposure to falling objects, using mean estimated densities of the most common marine mammals and sea turtles in Atlantic Zone 2

	Marine Mammals	Sea Turtles – Offshore	Sea Turtles – Nearshore
Density (animals/ km^2)	0.0068	0.067	1.553
Launch Vehicle Area (km^2)	0.01737	0.01737	0.01737
Reentry vehicle area (km^2)	0.00049	0.00049	0.00049
Fairing half area (km^2)	0.00021	0.00021	0.00021
Number of launch vehicle landings	60	60	1*
Number of reentry vehicle landings	10	10	1*
Number of fairing half landings	1,200	1,200	24
Estimated Exposure – Launch Vehicle	0.0071	0.076	0.035
Estimated Exposure – Reentry Vehicle	0.00003	0.0003	0.0002
Estimated Exposure – Fairings	0.0017	0.017	0.0078

km^2 = square kilometers
* Rounded to largest whole number

Density data for hawksbill sea turtles and protected fishes were not available; however, it is expected that those densities will be lower than that for sperm whales and loggerhead sea turtles because Zone 2 does not include aggregation or spawning areas. Additionally, because fishes are able to detect particle motion and are highly mobile, listed fishes are likely able to detect an object landing in the water and evade the oncoming object. Other components, debris, and radiosondes that may land in this area will be smaller than a launch vehicle and therefore would result in an even smaller number of species exposures. Additionally, based on six years of annual reporting from the action agencies, nearly 95% of falling objects occurred at least 80 mi (128.7 km) from shore, where species densities are lower than as described above for sperm whales and loggerhead sea turtles. Therefore, the likelihood that an ESA-listed species will be in the exact location at the exact time that an object falls and lands in the Atlantic Zone 2 is extremely unlikely, and thus, the effects are discountable.

Atlantic – Zone 3b

In Zone 3b, which encompasses the Southeastern unit of North Atlantic right whale critical habitat, space launch and reentry operations are limited to vessel transit only from November 1–April 30. This seasonal restriction reduces potential adverse effects to North Atlantic right whales during their calving season (81 Fed. Reg. 4838). Thus, except for North Atlantic right whales, the effects analysis is similar to that of the Zone 2 Atlantic area. Regarding North Atlantic right whales, due to the seasonal restriction on operations, it is extremely unlikely that an object will strike a North Atlantic right whale. Thus, the effects are discountable.

76

Atlantic – Zone 3c

In Zone 3c, which encompasses the Northeastern unit of North Atlantic right whale critical habitat and the Gulf of Maine and Georges Bank IMMA, space launch and reentry operations are limited to vessel transit only from January 1–July 31. This seasonal restriction reduces potential adverse effects to North Atlantic right whales that aggregate in this area to forage (81 Fed. Reg. 4838). Thus, except for North Atlantic right whales, the effects analysis is similar to that of the Zone 2 Atlantic area. Regarding North Atlantic right whales, due to the seasonal restriction on operations, it is extremely unlikely that an object will strike a North Atlantic right whale. Thus, the effects are discountable.

Atlantic – Zone 5a

In Zone 5a, which encompasses the loggerhead sea turtle Northwest Atlantic Ocean DPS critical habitat – specifically, winter critical habitat – space launch and reentry operations are limited so that no stages, components, or debris will be expended November 1–April 30. This seasonal restriction reduces potential adverse effects to juvenile and adult loggerhead sea turtles that aggregate in this warm-water area over the winter months (79 Fed. Reg. 39856). Thus, except for Northwest Atlantic Ocean DPS loggerhead sea turtles, the effects analysis is similar to that of the Zone 2 Atlantic area. Regarding Northwest Atlantic Ocean DPS loggerhead sea turtles, due to the seasonal restriction on operations, it is extremely unlikely that an object will strike a Northwest Atlantic Ocean DPS loggerhead sea turtle. Thus, the effects are discountable.

Atlantic – Zone 5b

In Zone 5b, which encompasses the loggerhead sea turtle Northwest Atlantic Ocean DPS critical habitat – specifically, breeding critical habitat – space launch and reentry operations are limited so that no stages, components, or debris will be expended April 1–November 30. This seasonal restriction reduces potential adverse effects to male and female adult loggerhead sea turtles that occur in high densities in this area during the breeding season (79 Fed. Reg. 39856). Thus, except for Northwest Atlantic Ocean DPS loggerhead sea turtles, the effects analysis is similar to that of the Zone 2 Atlantic area. Regarding Northwest Atlantic Ocean DPS loggerhead sea turtles, due to the seasonal restriction on operations, it is extremely unlikely that an object will strike a Northwest Atlantic Ocean DPS loggerhead sea turtle. Thus, the effects are discountable.

Bahamas/Caribbean

Based on annual reports, operations that have occurred in the Bahamas include expended skirt rings and fairing/parachute recoveries. As part of this reinitiation, skirt rings will no longer be expended in the Bahamas/Caribbean portion of the action area (see Area-specific PDCs). Only booster landings on a droneship and fairing recoveries (fairing recoveries only in the Exuma Sound) will occur in the Bahamas/Caribbean portion of the action area. It is extremely unlikely that ESA-listed species will be directly struck by a fairing landing in the Exuma Sound. For an ESA-listed species to be directly struck by a fairing landing, they would have to occur at the same time and same place as the fairing, which is unlikely. Only 20 missions may occur in the Exuma Sound, making that likelihood even less. The Exuma Sound is characterized by steep drops past the continental shelf to depths of approximately 5,250–6,562 ft (1,600–2,000 m).

ESA-listed corals inhabit shallow waters and would not be exposed to falling fairings as all recovery operations will occur in deep waters. Given the limited number of times fairings may land in the Exuma Sound, the likelihood of a direct impact on ESA-listed species is extremely unlikely, and thus, the effects are discountable.

Summary

It is extremely unlikely that ESA-listed marine mammals, sea turtles, fishes, corals, and the chambered nautilus will be directly struck by falling objects. Throughout the action area, other ESA-listed benthic invertebrates (black abalone, queen conch, white abalone, and the proposed sunflower sea star) may be exposed to a direct impact from an object sinking through the water column. However, as part of the proposed action, PDCs exclude any stages, components, or debris from landing, hitting the water, and sinking within these species' ranges. The National Institute of Water and Atmospheric Research Ltd (2017) came to a similar conclusion of the effects of a direct strike from space launches causing species mortality off New Zealand. Though they estimated that the likelihood of debris in the marine environment was high, they estimated that the consequence of a direct strike was negligible, and thus overall risk was very low. Additionally, ESA-listed species spend a majority, if not all, of their time underwater. A direct strike would only occur if an animal were at or near the surface. Therefore, the potential for effects to ESA-listed species from a direct impact by falling objects is discountable, and we conclude that direct impacts from fallen objects to ESA-listed species in the action area, because of activities covered under this programmatic, may affect, but are not likely to adversely affect ESA-listed species.

Entanglement

Space launch and reentry operations such as the deployment of weather balloons, spacecraft recovery, and fairing recovery may result in entanglement of ESA-listed species in the parachutes, parafoils, and attached suspension lines, particularly if the launch operator does not recover them. Launch operators typically try to recover these components particularly when part of recovery operations, though it may be limited (see below). Entanglement can impact a marine animal by limiting its ability to move through the water and can affect feeding, reproduction, migration, or predation escape (Laist 1997). Animals with gear entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health, and may even lead to death.

Drogue and pilot parachutes are the smallest and are cut away at altitude, separating from the spacecraft or fairing well before the point of splashdown (i.e., much further from shore) and thus are less likely to be recovered than the main parachutes and parafoils. The drogue parachute's primary material (nylon) is in the family of high molecular weight polymers, which are not easily degraded by abiotic (physical or chemical) or biotic processes (Haines and Alexander 1975). Photooxidative degradation, the process of decomposition of the material by light (most effectively by near-ultraviolet [UV] and UV wavelengths) would be the most effective source of damage exerted on the nylon parachute. However, the drogue parachute assembly becomes saturated within approximately one minute of splashing down and begins to sink. The drogue parachutes are expected to sink at a rate of approximately 1,000 ft (304.8 m) in 46 minutes (or approximately 22 ft [6.7 m] per minute), rapidly sinking below the depths to which UV radiation penetrates in the oceans, eventually resting on the ocean floor where exposure to UV light would not occur, making photo-oxidation improbable. Once on the ocean floor, the relatively constant temperatures and lower oxygen concentration (as compared to the atmosphere) would slow the degradation process (Andrady 1990).

Based on annual reports, approximately 12% of drogue parachutes were recovered. Fairing recovery has generally occurred approximately 200 mi (321.9 km) offshore, thus drogue parachutes are expected to land even further offshore and settle in waters more than 9,800 ft (3,000 m) deep. Species densities are low (near zero for a majority of species for which there is density data) that far offshore and none of the ESA-listed species considered in this programmatic forage that deep. Therefore, they are not expected to encounter drogue or pilot parachutes.

If the larger main parachutes or parafoils are not recovered, they will take longer than the drogue parachutes to become saturated and will sink more slowly, but even the largest parafoil is expected to sink at a rate of approximately 1,000 ft (304.8 m) in 145.5 minutes (or approximately 7 ft [2.1 m] per minute). This still is a relatively short amount of time to pass through the water column, likely reaching the ocean floor within a matter of hours. Based on annual reports, the main parachutes and parafoils were less likely to be recovered when recovery operations first began. However, as operations continued to improve, recovery was more likely. For example, 40% of main parachutes and 45% of parafoils were recovered between 2018 and 2024. But in 2025, approximately 87.5% of main parachutes were recovered. Fairing recovery (parafoil) has generally occurred approximately 200 mi (321.9 km) offshore, where species densities are expected to be low. Dragon landings (main parachutes) will occur approximately 15.5 mi (25 km) off San Diego and northern Los Angeles, California. The future planned capsule (main parachutes) will initially land hundreds of miles offshore and land closer to shore following successful missions. Once fully operational, it will land at least 13.8 mi (22.2 km) from shore off the west coast of North America. As mentioned previously, Dragon parachutes have been recovered a majority of the time and are expected to sink within hours.

Daniel et al. (2023) observed two Kemp’s ridley turtles entangled and deceased in weather balloon equipment off Virginia. For context, an average of 60 Kemp’s ridley turtles stranded per year in Virginia from 2012–2021. Approximately 67,000 weather balloons are released each year in the U.S. by the National Weather Service compared to a maximum of approximately 17,500 released each year under this programmatic – if each launch used the maximum number of weather balloons. Weather balloons released as part of the programmatic action, and weather balloons released by the National Weather Service are not recovered.

Considering that in areas of high species density, there is a relatively low occurrence of unrecovered weather balloons, parachutes, and parafoils, and that unrecovered components spend limited time in the water column before settling in deep water, exposure of ESA-listed mammals, sea turtles, fishes, or invertebrates to unrecovered weather balloons, parachutes, and parafoils is extremely unlikely. Therefore, the effects to ESA-listed species from entanglement are discountable, and we conclude that the effects of entanglement on ESA-listed species in the action area, because of activities covered under this programmatic, may affect, but are not likely to adversely affect ESA-listed species.

Unrecovered Debris

Unrecovered debris from expended stages, components, weather balloons, radiosondes, and debris may affect ESA-listed species. Unrecovered debris may be ingested by ESA-listed species foraging in the action area. 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. 2014; 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).

Based on more detailed information from the Reinitiation of the Conference and Biological Opinion on SpaceX 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 Authorized by the Federal Aviation Administration (OPR-2025-02468; NMFS 2025), a majority of debris from expended stages and components (such as fairings) is expected to be stainless steel, composite materials, or other similar metallic materials that will sink immediately due to their density and weight, if not recovered. In 2024, 94% of fairings were recovered in the Atlantic and Pacific Oceans. Debris that may float, such as plastic, is either likely to be contained within the stage or component if it is expended intact, or likely to be incinerated by heat generated during the breakup of a stage or component during reentry. It is difficult to assess the impacts of unrecovered debris on ESA-listed species in a robust way because a majority of expended stages, components, and debris are expended far offshore. Additionally, as mentioned by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), the impact of space debris is uncertain and there is no information on its final fate in the marine environment (GESAMP 2021). Because of the emerging and rapidly expanding industry, it is difficult to predict exactly what materials would survive to the ocean surface and where they will end up, both across the ocean and within the water column. However, based on the aforementioned studies on debris ingestion, it appears unlikely that ESA-listed species would ingest unrecovered debris.

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 1989b; Cullis et al. 2017). This was confirmed by researchers at the University of Colorado and NOAA (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 over months from UV exposure and weathering (Andrady 1990; Irwin 2012; Pegram and Andrady 1989), eventually sinking due to the weight from biofouling (Burchette 1989a; Foley 1990; Lobelle and Cunliffe 2011; Thompson et al. 2004; Ye and Andrady 1991). Burchette (1989a) observed significant degradation of balloon samples after six weeks of exposure. The degree to which such biofouling may occur will correspond to the amount of time the balloon remains at or near the ocean's surface. Additionally, an area's geographic latitude (and corresponding climatic conditions) has a marked effect on the degree of biofouling on marine debris. Fouling of the latex shreds could be confused with organic matter while ESA-listed species are foraging. Green sea turtles are herbivorous and a large study of green sea turtles that stranded in Texas between 1987 and 2019, discovered 48% had ingested plastic, although there was no evidence of mortality related to the ingestion of the plastics (Choi et al. 2021).

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 present in the upper portions of the water column on the order of weeks, the potential for exposure of ESA-listed species to these shreds, and thus the likelihood of their ingestion, is extremely low.

Parachutes and parafoils will also sink to the seafloor, typically within a matter of hours. As discussed previously, the degradation of parachute and parafoil materials will be a slow process that takes place after the materials have settled on the sea floor. It is possible that small fragments could temporarily resuspend in the water column, but the potential for this depends on local ocean floor conditions and the fragments are not expected to resuspend high in the water column where they would likely be encountered by ESA-listed species. There are benthic ESA-listed species, but as previously discussed, recovery operations involving parachutes and parafoils typically have occurred approximately 200 mi (321.9 km) from shore and those that are not recovered are expected to settle in waters more than 9,800 ft (3,000 m) deep. None of the ESA-listed species considered in this programmatic forage that deep. The National Institute of Water and Atmospheric Research Ltd (2017) came to a similar conclusion for species off New Zealand, determining that the risk of ingestion of debris was very low. Therefore, the likelihood of them encountering ingestible material once it has settled over the long-term is expected to be extremely unlikely to occur.

Therefore, the potential for effects to ESA-listed species from unrecovered debris is discountable, and we conclude that effects from unrecovered debris to ESA-listed species in the action area, because of activities covered under this programmatic, may affect, but are not likely to adversely affect, ESA-listed species.

Pollution

Pollution from vessels, propellant from expended stages, and launch and reentry emissions may affect ESA-listed species. This includes in-air and in-water pollution.

In-air pollutants include those emitted by vessels used during pre-launch surveillance or recovery operations (carbon dioxide, nitrogen oxides, sulfur oxides), emissions from launches (including nitrogen oxides, carbon dioxide, vaporized metal particles such as alumina and black carbon), and propellant from vehicle launch failures.

ESA-listed species that occur near launch sites will be more exposed to this stressor than other species. Although vessels and launches will occur in 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 air-breathing ESA-listed marine mammals or sea turtles given the relatively small amount of pollutants especially compared to global emissions, 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.

Recently, scientists have studied how rocket launch 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. 2019). Monitoring from the NASA Space Shuttle Program also documented particulates and exhaust from solid rocket boosters in the environment post-launch (Hall et al. 2014). Hawkins et al. (1984) documented changes in pH in lagoons near the launch site that were exposed to the exhaust plume, which the authors hypothesized led to some mortality of small fishes. However, they also conclude that the cause of death was unclear and that some fish recovered after exposure. We currently do not have sufficient information on the magnitude of activities that will occur to determine whether effects to ESA-listed species will be more than insignificant. At present, it is reasonable to conclude that the emissions emitted by space launch and reentry operations covered under this programmatic are a minute fraction of the global level of emissions, and effects to ESA-listed species are not measurable.

In the event of a launch failure, propellant may be released into the air. 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. In most launch failures, a majority of the propellant will be consumed by the failure (i.e., consumed by the ensuing explosion). and will not be prevalent or pervasive enough in the atmosphere to have a measurable impact on air-breathing ESA-listed marine mammals and sea turtles.

In-water pollutants include those emitted by vessels such as fuel or oil leaks and spills, and propellant from expended vehicles.

A fuel or oil leak would likely pose a risk to the vessel and its crew, and actions to correct a leak would occur immediately to the fullest extent possible. There are no reports of a fuel or oil spill over many years of vessel surveillance and recovery activities related to space launch and reentry vessel operations. In the unlikely event that a leak should occur, the amount of fuel or oil onboard a given vessel is not expected to cause widespread, high-dose contamination (given dispersion by surface currents and wind) that would impact ESA-listed species.

Residual propellant, including hypergolic fuels, may remain on launch vehicles and stages that land or are expended in the ocean. Launch vehicles and reentry vehicles are generally designed to retain propellant. However, if residual propellant ends up in the ocean, it is expected to evaporate/burn (if vented to the air, or if there is a launch failure or explosive event), transform into a much less toxic substance (through chemical reactions with air or water), or be dispersed relatively quickly due to surface currents and ocean mixing.

It is unlikely that residual propellant will contribute measurably to the overall pollutant levels in the action area. Given that a majority (approximately 90%) of space launch and reentry operations use Falcon 9, which is reusable and lands on a droneship or barge, only a small fraction of space launch and reentry operations will result in a stage being expended and residual propellant reaching the ocean. The National Institute of Water and Atmospheric Research Ltd (2017) came to a similar conclusion for species off New Zealand, determining that the risk of exposure to toxic contaminants was very low. Other studies have documented or modeled the occurrence of pollutants such as heavy metals (mercury, aluminum, zinc, arsenic, lead, etc.) and hydrocarbons from space launch and reentry operations in the marine environment (Ayassamy 2025; Fourie et al. 2019; Lonsdale and Phillips 2021). Only one study has documented trace elements in a species (the American alligator [*Alligator missisippiensis*] at the Merritt Island National Wildlife Refuge near Cape Canaveral, Florida), though it is still unclear the exact impacts of those elements and whether those elements are directly caused by nearby space activities (Horai et al. 2014). Thus, at this time, the effects of pollution from space launch and reentry operations on ESA-listed species are not measurable.

Therefore, the potential for effects to ESA-listed species from pollution is insignificant, and we conclude that effects from pollution to ESA-listed species in the action area, because of activities covered under this programmatic, may affect, but are not likely to adversely affect, ESA-listed species.

In-Air Sound

ESA-listed species that surface to breathe (marine mammals and sea turtles) may be exposed to in-air sound from launch and reentry operations involving aircraft, sonic booms, stage landings, explosive events, and launch operations. 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 the activity 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. Sonic booms, stage landings, and explosive events may occur across a broad area. Species densities in a vast majority of these areas are low and given the large areas over which ESA-listed species can be distributed, it is extremely unlikely that an ESA-listed species will occur at the surface at the exact time and place as a sonic boom, stage landing, or explosive event. Thus, the effects are discountable.

ESA-listed species that occur in close proximity to launch sites, particularly CCSFS and KSC where nearly all space launches have occurred in the past couple of years, will be exposed to in-air sound from launch operations (e.g., the launch itself but also static fire tests and other pre-launch safety checks) more than other species. Based on density, the species that will be most exposed to in-air launch noise would be the North Atlantic DPS of green turtle and Northwest Atlantic Ocean DPS of loggerhead sea turtle. The Kemp's ridley turtle and leatherback turtle may be exposed but to a lesser degree, and it is unlikely that North Atlantic right whales would be exposed. At present, our knowledge of the potential effects of launch noise on sea turtles is limited. Though the amount of time that sea turtles spend at the surface is short and it is unlikely that a sea turtle would surface at the same time as a launch, given the increase in launches, it is reasonable to conclude that at some point in the future, sea turtles will be exposed to in-air sound from launches. Hauled-out pinnipeds may be present around VSFB. Monitoring of launch impacts has occurred at VSFB for many years due to MMPA Letter of Authorization (LoA) requirements for VSFB (e.g., USSF 2026). Monitoring does not occur for all activities, nor does it occur for every launch. However, in accordance with the LoA, USSF must conduct marine mammal monitoring and acoustic measurements 1) for all new rockets, 2) for rockets (existing and new) launched from new facilities, 3) for larger or louder rockets than those that have been previously launched from VSFB during their first three launches, and 4) for the first three launches from any new facilities during March through July. Observed behavioral reactions during that monitoring of launches included alerting and flushing, with no documented instances of prolonged or severe disturbance, injury, or mortality. Thus, available information on potential effects at this time indicates that the effects would not be more than insignificant.

We conclude that in-air sound effects to ESA-listed species in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect, ESA-listed species.

Impulsive Underwater Sound

During space launch and reentry operations, impulsive sounds such as sonic booms, stage/component/debris landings, and explosive events may affect ESA-listed species underwater.

During space launch and reentry operations, sonic booms of up to 50 pounds per square foot (psf) may be generated. 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 Research Laboratory (2000) determined that a peak pressure of 12 pounds per square inch (psi) in the water would be needed to meet the outdated 182 decibels (dB) referenced (re) to the standard unit of acoustic pressure underwater, 1 micro Pascal (µPa), threshold for marine mammal and sea turtle adverse effects. Current thresholds utilized by NMFS (FHWG 2008; NMFS 2024; U.S. Department of the Navy 2024a) for the onset of behavioral disturbance from impulsive sound sources (in water) are lower than the outdated 182 dB: 175 dB for sea turtles, 160 dB for marine mammals, and 150 dB for fishes. It is important to note that these current thresholds are root mean square (rms) values and not peak pressure values. The rms value is the square root of the average of the square of the sound signal pressure over a given duration. Due to the squaring and averaging of sound pressure values (which tends to level out large values), the rms value generally results in a lower value than the peak value. However, to produce even 12 psi in water, a surface (i.e., at the ocean surface) pressure of approximately 900 psf is needed.

Rather than responding primarily to sound pressure, fish and 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 fish and invertebrates likely less than the impact on marine mammals and sea turtles.

Thus, it would take a much greater sonic boom than will be generated by the vehicles under this programmatic to create an acoustic impact underwater that could cause a measurable response in ESA-listed species exposed to the sonic booms, and thus the effects are insignificant.

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 stage 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 vehicles may land or be expended, and the short duration (only a few seconds) of landings. Ribeiro Guimaraes Dombroski (2023) detected airborne sounds (such as commercial airplanes and emergency vehicle sirens) underwater on tagged manatees. However, the manatees did not exhibit any behavioral changes to the sounds and they occurred in much shallower and protected waters than where ESA-listed species under NMFS's jurisdiction are expected to occur (i.e., the airborne sounds are likely only detected at the surface of the water; J. Dombroski, RWSC, pers. comm. to E. Chou, NMFS, December 10, 2025). Therefore, any effect from vehicle launches and landings on ESA-listed species while underwater would be immeasurable or extremely unlikely, respectively, and therefore the effects are insignificant or discountable, respectively.

ESA-listed species may also be affected by the underwater sound from explosive events. Explosive events under this programmatic may occur only under the following conditions: 1) explosive events will occur, at minimum, 11 ft (3.4 m) above the surface of the ocean; 2) the explosive weight (calculated from the amount of remaining propellant and its explosive yield) will not exceed 55,800 kilograms (123,018 lbs); and 3) explosive events will only occur in the Atlantic portion of the action area at least 100 mi (160.9 km) from any major land mass (see Figure 5).

To estimate exposure of ESA-listed species to underwater sound from explosive events, we reviewed and adopted FAA's calculations of the ensonified area (area filled with sound from an explosive event) within which species could respond to the sound. The ensonified area within which species could respond was determined by the bounding (largest) explosive event and NMFS's acoustic thresholds (Table 7).

Table 7. NMFS acoustic thresholds and resulting underwater ensonified area from first stage testing explosive events

Hearing/Species Group	Minimum Threshold to a Response* (dB re 1 µPa)	Ensonified Area (km^2) per Explosive Event
Low-frequency cetacean (blue whale, fin whale, North Atlantic right whale, sei whale)	216	1.923
High-frequency cetacean (sperm whale)	224	0.305
Sea turtle (green turtle, Kemp's ridley turtle, leatherback turtle, loggerhead sea turtle)	224	0.305
Fish ≥ 2g (giant manta ray, oceanic whitetip shark, scalloped hammerhead shark)	206	19.225

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

Marine mammal and sea turtle (blue, fin, North Atlantic right, sei, and sperm whales; green, Kemp's ridley, leatherback, and loggerhead sea turtles) densities are near zero 100 mi (160.9 km) from shore where explosive events may occur (Roberts et al. 2023; Roberts et al. 2016; Roberts et al. 2024; DiMatteo et al. 2024). The highest monthly mean species density in the explosive events area (see Figure 5) was 0.007 sperm whales per km^2, other marine mammal and sea turtle densities are magnitudes lower than those for sperm whales. Given the relatively small ensonified areas within which measurable responses could be expected, it is extremely unlikely that ESA-listed marine mammals and sea turtles (blue, fin, North Atlantic right, sei, and sperm whales; green, Kemp's ridley, leatherback, and loggerhead sea turtles) will be exposed to underwater acoustic effects from explosive events. Densities for other ESA-listed species including other sea turtles (hawksbill turtle), fishes, and invertebrates are not expected to be higher than the densities described above. This is because the areas where explosive events can occur are far offshore and do not include where these species aggregate. Therefore, it is extremely unlikely that these species will be exposed to underwater acoustic effects from explosive events, and the effects are discountable.

We conclude that effects to ESA-listed species in the action area from impulsive underwater sound because of activities covered under this programmatic may affect, but are not likely to adversely affect, ESA-listed species.

Noise and Visual Disturbance

Aircraft overflights, vessels, and stages/components/debris expended from space launch and reentry operations will have sounds associated with their activity (see also In-Air Sound and Impulsive Underwater Sound). There could also be a visual stimulus from aircraft, vessels, and falling objects that could potentially lead to a change in behavior. Visual disturbance and noise can co-occur, making it difficult to discern which stimulus causes a reaction or whether the reaction is to the combined stimuli. Similar to noise, the visual stimulus impacts would be transient and only occur if an individual is surfacing or very close to the surface at the same time an aircraft happens to be flying over, a vessel is transiting, or an expended object is descending, within a detectable distance.

Cetacean (sperm whales and bowhead whales) studies observed that a few individuals may dive in response to fixed wing aircraft overflights, and some individuals may delay vocalizations, surface for shorter periods, breach, or tail slap (Patenaude et al. 2002b; Richter et al. 2003a; Smultea et al. 2008b; Würsig et al. 1998). These responses mostly occurred when the aircraft was below an altitude of approximately 820.2 ft (250 m), which is lower than the altitude at which aircraft will be operating during proposed activities under this programmatic (1,000 ft, or 304.8 m).

Species-specific studies on the reaction of sea turtles to fixed-wing aircraft overflights are lacking. 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 (Lutcavage and Lutz 2017) and the low frequency and short duration of surveillance flights, the probability of exposing an individual to a 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.

As stated in the PDCs, 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) over North Atlantic right whales. Additionally, aircraft will avoid flying in circles if marine mammals or sea turtles are spotted to avoid any type of harassing behavior. Thus, the chances of an individual ESA-listed species being exposed to the proposed aircraft overflights are extremely low.

Studies have observed changes in the behavior of marine mammals, sea turtles, and fishes to vessel noise (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). Vessel noise will not exceed that of larger commercial shipping vessels and will only be temporary (only used for pre-launch surveillance and post-launch recovery) compared to the more persistent presence of commercial vessels. Additionally, while not specifically designed to do so, several aspects of the PDCs will minimize effects associated with vessel acoustic disturbance to ESA-listed species (e.g., maintaining separation distances from protected species, slowing to 10 knots or less around certain species and in specific areas; see Project Design Criteria). Similar to noise, visual stimulus impacts would be transient and even less likely to be perceived than sound as light does not travel as well underwater. Given the PDCs and the relatively small contribution of the vessels associated with the proposed action to the overall vessel activity in the action area, effects from vessel presence (visual or acoustic) are expected to be so minor that they cannot be meaningfully evaluated.

After an expended stage, components, or debris has descended and hit the surface of the water (associated acoustic impact discussed in Impulsive Underwater Sound), it begins to sink through the water column. Because the object is sinking through the water column (i.e., underwater), there may be greater opportunities for the object to been seen by an ESA-listed species as opposed to in the atmosphere. If the object is visually detected by an ESA-listed species it could result in a behavioral response, such as leaving the vicinity. Marine animals may avoid areas with disturbing stimuli (visual presence, noise), such as from marine energy devices (Hemery et al. 2024). The sinking expended object may incite temporary avoidance but once it has sunk or sunk past the detection range of the animal, the animal may reoccupy that area of water column, resulting in only a brief minor disruption. As previously discussed (in Direct Impact by Falling Objects), exposure to objects expended during space launch and reentry operations is extremely unlikely considering vast areas where they return to earth and the low densities of ESA-listed species in those areas.

Given the limited and temporary behavioral responses to similar stimuli documented in available research, we expect that potential effects on ESA-listed species, should they occur, would be insignificant. We conclude that visual and acoustic effects to ESA-listed species in the action area from aircraft overflight, vessel transit, and expended objects covered under this programmatic may affect, but are not likely to adversely affect, ESA-listed species.

Vessel Strike

ESA-listed species may be exposed to vessels associated with launch and reentry operations in all portions of the action area (except the Indian Ocean, South Pacific Ocean, South Atlantic Ocean, and Southern Ocean). A vessel strike could result in injury or mortality. The duration of vessel operations is temporary (for example, with SpaceX's Starship-Super Heavy, vessel operations last 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 continuously every 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.

The potential for a vessel striking an ESA-listed marine mammal, sea turtles, or fish is unlikely because the proposed action consists of limited vessel operations and the action area is extremely large. A vessel grounding in an area where ESA-listed corals, black abalone, white abalone, queen conch, or the proposed sunflower sea star occur would be extremely unlikely because there is no planned vessel activity in shallow nearshore or offshore reef areas. No vessel groundings have occurred during any previous vessel operations associated with space launch and reentry operations.

Sturgeon may be exposed to vessel strikes when vessels are departing or returning to ports that are located where sturgeon are present. Ports that have been used or are planned to be used including Piney Point, Maryland, Port of Baltimore, Maryland, Port of Hampton Roads, Virginia, and Port of Norfolk, Virginia, occur where migratory and foraging Atlantic and shortnose sturgeon may be present. It is unlikely that sturgeon would be struck by vessels because they are generally bottom-dwelling, though they swim at various depths and may occur near the surface during migrations or spawning movements (Balazik et al. 2012a; Balazik et al. 2012b). The draft of the vessels that would be used would not approach the depth of the channels and ports used. Sturgeon tend to occur in the bottom 3 ft (1 m) of the channel or port; thus, it is unlikely that sturgeon will be struck by vessels. Additionally, vessel activity is temporary and limited, further reducing the likelihood of a vessel strike.

The PDCs include several measures to avoid vessel strikes including the presence of dedicated observers on board to monitor for marine mammals and sea turtles, as well as adhering to minimum avoidance distances and speed restrictions when in proximity to certain ESA-listed species. Implementation of the PDCs reduces the potential risk for vessel strike making it extremely unlikely to occur.

Thus, effects to ESA-listed species from vessel strike are discountable. We conclude that impacts from vessel strike to ESA-listed species in the action area because of vessel activities covered under this programmatic may affect, but are not likely to adversely affect ESA-listed species.

Increased Sea Surface Temperature

Heat from stage landings (produced by engines during the landing burn), explosive events, or launches (heat plume) may affect ESA-listed species that spend time at the surface of the ocean (marine mammals, sea turtles, fishes, and chambered nautilus). These activities may result in a temporary but significant increase in temperature at the surface of the ocean.

To be exposed to this stressor, ESA-listed species would have to be in the exact same place at the exact same time that a vehicle landing, launch, or explosive event occurs. As previously discussed, it is extremely unlikely that an ESA-listed species would occur at the exact same place and time as a vehicle landing or explosive event, the latter of which will only occur far from shore where species densities are low or near zero. Species that occur near launch sites (see In-Air Sound) have a greater chance of being exposed to heat plumes from launches than other species. 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.

We are not aware of heat plume monitoring for any Falcon 9 launch, which is the most widely used launch vehicle. However, monitoring of heat plumes from SpaceX's 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; which is similar ambient temperature at some launch sites during certain months) within a 0.6-mi (1-km) radius surrounding the launch site (FAA 2024). Starship-Super Heavy is expected to have a much larger and more intense (in terms of degrees in temperature) heat plume than launch vehicles covered under this programmatic because the total thrust of Starship-Super Heavy is more than 2.5 times the total thrust of a launch vehicle under this programmatic. This results in a very small area that may be exposed to high temperatures.

Additionally, ESA-listed marine mammals, sea turtles, fishes, and chambered nautilus 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 launches is extremely unlikely and, thus, discountable.

We conclude that impacts to ESA-listed species in the action area from heat because of activities covered under this programmatic may affect, but are not likely to adversely affect, ESA-listed species.

Vibration

Vibration from launches may affect species near the launch sites, particularly CCSFS and KSC, where nearly all launches have occurred in the past couple of years. Based on density data mentioned previously, this includes the North Atlantic DPS of green turtle and Northwest Atlantic Ocean DPS of loggerhead sea turtle. The Kemp's ridley turtle and leatherback turtle may be exposed but to a lesser degree, and it is unlikely that North Atlantic right whales will be exposed. Smalltooth sawfish and Atlantic sturgeon may also be exposed to vibration from launches.

We are not aware of launch vibration monitoring for vehicles other than Starship-Super Heavy. During previous Starship-Super Heavy launches, vibration was observed from the launch site out to a radius of approximately 0.7 mi (1.1 km) from the launch site (FAA 2024). Though monitoring stations were only located on land, it was determined that a majority of the energy was distributed through the air and not the ground (FAA 2024). 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. Vibration from Starship-Super Heavy launches is expected to affect a much larger area than vibration from launch vehicles covered under this programmatic because the total thrust of Starship-Super Heavy is more than 2.5 times the total thrust of a launch vehicle under this programmatic. This results in a very small area that may be exposed to vibration.

In the event that those vibrations enter the marine environment, it is likely only to affect fishes such as smalltooth sawfish and Atlantic sturgeon because fish are especially able to detect particle motion. Thus, based on the limited information currently available, we conclude that effects to ESA-listed fishes from launch vibrations will be so small as to not be measurable and, thus, insignificant. Thus, impacts to ESA-listed species in the action area from vibration because of activities covered under this programmatic may affect, but are not likely to adversely affect, ESA-listed species.

Critical Habitat

Most of the proposed operations would occur well offshore in deep waters and avoid critical habitat areas (see zones identified in the Action Area section). PDCs associated with zones of the action area avoid or restrict activities in most critical habitat areas. In this section, we assess the potential effects of activities that may occur in designated or proposed critical habitat.

Temperature

Heat from stage landings (produced by engines during the landing burn), explosive events, or launches (heat plume) may cause a temporary increase in sea surface temperatures. PBFs of critical habitat occurring in the action area that may be affected by changes in temperature are listed in Table 8.

Table 8. Temperature-related PBFs of critical habitat in the action area that may be affected

Physical and Biological Feature	Associated Critical Habitat	Activities
Calving habitat: Sea surface temperatures from a minimum of 7°C, and never more than 17°C	North Atlantic Right Whale	Launches, landings (stage/barge)
Calving habitat: Water depths of 6–28 m, where the sea surface conditions and temperature features simultaneously co-occur over contiguous areas of at least 231 NM^2 of ocean waters during the months of November through April	North Atlantic Right Whale	Launches, landings (stage/barge)
Sargassum habitat: Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Launches, landings (stage/barge), explosive events
Winter habitat: Water temperatures above 10°C from November through April	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Landings (stage/barge)
Foraging habitat: Water temperatures to support loggerhead inhabitance, generally above 10°C	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Launches, landings (stage/barge), explosive events

Launch (i.e., ignition of the rocket's engines) can cause a temporary increase in temperatures near coastal launch sites (e.g., KSC, CCSFS). Heat continues to be emitted as the rocket gains altitude. Most of this heat dissipates in the atmosphere, while a fraction may be absorbed in the top layer of the ocean surface directly adjacent to the launch site. This temperature increase is expected to extend only into a very shallow layer at the surface in the first few seconds after launch and dissipate within seconds.

Return of stages, whether resulting in a controlled landing (i.e., there is a landing burn), barge landing, or explosive event, may also increase sea surface temperatures. The stage enters the atmosphere at hypersonic speeds, and the friction causes compression of air, producing heat. For stages that land in the ocean, the landing burn or physical impact of the stage hitting the water at high speed can create a brief, localized surge of heat at the surface. An explosive event would also result in a temporary but significant increase in temperatures at the surface of the ocean due to the burning of residual propellant. However, explosive events will not occur near any critical habitat.

As mentioned previously, water has a significantly higher specific heat capacity than air, so we expect that ocean temperatures are not affected by launches as significantly as the surrounding air. Heat added at the surface is anticipated to be localized to the area near the launch or landing location, and would be temporary. The likelihood of effects is also minimized through PDCs, such as no disposals (controlled landings) in Zone 5a, which overlaps Northwest Atlantic Ocean DPS loggerhead sea turtle winter critical habitat, November through April.

Thus, based on the limited information, the effect of temperature on critical habitats listed in Table 8 is expected to not be measurable and are insignificant. We conclude that impacts to designated critical habitats in the action area from heat because of activities covered under this programmatic may affect, but are not likely to adversely affect, designated critical habitat.

Benthic/Obstruction

Radiosondes, stages, fairings, and debris falling and landing in the action area have the potential to affect critical habitat. As described for effects to species, the action area where objects may land encompasses vast expanses of ocean, the vast majority of which is outside critical habitat. Therefore, debris is more likely to be expended outside critical habitat. For the fraction that are expended within critical habitat, expended components could crush or smother features of critical habitat, disturb substrate, and/or act as an obstruction if they are unrecovered.

Benthic impacts

Unrecovered debris (e.g., from disposals or expended boosters, fairings, spacecraft, debris, or radiosondes from weather balloons) that does not fully burn up on reentry or break up, may sink and can affect benthic habitat features (Table 9).

Table 9. Benthic habitat PBFs of critical habitat within the action area that may be affected

Physical and Biological Feature	Associated Critical Habitat	Activities
Benthic foraging/resting essential features: From the mean high water line to 20 m depth, underwater refugia and food resources (i.e., seagrasses, macroalgae, and/or invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction	Green Sea Turtle – North Atlantic DPS (Proposed)	Landings (disposal and expended)

Only a small portion of the proposed North Atlantic DPS green turtle critical habitat benthic foraging/resting feature overlaps Zone 2 in the Gulf, where spacecraft reentry and debris may land and sink. Given the limited area of critical habitat that overlaps Zone 2, the effects of unrecovered debris on the benthic foraging/resting feature of North Atlantic DPS green turtle proposed critical habitat is expected to be so small as to not be measurable. Thus, effects to the North Atlantic DPS green turtle proposed critical habitat are insignificant.

Movement obstruction impacts

Unrecovered debris in the ocean may present barriers to movement and obstruct passage of ESA-listed species, impacting related critical habitat PBFs (Table 10).

Table 10. Migration, passage, movement, and access PBFs of critical habitat in the action area that may be affected

Physical and Biological Feature	Associated Critical Habitat	Activities
Migratory essential feature: From the mean high water line to 20 m depth, sufficiently unobstructed corridors that allow for unrestricted transit between foraging and nesting areas for reproductive individuals	Green Sea Turtle – North Atlantic DPS (Proposed)	Landings (disposal and expended)
Reproductive essential feature: From the mean high water line to 20 m depth, sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches proposed as critical habitat by U.S. Fish and Wildlife Service, to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings	Green Sea Turtle – North Atlantic DPS (Proposed)	Landings (disposal and expended)
Constricted migratory habitat: Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Landings (disposal and expended)

Potential effects to these PBFs are minimized by the PDCs. For example, Zone 5, which encompasses Northwest Atlantic Ocean DPS loggerhead sea turtle constricted migratory critical habitat and proposed North Atlantic DPS green turtle reproductive and migratory critical habitat, will not have any disposals or expended stages, components, or debris. Thus, it is extremely unlikely that unrecovered debris will occur in the critical habitats listed in Table 10, and the effects are discountable.

We conclude that impacts to designated or proposed critical habitats in the action area from unrecovered debris because of activities covered under this programmatic may affect, but are not likely to adversely affect, designated or proposed critical habitat.

Noise

Rocket launches, landings, disposals/expenditures, and vessel and aircraft transits will introduce sound in the action area. These could have both in-air and underwater components and may affect critical habitat PBFs related to noise (Table 11).

Table 11. Noise-related PBFs of critical habitat in the action area that may be affected

Physical and Biological Feature	Associated Critical Habitat	Activities
Terrestrial, air, and aquatic areas that support reproduction, foraging, rest, and refuge	Steller Sea Lion – Western DPS	Launches, sonic booms, vessels, aircraft
Spawning Habitat. Marine sites used for spawning and adjacent waters that support movement and staging associated with spawning	Nassau Grouper	Barge landings, vessels, aircraft
Sufficiently quiet conditions for normal use and occupancy, including intraspecific communication, navigation, and detection of prey, predators, and other threats	Rice's Whale (Proposed)	Vessels, aircraft

Given the temporary nature and short duration that sonic booms, impulse noise, and vessel and aircraft noise will occur, in addition to the ineffective transmission of acoustic energy across the air-water boundary (for in-air sounds), the additional sound from these activities is not expected to measurably affect the long-term acoustic conditions of critical habitat. Thus, the effects of sound on the critical habitats listed in Table 11 are insignificant. We conclude that impacts to designated or proposed critical habitat in the action area from sound because of activities covered under this programmatic may affect, but are not likely to adversely affect, designated or proposed critical habitat.

Pollution

Pollutants discussed in regards to effects to species (e.g., from vessels including droneships, propellant from expended stages, launch and reentry emissions) may also affect PBFs of multiple species' critical habitats (Table 12).

Table 12. Pollution-related PBFs of critical habitat in the action area that may be affected

Physical and Biological Feature	Associated Critical Habitat	Actions
Terrestrial, air, and aquatic areas that support reproduction, foraging, rest, and refuge	Steller Sea Lion – Western DPS	Launches, vessels
Spawning Habitat. Marine sites used for spawning and adjacent waters that support movement and staging associated with spawning	Nassau Grouper	Barge landings, vessels

Physical and Biological Feature	Associated Critical Habitat	Actions
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. Several attributes of these sites determine the quality of the area and influence the value of the associated feature to the conservation of the species, including: Marine water with levels of anthropogenically-introduced (from humans) chemical contaminants that do not preclude or inhibit any demographic function	Boulder Star Coral Lobed Star Coral Mountainous Star Coral Pillar Coral Rough Cactus Coral	Barge landings, vessels
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	Rice's Whale (Proposed)	Vessels
Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels	Chinook Salmon – Puget Sound ESU Chum Salmon – Hood Canal Summer-Run ESU	Vessels
Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages	Gulf Sturgeon	Vessels
Suitable water quality. Suitable water quality includes temperature, salinity, pH, and other chemical characteristics necessary for normal settlement, growth, behavior, and viability of black abalone	Black Abalone	Vessels
The critical habitat designation did not precisely define PBFs; however, critical habitat was designated to provide protection	Green Sea Turtle – North Atlantic DPS	Vessels

Physical and Biological Feature	Associated Critical Habitat	Actions
for important developmental and resting habitats. Seagrass is the principal dietary component of juvenile and adult green sea turtles. Coral reefs and other topographic features within the waters surrounding Culebra provide shelter from predators. Nearby sandy beaches provide nesting grounds for adult females		
The critical habitat designation did not precisely define PBFs; however, important features of these areas for hawksbill turtles include foraging habitat, shelter for resting and refuge from predators, access to nesting sites, and natal development habitat	Hawksbill Sea Turtle	Vessels
Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities	Yelloweye Rockfish – Puget Sound/Georgia Basin DPS Bocaccio – Puget Sound/Georgia Basin DPS	Vessels
Water quality to support growth and development	Killer Whale – Southern Resident DPS	Barge landings, vessels
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	Gulf Sturgeon	Vessels
Coastal marine areas: Water quality - Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, PAHs, heavy metals that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon)	Green Sturgeon – Southern DPS	Barge landings, vessels
Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales	Beluga Whale – Cook Inlet DPS	Vessels

Water quality may be temporarily degraded as a result of vessel pollutants or a launch failure. Recovery activities and any emergency response and cleanup procedures would reduce the magnitude and duration of impacts from a launch failure. As previously discussed, pollutants are expected to evaporate and quickly become dispersed due to wind and currents, limiting any impacts to a temporary duration. Given the limited use of vessels and brief exposure to pollutants, the effect of pollution on related PBFs will be so small as to not be measurable. Thus, the effects on designated critical habitats in Table 12 are insignificant. We conclude that impacts to designated or proposed critical habitat in the action area from pollution because of activities covered under this programmatic may affect, but are not likely to adversely affect, designated or proposed critical habitat.

Food Resources

Many species' critical habitats include PBFs related to their food or prey resources (Table 13). Food, prey, and forage areas may be affected by similar stressors as ESA-listed species.

Table 13. Food, prey, and forage PBFs of critical habitat in the action area that may be affected

Physical and Biological Feature	Associated Critical Habitat	Activities
Abundant food items, such as detritus, aquatic insects, worms, and/or molluscs, within riverine habitats for larval and juvenile life stages; and 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	Gulf Sturgeon	Vessels
Benthic foraging/resting essential features: From the mean high water line to 20 m depth, underwater refugia and food resources (i.e., seagrasses, macroalgae, and/or invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction	Green Sea Turtle – East Pacific DPS, North Atlantic DPS, South Atlantic DPS (Proposed)	Launches, barge landings (North Atlantic DPS only), landings (disposal and expended; North Atlantic DPS only), vessels
Food resources. Abundant food resources including bacterial and diatom films, crustose coralline algae, and a source of detrital macroalgae, are required for growth and survival of all stages of black abalone	Black Abalone	Vessels

Physical and Biological Feature	Associated Critical Habitat	Activities
Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. Eulachon prey on a wide variety of species including crustaceans such as copepods and euphausiids, unidentified malacostracans, cumaceans mysids, barnacle larvae, and worm larvae	Eulachon – Southern DPS	Vessels
Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels	Chinook Salmon – Puget Sound ESU Chum Salmon – Hood Canal Summer-Run ESU	Vessels
Nutrients, physical oceanography processes, certain species of zooplankton (copepods), and long photo-period due to the high latitude	North Pacific Right Whale	Vessels
Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth	Killer Whale – Southern Resident DPS	Barge landings, vessels
Prey species, primarily euphausiids (*Thysanoessa* and *Euphausia*) and small pelagic schooling fishes, such as 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	Humpback Whale – Western North Pacific DPS	Launches, vessels

Physical and Biological Feature	Associated Critical Habitat	Activities
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	Humpback Whale – Mexico DPS	Launches, barge landings, landings (disposal and expended), vessels
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 – Central America DPS	Barge landings, landings (disposal and expended), vessels
Primary prey resources to support Arctic ringed seals, which are defined to be small, often schooling, fishes, in particular Arctic cod, saffron cod, and rainbow smelt; and small crustaceans, in particular, shrimps and amphipods	Ringed Seal – Arctic Subspecies	Barge landings, landings (disposal and expended), vessels
Primary prey resources to support bearded seals: Waters 200 m or less in depth containing benthic organisms, including epifaunal and infaunal invertebrates, and demersal fishes	Bearded Seal – Beringia DPS	Barge landings, landings (disposal and expended), vessels
Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities	Yelloweye Rockfish – Puget Sound/Georgia Basin DPS	Vessels

100

Physical and Biological Feature	Associated Critical Habitat	Activities
Sufficient density, quality, abundance, and accessibility of small demersal and vertically migrating prey species, including scombriformes, stomiiformes, myctophiformes, and myopsida	Rice's Whale (Proposed)	Vessels
Surface-pelagic foraging/resting essential features: 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	Green Sea Turtle – North Atlantic DPS (Proposed)	Launches, barge landings, landings (disposals and expended), explosive events, vessels
Terrestrial, air, and aquatic areas that support reproduction, foraging, rest, and refuge	Steller Sea Lion – Western DPS	Launches, vessels
The critical habitat designation did not precisely define PBFs; however, critical habitat was designated around Puerto Rico to provide protection for important developmental and resting habitats. Seagrass is the principal dietary component of juvenile and adult green sea turtles. Coral reefs and other topographic features within the waters surrounding Culebra provide shelter from predators. Nearby sandy beaches provide nesting grounds for adult females	Green Sea Turtle – North Atlantic DPS	Vessels
The critical habitat designation did not precisely define PBFs; however, important features of these areas for hawksbill turtles include foraging habitat, shelter for resting	Hawksbill Sea Turtle	Vessels

101

Physical and Biological Feature	Associated Critical Habitat	Activities
and refuge from predators, access to nesting sites, and natal development habitat		
U.S. West Coast – Prey species, primarily scyphomedusae (i.e., jellyfish) 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	Leatherback Sea Turtle	Barge landings, vessels
Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities	Bocaccio – Puget Sound/Georgia Basin DPS	Vessels
Coastal marine areas: Food resources. Abundant prey items for subadults and adults, which may include benthic invertebrates and fish	Green Sturgeon – Southern DPS	Barge landings, vessels
Foraging habitat: Diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region	North Atlantic Right Whale	Landings (disposal and expended), vessels
Foraging habitat: Late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region	North Atlantic Right Whale	Landings (disposal and expended), vessels
Foraging habitat: Low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins	North Atlantic Right Whale	Landings (disposal and expended), vessels
Foraging habitat: Sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit,	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Launches, barge landings, landings (disposals and

Physical and Biological Feature	Associated Critical Habitat	Activities
blue, horseshoe), mollusks, echinoderms and sea pens		expended), explosive events, vessels
Sargassum habitat: 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	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Landings (disposal and expended), explosive events, vessels
Sargassum habitat: *Sargassum* in concentrations that support adequate prey abundance and cover	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Landings (disposal and expended), explosive events, vessels
Sargassum habitat: 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	Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS	Landings (disposal and expended), explosive events, vessels
Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole	Beluga Whale – Cook Inlet DPS	Vessels

Stressors such as falling objects, impulsive sounds (including overpressures from barge landings), and noise and visual disturbance (e.g., vessels) may affect prey. These stressors may temporarily displace prey for the short time a vessel transits through an area, an object sinks through the water column, or the duration of the sound. However, the duration of these stressors is brief (the longest vessel transit would likely be on the order of days), limited to the immediate vicinity of the activity, and is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Pieces of weather balloons or parachutes/parafoils are not expected to be available to prey species in sufficient concentrations to measurably affect prey populations. Prey species could get entrapped or entangled in the parachute/parafoil if parachutes/parafoils land within critical habitat and are not recovered. However, the removal of a small amount of prey is not expected to reduce the conservation value of that PBF in any designated or proposed critical habitats. Thus, the consequences from stressors on critical habitats listed in Table 13 will be so small as to not be measurable and thus are insignificant.

We conclude that impacts to designated or proposed critical habitat in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect, designated or proposed critical habitat.

CONCLUSION

Based on this analysis, NMFS ESA Interagency Cooperation Division concurs with the FAA, NASA, and USSF, that the proposed action may affect, but is not likely to adversely affect, ESA-listed or proposed species and designated or proposed critical habitat.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are "suggestions … regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information" (50 CFR §402.02).

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

1. The action agencies should coordinate with NMFS ESA Interagency Cooperation Division and the NOAA Marine Debris Program (MDP), to evaluate how activities of the MDP may apply to debris that originates from space launch and reentry operations (e.g., expended stages, components, debris, and parachutes).
2. Action agencies should consider all means to reduce marine debris (from expended stages, component, parachutes, etc.) from space launch and reentry operations. This includes, but is not limited to, exploring ways to recover all parachutes/parafoils, weather balloons, and using materials, instruments, or components that are biodegradable or use less plastic. For example, radiosonde RS41-E models use biodegradable materials and reduces plastic use by 66% and High Altitude LiDAR Atmospheric Sensing (HALAS) can provide real-time atmospheric data for launches without expending weather balloons.
3. The action agencies should follow the voluntary vessel speed reduction zones and Areas To Be Avoided (ATBA) off California (https://channelislands.noaa.gov/manage/resource/ship-strikes.html). NOAA annually issues these May 1–December 31 to reduce the risk of vessel strike, reduce ocean noise, and reduce air pollution.
4. We recommend the action agencies help fund or undertake scientific research to investigate the assumptions in the Effects Analysis and the potential impacts of space launch and reentry operations on ESA-listed species and critical habitat. This could include analyzing species' responses to operations, locations and fates of unrecovered debris (weather balloons, parachutes/parafoils, stages, components, debris, etc.), verification of underwater sound levels from operations, etc.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the FAA, NASA, and USSF should notify the ESA Interagency Cooperation Division of any conservation recommendations implemented as part of activities included in this programmatic consultation. This information can be included in annual reports.

REINITIATION OF CONSULTATION

Reinitiation of consultation is required and shall be requested by the federal agency (FAA, USSF, and/or NASA) or NMFS, where discretionary federal involvement or control over the action has been retained or is authorized by law and (1) new information reveals effects of the action that may affect an ESA-listed species or designated critical habitat in a manner or to an extent not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect to the ESA-listed species or designated critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR §402.16).

Programmatic consultations often involve actions that occur at some frequency over many years and possibly continue for an indefinite time. The action agencies are required to submit annual reports to NMFS describing the activities and any effects to ESA-listed species and critical habitat (see Reporting). Should the annual reports indicate that the activities undertaken may affect ESA resources differently than assessed in this programmatic letter of concurrence, or that the scope and magnitude of the activities are inconsistent with the description of the proposed action and action area, reinitiation may be required.

Please direct questions regarding this programmatic letter of concurrence to Emily Chou, Consulting Biologist, at (301) 427-8483 or emily.chou@noaa.gov, or me at (240) 723-6321 or tanya.dobrzynski@noaa.gov.

Sincerely,

DOBRZYNSKI.TANYA.JANINE.1365846517
Digitally signed by DOBRZYNSKI.TANYA.JANINE.1365846517
Date: 2026.05.04 11:18:20 -04'00'

Tanya Dobrzynski
Chief, ESA Interagency Cooperation Division
Office of Protected Resources

Cc: Nicholas Baker, FAA
Amy Hanson, FAA

LITERATURE CITED

Abecassis, M., Senina, I., Lehodey, P., Gaspar, P., Parker, D., Balazs, G., & Polovina, J. (2013). A model of loggerhead sea turtle (*Caretta caretta*) habitat and movement in the oceanic North Pacific. *PLoS ONE* 8(9):e73274. https://doi.org/10.1371/journal.pone.0073274.t001

Allen, B. M., Angliss, R. P., & Wade, P. R. (2011). *Alaska marine mammal stock assessments, 2010*. Citeseer.

Altenritter, M. E., Kinnison, M. T., Zydlewski, G. B., Secor, D. H., & Zydlewski, J. D. (2015). Assessing dorsal scute microchemistry for reconstruction of shortnose sturgeon life histories. *Environmental Biology of Fishes* 98(12):2321-2335.

Alzugaray, L., Di Martino, M., Beltramino, L., Rowntree, V. J., Sironi, M., & Uhart, M. M. (2020). Anthropogenic debris in the digestive tract of a southern right whale (Eubalaena australis) stranded in Golfo Nuevo, Argentina. *Marine Pollution Bulletin* 161:111738. https://doi.org/https://doi.org/10.1016/j.marpolbul.2020.111738

Andrady, A. L. (1990). Environmental degradation of plastics under land and marine exposure conditions. Pages 848-869 *in* Second International Conference on Marine Debris (April 1989)(Honolulu, HI).

ASMFC. (2006). *ASMFC Atlantic sturgeon by-catch workshop*. Norfolk, Virginia.

Aurioles-Gamboa, D., Hernandez-Camacho, C. J., & Rodriguez-Krebs, E. (1999). Notes on the southernmost records of the Guadalupe fur seal, *Arctocephalus townsendi*, in Mexico. *Marine Mammal Science* 15(2):581-583.

Ayassamy, P. (2025). Space Launches and Their Possible Impact on the Deterioration of the Indian River Lagoon Marine Ecosystem in Florida? *Thalassas: An International Journal of Marine Sciences* 41(3):137.

Balazik, M. T., Garman, G. C., Van Eenennaam, J. P., Mohler, J., & Woods III, L. C. (2012a). Empirical evidence of fall spawning by Atlantic Sturgeon in the James River, Virginia. *Transactions of the American Fisheries Society* 141(6):1465-1471.

Balazik, M. T., Reine, K. J., Spells, A. J., Fredrickson, C. A., Fine, M. L., Garman, G. C., & McIninch, S. P. (2012b). The potential for vessel interactions with adult Atlantic sturgeon in the James River, Virginia. *North American Journal of Fisheries Management* 32(6):1062-1069.

Baldwin, R., Hughes, G. R., & Prince, R. I. T. (2003). Loggerhead turtles in the Indian Ocean. Pages 218-232 *in* A. B. Bolten & B. E. Witherington, editors. *Loggerhead Sea Turtles*. Smithsonian Institution Press, Washington, D. C.

Belcher, R. L. & T.E. Lee, Jr. (2002). Arctocephalus townsendi. *Mammalian Species* 700(1):1-5.

Benson, S. R., Eguchi, T., Foley, D. G., Forney, K. A., Bailey, H., Hitipeuw, C., Samber, B. P., Tapilatu, R. F., Rei, V., Ramohia, P., Pita, J., & Dutton, P. H. (2011). Large-scale movements and high-use areas of western Pacific leatherback turtles,Dermochelys coriacea. *Ecosphere* 2(7):art84. https://doi.org/10.1890/es11-00053.1

Bjorndal, K. A. & Bolten, A. B. (2010). Hawksbill sea turtles in seagrass pastures: success in a peripheral habitat. *Marine Biology* 157:135-145.

Boreman, J. (1997). Sensitivity of North American sturgeons and paddlefish to fishing mortality. *Environmental Biology of Fishes* 48(1-4):399-405.

Burchette, D. (1989a). A study of the effect of balloon releases on the environment. *National Association of Balloon Artists* 20.

Burchette, D. (1989b). A study of the effect of balloon releases on the environment. *National Association of Balloon Artists*:20.

Burdin, A. M., Sychenko, O. A., & Sidorenko, M. M. (2013). *Status of western gray whales off northeastern Sakhalin Island, Russia in 2012*. IWC Scientific Committee, Jeju, Korea.

Butler, J., DeVogelaere, A., Gustafson, R., Mobley, C., Neuman, M., Richards, D., Rumsey, S., Taylor, B., & VanBlaricom, G. (2009). *Status review report for black abalone (Haliotis cracherodii Leach, 1814)*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Long Beach, California.

Cameron, M. F., Bengtson, J. L., Boveng, P. L., Jansen, J. K., Kelly, B. P., Dahle, S. P., Logerwell, E. A., Overland, J. E., Sabine, C. L., & Waring, G. T. (2010). Status review of the bearded seal (Erignathus barbatus).

Carr, S., Tatman, F., & Chapman, F. (1996). Observations on the natural history of the Gulf of Mexico sturgeon (Acipenser oxyrinchus de sotoi Vladykov 1955) in the Suwannee River, southeastern United States. *Ecology of Freshwater Fish* 5(4):169-174.

Choi, D. Y., Gredzens, C., & Shaver, D. J. (2021). Plastic ingestion by green turtles (Chelonia mydas) over 33 years along the coast of Texas, USA. *Marine Pollution Bulletin* 173:113111.

Cliff, G., Dudley, S. F. J., Ryan, P. G., & Singleton, N. (2002). Large sharks and plastic debris in KwaZulu-Natal, South Africa. *Marine and Freshwater Research* 53(2):575-581. https://doi.org/https://doi.org/10.1071/MF01146

Compagno, L. J. (1984). *FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes*, FAO;.

Cullis, P., Sterling, C., Hall, E., Jordan, A., Johnson, B., & Schnell, R. (2017). Pop Goes the Balloon!: What Happens when a Weather Balloon Reaches 30,000 m asl? *Bulletin of the American Meteorological Society* 98(2):216-217. https://doi.org/https://doi.org/10.1175/BAMS-D-16-0094.1

Dallas, J. A., Raval, S., Alvarez Gaitan, J. P., Saydam, S., & Dempster, A. G. (2020). The environmental impact of emissions from space launches: A comprehensive review. *Journal of Cleaner Production* 255:120209. https://doi.org/https://doi.org/10.1016/j.jclepro.2020.120209

Daniel, J. T., Costidis, A. M., & Barco, S. G. (2023). Fatal entanglements of sea turtles caused by widely deployed weather instruments. *Marine Pollution Bulletin* 193:115108. https://doi.org/https://doi.org/10.1016/j.marpolbul.2023.115108

de Carvalho, R. H., Lacerda, P. D., da Silva Mendes, S., Barbosa, B. C., Paschoalini, M., Prezoto, F., & de Sousa, B. M. (2015). Marine debris ingestion by sea turtles (Testudines) on the Brazilian coast: an underestimated threat? *Marine Pollution Bulletin* 101(2):746-749. https://doi.org/https://doi.org/10.1016/j.marpolbul.2015.10.002

Department of the Air Force. (2025). *Final Environmental Impact Statement for Authorizing Changes to the Falcon Launch Program at Vandenberg Space Force Base, California. October 2025.* Department of the Air Force, Vandenberg Space Force Base, California.

DiMatteo, A., Roberts, J. J., Jones, D., Garrison, L., Hart, K. M., Kenney, R. D., McLellan, W. A., Lomac-MacNair, K., Palka, D., Rickard, M. E., Roberts, K. E., Zoidis, A. M., & Sparks, L. (2024). Sea turtle density surface models along the United States Atlantic coast. *Endangered Species Research* 53:227-245.

Dionne, P. E., Zydlewski, G. B., Kinnison, M. T., Zydlewski, J., & Wippelhauser, G. S. (2013). Reconsidering residency: characterization and conservation implications of complex migratory patterns of shortnose sturgeon (Acispenser brevirostrum). *Canadian Journal of Fisheries and Aquatic Sciences* 70(1):119-127.

Erickson, D. L. & Hightower, J. E. (2007). Oceanic distribution and behavior of green sturgeon. Pages 197 *in* American Fisheries Society Symposium. American Fisheries Society.

Esperon-Rodriguez, M. & Gallo-Reynoso, J. P. (2013). Juvenile and subadult feeding preferences of the Guadalupe fur seal (*Arctocephalus townsendi*) at San Benito Archipelago, Mexico. *Aquatic Mammals* 39(2):125-131.

Evermann, B. W. & Bean, B. A. (1898). Indian River and its Fishes. *Report U.S. Comm. Fish and Fisheries for 1896.*

FAA. (2024). *Revised Draft Tiered Environmental Assessment for SpaceX Starship/Super Heavy Vehicle Increased Cadence at the SpaceX Boca Chica Launch Site in Cameron County, Texas. 24 May 2024.*

Ferreira, J. P., Huang, Z., Nomura, K. i., & Wang, J. (2024). Potential ozone depletion from satellite demise during atmospheric reentry in the era of mega-constellations. *Geophysical Research Letters* 51(11):e2024GL109280.

FHWG, F. H. W. G. (2008). *Agreement in principle for interim criteria for injury to fish from pile driving activities.*

Fisher, W. K. (1928). Asteroidea of the North Pacific and adjacent waters. Pages 445 pp *in*. United States National Museum, Washington, D.C.

Foley, A. (1990). A Preliminary Investigation on Some Specific Aspects of Latex Balloon Degradation. *Florida Department of Natural Resources.*

Fourie, D., Hedgecock, I. M., De Simone, F., Sunderland, E. M., & Pirrone, N. (2019). Are mercury emissions from satellite electric propulsion an environmental concern?*. *Environmental Research Letters* 14(12):124021. https://doi.org/10.1088/1748-9326/ab4b75

Fox, D. A., Hightower, J. E., & Parauka, F. M. (2002). Estuarine and nearshore marine habitat use by Gulf sturgeon from the Choctawhatchee River system, Florida. Pages 111-126 *in* American Fisheries Society Symposium.

Garrison, L. P., Ortega-Ortiz, J., Rappucci, G., Aichinger-Dias, L., Mullin, K., & Litz, J. (2023a). *Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPS): marine mammals. Volume 2: appendix C: Gulf of Mexico marine mammal spatial density models.* New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management. , NOAA Southeast Fisheries Science Center, Miami, FL.

Garrison, L. P., Ortega-Ortiz, J., Rappucci, G., Aichinger-Dias, L., Mullin, K., & Litz, J. (2023b). *Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPS): marine mammals. Volume 3: appendix D: Gulf of Mexico sea turtle spatial density models.* New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management., NOAA Southeast Fisheries Science Center, Miami, FL.

Germanov, E. S., Marshall, A. D., Bejder, L., Fossi, M. C., & Loneragan, N. R. (2018). Microplastics: No Small Problem for Filter-Feeding Megafauna. *Trends in Ecology & Evolution* 33(4):227-232. https://doi.org/https://doi.org/10.1016/j.tree.2018.01.005

GESAMP. (2021). *Sea-based sources of marine litter*. IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.

Gravem, S. A., Heady, W. N., Saccomanno, V. R., Alvstad, K. F., Gehman, A. L. M., Frierson, T. N., & Hamilton, S. L. (2021). IUCN Red List of Threatened Species: *Pycnopodia helianthoides*. Pages 20 pp *in*. International Union for the Conservation of Nature.

Grunwald, C., Maceda, L., Waldman, J., Stabile, J., & Wirgin, I. (2008). Conservation of Atlantic sturgeon Acipenser oxyrinchus oxyrinchus: delineation of stock structure and distinct population segments. *Conservation Genetics* 9(5):1111-1124.

Gustafson, R. G., editor. (2016). *Status Review Update of Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segement*.

Haaker, P. L., Henderson, K. C., & Parker, D. O. (1986). California abalone. *in* California Fish and Game Marine Resources Leaflet No. 11. . California Department of Fish and Game, Marine Resources Division.

Haines, J. & Alexander, M. (1975). Microbial degradation of polyethylene glycols. *Applied Microbiology* 29(5):621-625.

Harrison, R. J. & Ridgway, S. H. (1981). *Handbook of marine mammals*, Academic Press.

Harwood, L. A., Smith, T. G., & Auld, J. C. (2012). Fall migration of ringed seals (Phoca hispida) through the Beaufort and Chukchi Seas, 2001—02. *Arctic*:35-44.

Hazel, J., Lawler, I., Marsh, H., & Robson, S. (2007a). Vessel speed increases collision risk for the green turtle Chelonia mydas. *Endangered Species Research* 3:105-113. https://doi.org/10.3354/esr003105

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

Hemery, L. G., Garavelli, L., Copping, A. E., Farr, H., Jones, K., Baker-Horne, N., Kregting, L., McGarry, L. P., Sparling, C., & Verling, E. (2024). Animal displacement from marine energy development: Mechanisms and consequences. *Science of the Total Environment* 917:170390.

Hemery, L. G., Marion, S. R., Romsos, C. G., Kurapov, A. L., Henkel, S. K., & Thuiller, W. (2016). Ecological niche and species distribution modelling of sea stars along the Pacific Northwest continental shelf. *Diversity and Distributions* 22(12):1314-1327. https://doi.org/10.1111/ddi.12490

Heublein, J. C., Kelly, J. T., Crocker, C. E., Klimley, A. P., & Lindley, S. T. (2009). Migration of green sturgeon, Acipenser medirostris, in the Sacramento River. *Environmental Biology of Fishes* 84(3):245-258.

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C. K., & Veirs, S. (2009). Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. *Journal of the Acoustical Society of America* 125(1):El27-El32.

Horai, S., Itai, T., Noguchi, T., Yasuda, Y., Adachi, H., Hyobu, Y., Riyadi, A. S., Boggs, A. S. P., Lowers, R., Guillette, L. J., & Tanabe, S. (2014). Concentrations of trace elements in American alligators (Alligator mississippiensis) from Florida, USA. *Chemosphere* 108:159-167. https://doi.org/https://doi.org/10.1016/j.chemosphere.2014.01.031

Horn, C., M. Karnauskas, J. C. Doerr, M. H. Miller, M. Neuman, R. Hill, & McCarthy, K. J. (2022). *Endangered species act status review report: Queen conch (Aliger gigas)*.

Huff, J. A. (1975). Life history of Gulf of Mexico sturgeon, Acipenser oxrhynchus desotoi, in Suwannee River, Florida.

Im, J., Joo, S., Lee, Y., Kim, B.-Y., & Kim, T. (2020). First record of plastic debris ingestion by a fin whale (Balaenoptera physalus) in the sea off East Asia. *Marine Pollution Bulletin* 159:111514. https://doi.org/https://doi.org/10.1016/j.marpolbul.2020.111514

Irwin, S. (2012). Mass Latex Balloon Releases and the Potential Effects on Wildlife.

Jacobsen, J. K., Falcone, E. A., Cerchio, S., & Cholewiak, D. ((In Press)). Population characteristics of humpback whales wintering at the Archipielago Revillagigedo, Mexican Pacific, 1996-2001.

Jacobsen, J. K., Massey, L., & Gulland, F. (2010). Fatal ingestion of floating net debris by two sperm whales (Physeter macrocephalus). *Marine Pollution Bulletin* 60(5):765-767. https://doi.org/https://doi.org/10.1016/j.marpolbul.2010.03.008

Keller, A. A., Horness, B. H., Fruh, E. L., Simon, V. H., Tuttle, V. J., Bosley, K. L., J. C. Buchanan, Kamikawa, D. J., & Wallace, J. R. (2008). The 2005 U.S. West Coast bottom trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition. Pages 153 pp *in*. National Oceanic and Atmospheric Administration.

King, T., Lubinski, B., & Spidle, A. (2001). Microsatellite DNA variation in Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) and cross-species amplification in the Acipenseridae. *Conservation Genetics* 2(2):103-119.

Kokkinakis, I. W. & Drikakis, D. (2022). Atmospheric pollution from rockets. *Physics of fluids* 34(5).

Laist, D. W. (1997). Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Pages 99-139 *in Marine debris: sources, impacts, and solutions*. Springer.

Lambert, P. (2000). *Sea Stars of British Columbia, Southeast Alaska, and Puget Sound*, UBC Press, Royal British Columbia Museum.

Lobelle, D. & Cunliffe, M. (2011). Early microbial biofilm formation on marine plastic debris. *Marine Pollution Bulletin* 62(1):197-200.

Lonsdale, J.-A. & Phillips, C. (2021). Space launches and the UK marine environment. *Marine Policy* 129:104479. https://doi.org/https://doi.org/10.1016/j.marpol.2021.104479

Luksenburg, J. & Parsons, E. (2009). *The effects of aircraft on cetaceans: implications for aerial whalewatching*. International Whaling Commission, SC/61/WW2.

Lutcavage, M. E. & Lutz, P. L. (2017). Diving physiology. Pages 277-296 *in The biology of Sea turtles, volume I*. CRC press.

Maloney, C. M., Portmann, R. W., Ross, M. N., & Rosenlof, K. H. (2022). The Climate and Ozone Impacts of Black Carbon Emissions From Global Rocket Launches. *Journal of Geophysical Research: Atmospheres* 127(12):e2021JD036373. https://doi.org/https://doi.org/10.1029/2021JD036373

Masuda, A. (2010). Natal Origin of Juvenile Loggerhead Turtles from Foraging Ground in Nicaragua and Panama Estimated Using Mitochondria DNA.

McCue, L. M., Fahy, C. C., Greenman, J., & Wilkinson, K. (2021). *Status Review of the Guadalupe Fur Seal (Arctocephalus townsendi)*. National Marine Fisheries Service, Protected Resources Division, West Coast Region, Long Beach, California.

Miller, M. H. (2018). Endangered Species Act status review report : chambered nautilus (Nautilus pompilius).

Morris, R. H., Abbott, D. P., & Haderlie, E. C. (1980). Intertidal invertebrates of California. *in* 1980. Stanford University Press, Stanford, California.

Murphy, D. M., Abou-Ghanem, M., Cziczo, D. J., Froyd, K. D., Jacquot, J., Lawler, M. J., Maloney, C., Plane, J. M. C., Ross, M. N., Schill, G. P., & Shen, X. (2023). Metals from spacecraft reentry in stratospheric aerosol particles. *Proceedings of the National Academy of Sciences* 120(43):e2313374120. https://doi.org/doi:10.1073/pnas.2313374120

Musick, J. A. & Limpus, C. J. (1997). Habitat utilization, and migration in juvenile sea turtles. Pages 137-163 *in* P. L. Lutz & J. A. Musick, editors. *The biology of sea turtles*. CRC Press, Boca Raton, Florida.

National Institute of Water and Atmospheric Research Ltd. (2017). *Ecological Risk Assessment of the impact of debris from space launches on the marine environment. Prepared for Ministry for the Environment.*

NMFS. (2010). Smalltooth sawfish (Pristis pectinata) 5-year review: summary and evaluation. *in N. O. A. A. National Marine Fisheries Service, Commerce*, editor. Protected Resources Division, St. Petersburg, FL.

NMFS. (2014). *Queen conch, Strombus gigas (Linnaeus 1758) status report*. National Marine Fisheries Service.

NMFS. (2015). Southern right whale (Eubalaena australis) 5-year Review: Summary and Evaluation. Pages 56 *in O. o. P. Resources*, editor, Silver Spring, MD.

NMFS. (2020). *Western Distinct Population Segment Steller sea lion (Eumetopias jubatus) 5-Year Review: Summary and Evaluation*. National Marine Fisheries Service, Protected Resources Division, Juneau, Alaska.

NMFS. (2024). *2024 Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA, Silver Spring, Maryland.

NMFS. (2025). National Marine Fisheries Service Endangered Species Act Section 7 Conference and Biological Opinion Reinitiation of the Conference and Biological Opinion on SpaceX 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 Authorized by the Federal Aviation Administration. https://doi.org/https://doi.org/10.25923/ps8h-x009

NMFS, USFWS, & SEMARNAT. (2010). Draft bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), second revision. *in*. National Marine Fisheries Service, U.S. Fish and Wildlife Service, and SEMARNAT, Silver Spring, Maryland.

Noren, D. P., Johnson, A. H., Rehder, D., & Larson, A. (2009). Close approaches by vessels elicit surface active behaviors by southern resident killer whales. *Endangered Species Research* 8(3):179–192.

Patenaude, N. J., Richardson, W. J., Smultea, M. A., Koski, W. R., Miller, G. W., Wursig, B., & Greene, C. R. (2002a). Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. *Marine Mammal Science* 18(2):309-335.

Patenaude, N. J., Richardson, W. J., Smultea, M. A., Koski, W. R., Miller, G. W., Würsig, B., & Greene Jr, C. R. (2002b). Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. *Marine Mammal Science* 18(2):309-335.

Pegram, J. E. & Andrady, A. L. (1989). Outdoor weathering of selected polymeric materials under marine exposure conditions. *Polymer degradation and stability* 26(4):333-345.

Poulakis, G. & Seitz, J. (2004). Recent occurrence of the smalltooth sawfish, Pristis pectinata (Elasmobranchiomorphi: Pristidae), in Florida Bay and the Florida Keys, with comments on sawfish ecology. *Florida Scientist* 67(1):27-35.

Poulakis, G. R., Stevens, P. W., Timmers, A. A., Wiley, T. R., & Simpfendorfer, C. A. (2011). Abiotic affinities and spatiotemporal distribution of the endangered smalltooth sawfish, Pristis pectinata, in a south-western Florida nursery. *Marine and Freshwater Research* 62(10):1165-1177.

Quattro, J., Greig, T., Coykendall, D., Bowen, B., & Baldwin, J. (2002). Genetic issues in aquatic species management: the shortnose sturgeon (Acipenser brevirostrum) in the southeastern United States. *Conservation Genetics* 3(2):155-166.

Record, N. R., Runge, J. A., Pendleton, D. E., Balch, W. M., Davies, K. T., Pershing, A. J., Johnson, C. L., Stamieszkin, K., Ji, R., & Feng, Z. (2019). Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. *Oceanography* 32(2):162-169.

Ribeiro Guimaraes Dombroski, J. (2023). MANATEES AND NOISE: INDIVIDUAL EXPOSURE AND BEHAVIORAL RESPONSES TO DISTURBANCE.

Richardson, W. J., Greene, C. R. J., Malme, C. I., & Thomson, D. H. (1995). *Marine mammals and noise*, Academic Press, San Diego, CA.

Richter, C. F., Dawson, S., & Slooten, E. (2003a). *Sperm whale watching off Kaikoura, New Zealand: effects of current activities on surfacing and vocalisation patterns*, volume 219. Department of Conservation Wellington.

Richter, C. F., Dawson, S. M., & Slooten, E. (2003b). Sperm whale watching off Kaikoura, New Zealand: Effects of current activities on surfacing and vocalisation patterns. *Science for Conservation* 219.

Roberts, J. J., Best, B. D., Mannocci, L., Fujioka, E., Halpin, P. N., Palka, D. L., Garrison, L. P., Mullin, K. D., Cole, T. V. N., Khan, C. B., McLellan, W. A., Pabst, D. A., & Lockhart, G. G. (2016). Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. *Scientific Reports* 6(1):22615. https://doi.org/10.1038/srep22615

Roberts, J. J., Mack, T. M., & Halpin, P. N. (2023). *Marine mammal density models for the U.S. Navy Atlantic Fleet Training and Testing (AFTT) study area for the Phase IV Navy Marine Species Density Database (NMSDD)*.

Roberts, J. J., Yack, T. M., Fujioka, E., Halpin, P. N., Baumgartner, M. F., Boisseau, O., Chavez-Rosales, S., Cole, T. V. N., Cotter, M. P., Davis, G. E., DiGiovanni, R. A., Jr., Ganley, L. C., Garrison, L. P., Good, C. P., Gowan, T. A., Jackson, K. A., Kenney, R. D., Khan, C. B., Knowlton, A. R., Kraus, S. D., Lockhart, G. G., Lomac-MacNair, K. S., Mayo, C. A., McKenna, B. E., McLellan, W. A., Nowacek, D. P., O'Brien, O., Pabst, D. A., Palka, D. L., Patterson, E. M., Pendleton, D. E., Quintana-Rizzo, E., Record, N. R., Redfern, J. V., Rickard, M. E., White, M., Whitt, A. D., & Zoidis, A. M. (2024). North Atlantic right whale density surface model for the US Atlantic evaluated with passive acoustic monitoring. *Marine Ecology Progress Series* 732:167-192.

Rodríguez, Y., Vandeperre, F., Santos, M. R., Herrera, L., Parra, H., Deshpande, A., Bjorndal, K. A., & Pham, C. K. (2022). Litter ingestion and entanglement in green turtles: An analysis of two decades of stranding events in the NE Atlantic. *Environmental Pollution* 298:118796. https://doi.org/https://doi.org/10.1016/j.envpol.2022.118796

Roman, L., Schuyler, Q., Wilcox, C., & Hardesty, B. D. (2021). Plastic pollution is killing marine megafauna, but how do we prioritize policies to reduce mortality? *Conservation Letters* 14(2):e12781. https://doi.org/https://doi.org/10.1111/conl.12781

Rosel, P. E., Wilcox, L. A., Yamada, T. K., & Mullin, K. D. (2021). A new species of baleen whale (Balaenoptera) from the Gulf of Mexico, with a review of its geographic distribution. *Marine Mammal Science* 37(2):577-610.

Ross, M. N., Danilin, M. Y., Weisenstein, D. K., & Ko, M. K. W. (2004). Ozone depletion caused by NO and H2O emissions from hydrazine-fueled rockets. *Journal of Geophysical Research: Atmospheres* 109(D21). https://doi.org/https://doi.org/10.1029/2003JD004370

Ross, S. T., Slack, W. T., Heise, R. J., Dugo, M. A., Rogillio, H., Bowen, B. R., Mickle, P., & Heard, R. W. (2009). Estuarine and coastal habitat use of Gulf sturgeon (Acipenser oxyrinchus desotoi) in the north-central Gulf of Mexico. *Estuaries and Coasts* 32(2):360-374.

Rugh, D. J. & Shelden, K. E. W. (2009). Bowhead whale, *Balaena mysticetus*. Pages 131-133 *in* W. F. Perrin, B. Wursig, & J. G. M. Thewissen, editors. *Encyclopedia of Marine Mammals*, Second edition. Academic Press, San Diego.

Ryan, R. G., Marais, E. A., Balhatchet, C. J., & Eastham, S. D. (2022). Impact of rocket launch and space debris air pollutant emissions on stratospheric ozone and global climate. *Earth's Future* 10(6):e2021EF002612.

Schmid, J. R. (1998). Marine turtle populations on the west-central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986-1995. *Fishery Bulletin* 96(3):589-602.

Schueller, P. & Peterson, D. L. (2010). Abundance and Recruitment of Juvenile Atlantic Sturgeon in the Altamaha River, Georgia. *Transactions of the American Fisheries Society* 139(5):1526-1535. https://doi.org/10.1577/t09-127.1

Schulze-Haugen, M., Corey, T., & Kohler, N. E. (2003). *Guide to sharks, tunas & billfishes of the US Atlantic & Gulf of Mexico*, Rhode Island Sea Grant, University of Rhode Island.

Schuyler, Q., Hardesty, B. D., Wilcox, C., & Townsend, K. (2014). Global Analysis of Anthropogenic Debris Ingestion by Sea Turtles. *Conservation Biology* 28(1):129-139. https://doi.org/https://doi.org/10.1111/cobi.12126

Scott, W. & Scott, M. (1988). Atlantic fishes of Canada Canadian Bulletin of Fisheries and Aquatic Science, 219. *in*. University of Toronto Press, Toronto, Canada.

Seitz, J. & Poulakis, G. R. (2002). Recent occurrence of sawfishes (Elasmobranchiomorphi: Pristidae) along the southwest coast of Florida (USA). *Florida Scientist* 65(4):256-266.

Seminoff, J. A., Allen, C. A., Balazs, G. H., Dutton, P. H., Eguchi, T., Haas, H. L., Hargrove, S. A., Jensen, M., Klemm, D. L., Lauritsen, A. M., MacPherson, S. L., Opay, P., Possardt, E. E., Pultz, S., Seney, E., Houtan, K. S. V., & Waples, R. S. (2015). *Status reviw of the green turtle (Chelonia mydas) under the Endnagered Species Act*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Seminoff, J. A., Eguchi, T., Carretta, J., Allen, C. D., Prosperi, D., Rangel, R., Gilpatrick, J. W., Forney, K., & Peckham, S. H. (2014). Loggerhead sea turtle abundance at a foraging hotspot in the eastern Pacific Ocean: Implications for at-sea conservation. *Endangered Species Research* 24(3):207-220. https://doi.org/10.3354/esr00601

Shoop, C. R. & Kenney, R. D. (1992). Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. *Herpetological Monographs* 6:43-67.

Simpfendorfer, C., Poulakis, G., O'Donnell, P., & Wiley, T. (2008). Growth rates of juvenile smalltooth sawfish Pristis pectinata Latham in the western Atlantic. *Journal of fish biology* 72(3):711-723.

Simpfendorfer, C. A., Yeiser, B. G., Wiley, T. R., Poulakis, G. R., Stevens, P. W., & Heupel, M. R. (2011). Environmental influences on the spatial ecology of juvenile smalltooth sawfish (Pristis pectinata): results from acoustic monitoring. *PLOS ONE* 6(2):e16918.

Smith, T. I. (1985). The fishery, biology, and management of Atlantic sturgeon, Acipenser oxyrhynchus, in North America. *Environmental Biology of Fishes* 14(1):61-72.

Smultea, M. A., Mobley, J. J. R., Fertl, D., & Fulling, G. L. (2008a). An unusual reaction and other observations of sperm whales near fixed-wing aircraft. *Gulf and Caribbean Research* 20:75–80.

Smultea, M. A., Mobley Jr, J. R., Fertl, D., & Fulling, G. L. (2008b). An unusual reaction and other observations of sperm whales near fixed-wing aircraft. *Gulf and Caribbean Research* 20(1):75-80.

Solé, M., Kaifu, K., Mooney, T. A., Nedelec, S. L., Olivier, F., Radford, A. N., Vazzana, M., Wale, M. A., Semmens, J. M., Simpson, S. D., Buscaino, G., Hawkins, A., Aguilar de Soto, N., Akamatsu, T., Chauvaud, L., Day, R. D., Fitzgibbon, Q., McCauley, R. D., & André, M. (2023). Marine invertebrates and noise. *Frontiers in Marine Science* 10. https://doi.org/10.3389/fmars.2023.1129057

Stein, A. B., Friedland, K. D., & Sutherland, M. (2004). Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. *Transactions of the American Fisheries Society* 133(3):527-537.

Sulak, K. & Clugston, J. (1999). Recent advances in life history of Gulf of Mexico sturgeon, Acipenser oxyrinchus desotoi, in the Suwannee River, Florida, USA: a synopsis. *Journal of Applied Ichthyology* 15(4-5):116-128.

TEWG. (2000). Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. *NOAA Technical Memorandum NMFS-SEFSC-444*.

Thompson, R. C., Olsen, Y., Mitchell, R. P., Davis, A., Rowland, S. J., John, A. W., McGonigle, D., & Russell, A. E. (2004). Lost at sea: where is all the plastic? *Science* 304(5672):838-838.

Tutschulte, T. C. (1976). The comparative ecology of three sympatric abalones. *Doctoral dissertation. University of California, San Diego.*

U.S. Air Force Research Laboratory. (2000). *Supersonic aircraft noise at and beneath the ocean surface: estimate of risk for effects on marine mammals.*

U.S. Department of the Navy. (2024a). *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis (Phase 4)*. Naval Information Warfare Center, Pacific, San Diego, CA.

U.S. Department of the Navy. (2024b). *U.S. Navy Marine Species Density Database Phase IV for the Hawaii-California Training and Testing Study Area.* U.S. Pacific Fleet Envrionmental Readiness Division, Pearl Harbor, HI.

USSF. (2026). *Annual Report National Marine Fisheries Service Letter of Authorization: Taking Marine Mammals Incidental to U.S. Space Force Launches and Operations at Vandenberg Space Force Base, California 01 JAN to 31 DEC 2025*. U.S. Space Force, Space Launch Delta 30, Vandenberg Space Force Base, CA.

Vladykov, V. D. & Greeley, J. R. (1963). Order Acipenseroidei. Pages 24-60 in Fishes of the Western North Atlantic. *Memoir Sears Foundation for Marine Research 1 (part III)*.

Von Duyke, A. L., Douglas, D. C., Herreman, J. K., & Crawford, J. A. (2020). Ringed seal (Pusa hispida) seasonal movements, diving, and haul-out behavior in the Beaufort, Chukchi, and Bering Seas (2011–2017). *Ecology and Evolution* 10(12):5595-5616. https://doi.org/https://doi.org/10.1002/ece3.6302

Waldman, J., Grunwald, C., Stabile, J., & Wirgin, I. (2002). Impacts of life history and biogeography on the genetic stock structure of Atlantic sturgeon Acipenser oxyrinchus oxyrinchus, Gulf sturgeon A. oxyrinchus desotoi, and shortnose sturgeon A. brevirostrum. *Journal of Applied Ichthyology* 18(4-6):509-518.

Waring, G. T. & et al. (2016). US Atlantic and Gulf of Mexico marine mammal stock assessments - 2015. https://doi.org/http://doi.org/10.7289/V57S7KTN

Werth, A. J., Kahane-Rapport, S. R., Potvin, J., Goldbogen, J. A., & Savoca, M. S. (2024). Baleen–Plastic Interactions Reveal High Risk to All Filter-Feeding Whales from Clogging, Ingestion, and Entanglement. *Oceans* 5(1):48-70.

Wilcox, C., Puckridge, M., Schuyler, Q. A., Townsend, K., & Hardesty, B. D. (2018). A quantitative analysis linking sea turtle mortality and plastic debris ingestion. *Scientific Reports* 8(1):12536. https://doi.org/10.1038/s41598-018-30038-z

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D. L., & Waldman, J. (2005). Range-wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of the mitochondrial DNA control region. *Estuaries* 28(3):406-421.

Würsig, B., Lynn, S., Jefferson, T., & Mullin, K. (1998). Behavior of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. *Aquatic Mammals* 24.

Ye, S. & Andrady, A. L. (1991). Fouling of floating plastic debris under Biscayne Bay exposure conditions. *Marine Pollution Bulletin* 22(12):608-613.

Young, C. N., Carlson, J., Hutchinson, M., Hutt, C., Kobayashi, D., McCandless, C.T., Wraith, J. (2016). Status Review Report: oceanic whitetip shark (*Carcharhinius longimanus*). Final report to the National Marine Fisheries Service, Office of Protected Resourses.:162.

APPENDIX A – PROJECT-SPECIFIC REVIEW CHECKLIST

This checklist may be used to determine whether a proposed projects falls under the scope of the space launch and reentry programmatic consultation and therefore does not require a project-specific review. A project-specific review is not required if the activities conducted are as described in the programmatic consultation's proposed action, occur within the action area, and comply with all relevant PDCs (see Proposed Action and Action Area).

Examples of when an action agency might need to coordinate a project-specific review include: operations using a new launch site, construction of a new launch site, a new launch or reentry vehicle that does not fall under the vehicle envelopes as described in the proposed action, vessels, tugs, or droneships that do not fall under the vessel specifications as described in the proposed action, substantial changes in technology or operations, or when activities will not occur within the action area, or cannot fully comply with the applicable PDCs.

When evaluating whether a project satisfies the requirements of this programmatic, the action agency should consider all activities of the proposed action and effects caused by proposed action. The action agency should also consider all areas where activities will occur, including pre-flight activities (e.g., vessels, aircraft, launch site, etc.), in-flight impacts (e.g. sonic booms, expended stages, components, or debris, etc.), and recovery operations (e.g., vessels, debris salvage, barge landings, etc.). In other words, the areas to be considered should include all areas that may be affected, directly or indirectly, by the project and not merely the immediate area of the launch or landing (see 50 CFR §402.02).

If an action agency has any uncertainty that a proposed activity falls within the scope of this programmatic consultation or needs a project-specific review, they should contact the NMFS Office of Protected Resources ESA Interagency Cooperation Division. Project-specific review requests should be sent by email to nmfs.hq.esa.consultations@noaa.gov with the subject line "Project Specific Review Request OPR-2025-02196 Space Launch and Reentry Program" and include the following information: a project description that details the proposed operations, including details on the activities that the action agency identified do not fall under this programmatic or are unsure whether they fall under this programmatic, where and when the activities will occur, the number or frequency of the proposed operations, any PDCs that may not be fully implemented, any proposed changes to those PDCs, or additional measures, and determination of effects to ESA-listed species and critical habitat that could result from the project. Requests for a project-specific review should be submitted at least six months in advance of the proposed activity to allow time for completion of a formal ESA section 7 consultation if one is required.

General requirements for projects that fall within the scope of the space launch and reentry programmatic consultation, as described in the Proposed Action and Action Area section (see section for details):

- ☐ The Federal action is one of the following:
    1. FAA commercial space transportation license or permit for launch or reentry operations: license to operate a launch site, license to operate a reentry site, experimental permit, or vehicle operator license;

2. USSF authorization for launch operations at CCSFS or VSFB (non-FAA-licensed operations); or
3. NASA authorization for launch operations at KSC or WFF (non-FAA-licensed operations).

- ☐ The proposed activities must be within the following parameters, and adhere to the listed requirements:
  1. Weather balloon deployment
     - ☐ Five to 15 weather balloon deployments per launch
     - ☐ Radiosonde, which does not use a parachute
  - ☐ Pre-launch vessel or aircraft surveillance
     - ☐ Surveillance vessels up to a maximum of 200 ft (61 m) in length
  - ☐ Launches
     - ☐ Launches occur only at launch sites listed in Table 1
     - ☐ Launch vehicles adhere to the launch vehicle specifications in Table 2, and do not exceed a total engine thrust of 6.5 million lbs or generate sonic booms over 50 psf during ascent or landing
  - ☐ Launch abort tests
     - ☐ Launch abort tests only occur in the Atlantic Zone 2 (see Figure 5)
  - ☐ Launch failure or anomalies
  - ☐ Expended stages, components, or debris
     - ☐ Launch vehicles of a maximum size as listed in Table 2
     - ☐ Reentry vehicles of a maximum size of 30 ft (9.1 m) in length and 15 ft (4.6 m) in diameter
     - ☐ Fairings of a maximum size of 75 ft (22.9 m) in length and 30 ft (9.1 m) in diameter
     - ☐ Components of a maximum size of 15 ft by 15 ft by 15 ft (4.6 m by 4.6 m by 4.6 m)
     - ☐ Interstage adapters of a maximum size of 15 ft (4.6 m) in length and 23 ft (7 m) in diameter
     - ☐ Debris of smaller size than stages, components, and interstage adapters.
  - ☐ Explosive events
     - ☐ Occur at minimum 11 ft (3.4 m) above the surface of the ocean
     - ☐ Explosive weight (calculated from the amount of remaining propellant and its explosive yield) will not exceed 55,800 kilograms (123,018 lbs)
     - ☐ Explosive events will only occur in the Atlantic portion of the action area at least 100 mi (160.9 km) from any major land mass (see Figure 5)
  - ☐ Reentries
     - ☐ Reentry vehicles adhere to the reentry vehicle specifications of a maximum size of 30 ft (9.1 m) in length and 15 ft (4.6 m) in diameter, and do not generate sonic booms of over 3 psf
  - ☐ Recovery of stages, components, or debris
     - ☐ Reentry vehicles of a maximum size of 30 ft (9.1 m) in length and 15 ft (4.6 m) in diameter
     - ☐ Fairings of a maximum size of 75 ft (22.9 m) in length and 30 ft (9.1 m) in diameter
     - ☐ Barges and droneships up to a maximum of 400 ft (122 m) in length

- ☐ Vessels and tugs up to a maximum of 200 ft (61 m) in length
- ☐ Drogue parachutes do not exceed 200 ft^2 (18.6 m^2) in size and do not exceed a suspension line length of 75 ft (22 m)
- ☐ Parafoils do not exceed 3,000 ft^2 (278.7 m^2) in size and do not exceed a suspension line length of 50 ft (15.2 m)
- ☐ Main parachutes do not exceed 10,600 ft^2 (984.8 m^2) in size and do not exceed a suspension line length of 150 ft (45.7 m)
- ☐ Pilot parachutes do not exceed 13.5 ft (4.1 m) in diameter, do not exceed a suspension line length of 8.75 ft (2.7 m), and are only used for the new SpaceX capsule

☐ All activities will occur within the action area as described in the programmatic and the area-based PDCs (see section below). No operations except vessel and aircraft transit will occur outside the areas depicted in Figures 1–11

☐ Only vessel or aircraft transit will occur within 5 NM of the U.S. coast (vessel transit will not occur in other countries' waters)

☐ Nothing will be expended or disposed of over coral reef areas

☐ No operations will occur in a National Marine Sanctuary, or affect National Marine Sanctuary resources, without the appropriate authorization, permit, or consultation

☐ If there is a launch failure, operators will follow their emergency response cleanup procedures

☐ All personnel associated with space launch and reentry operations will understand the ESA-listed species and critical habitat, and MMPA-protected species, that may be present in the operating area

☐ All vessel operators will look out for and attempt to avoid collision with ESA-listed and MMPA-protected species

☐ A dedicated observer, who can recognize ESA-listed and MMPA-protected species, will be on board for all vessel activity and monitor for ESA-listed and MMPA-protected species

☐ The dedicated observer will a) alert the vessel operators to implement the appropriate vessel speed restrictions and vessel avoidance measures, and b) gather relevant data on ESA-listed and MMPA-protected species including date, time, GPS location, species, number of animals, distance and bearing from the vessel, direction of travel, behavior, effects to the animals from space launch and reentry operations, any effects including injury and mortality observed in launch, landing, or recovery areas, and other relevant information

☐ When an ESA-listed or MMPA-protected species is observed, the vessel will:

- ☐ Maintain a minimum distance of 150 ft (45.7 m) from sea turtles
- ☐ Maintain a minimum distance of 300 ft (91.4 m) from all other ESA-listed and MMPA-protected species
- ☐ If the distance from the vessel to the ESA-listed or MMPA-protected species becomes less than the distance specified in these PDCs, reduce vessel speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area and transit route
- ☐ Reduce vessel speed to 10 knots or less when mother/calf pairs or groups (more than two individuals) of marine mammals are observed

- ☐ Attempt to remain parallel to (e.g., when animals are bow-riding), or move the vessel away from, an ESA-listed or MMPA-protected species' course while the vessel is in transit and avoid excessive speed or abrupt changes in direction until the animal(s) have left the area or transit route
- ☐ Aircraft will maintain a minimum height of 1,000 ft (304.8 m) above ESA-listed or MMPA-protected species and avoid flying in circles, or other types of harassing behaviors, above them
- ☐ Any ESA-listed or MMPA-protected species collision(s), injury(ies), mortality(ies), entanglement(s), or stranding(s) will be reported immediately to the appropriate contacts
- ☐ Action agencies will report annually on the nature of their activities, as covered under this programmatic consultation, including but not limited to locations of the activities, effects to ESA-listed species and critical habitat, implementation of PDCs, and implementation of conservation recommendations

Additional requirements for projects that occur in the Pacific Ocean (see Figure 2, Figure 3, and associated shapefiles for confirmation), as described in the Proposed Action and Action Area section (see section for details):

- ☐ Operations in Zone 2 are limited to the number of maximum annual operations described in Table 3
- ☐ Operations in Zone 3a are limited to vessel transit only from December 1 through April 30
- ☐ Operations in Zone 4 are limited to vessel transit and barge landings only
- ☐ No operations will occur around Isla Guadalupe and surrounding waters
- ☐ No operations will occur over areas with sea ice cover off Alaska
- ☐ Steller sea lion critical habitat in:
  - Alaska
    - ☐ No operations will occur within the aquatic zone that extends 20 NM (37 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery and major haulout that is west of 144° W longitude
    - ☐ No operations will occur within the aquatic zone that extends 3,000 ft (0.9 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery and major haulout in Alaska east of 144° W longitude
    - ☐ No operations will occur within the air zone that extends 3,000 ft (0.9 km) above the terrestrial zone of each major rookery and major haulout in Alaska (measured vertically from sea level)
    - ☐ No vessel operations will occur within 3 NM (5.6 km) of all Steller sea lion rookeries west of 150° W longitude
    - ☐ In the unlikely event that debris is expected to occur over or land within the air or aquatic critical habitat zones, debris should be monitored and cleaned up if in the water. If debris lands within 3 NM (5.6 km) of a rookery west of 150° W longitude, or if debris occurs on a major rookery or major haulout (i.e., on land), notify the appropriate contacts
  - California and Oregon

- ☐ No operations will occur in an aquatic zone that extends 3,000 ft (0.9 km) seaward from major rookeries
- ☐ No operations will occur in an air zone that extends 3,000 ft (0.9 km) above the terrestrial zone of major rookeries (measured vertically from sea level)

Additional requirements for projects that occur in the Gulf (see Figure 4 and associated shapefiles for confirmation), as described in the Proposed Action and Action Area section (see section for details):

- ☐ Operations in Zone 2 are limited to the number of maximum annual operations described in Table 3
- ☐ Operations in Zone 3 are limited to vessel transit only
- ☐ No operations will occur within Rice's whale core distribution area
- ☐ No operations will occur within 20 NM (37 km) of the Flower Garden Banks National Marine Sanctuary and the Florida Keys National Marine Sanctuary or listed coral reef areas
- ☐ Vessels will slow to 10 knots or less and maintain a minimum distance of 1,500 ft (457.2 m) from Rice's whale. 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
- ☐ Vessels will maintain speeds to 10 knots or less in Rice's whale proposed critical habitat

Additional requirements for projects that occur in the Atlantic Ocean (see Figure 5, Figure 6, and associated shapefiles for confirmation), as described in the Proposed Action and Action Area section (see section for details):

- ☐ Operations in Zone 2 are limited to the number of maximum annual operations described in Table 3
- ☐ Operations in Zone 3b are limited to vessel transit only, from November 1 through April 30
- ☐ Operations in Zone 3c are limited to vessel transit only, from January 1 through July 31
- ☐ Operations in Zone 5 (off North Carolina and Florida) will not include any disposals or expended stages, expended components, or debris
- ☐ Operations in Zone 5a will not include any disposals or expended stages, expended components, or debris between November 1 through April 30
- ☐ Operations in Zone 5b will not include any disposals or expended stages, expended components, or debris between April 1 through November 30
- ☐ Vessels will slow to 10 knots or less and maintain a minimum distance of 1,500 ft (457.2 m) from North Atlantic right whales
- ☐ Vessels will comply with the Right Whale Ship Strike Reduction Rule and reduce speeds to 10 knots or less in Seasonal Management Areas or in Right Whale Slow Zones
- ☐ Check various communication media for general information regarding avoiding vessel strikes and specific information regarding North Atlantic right whale sightings in the area. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners
- ☐ Aircraft will maintain a baseline minimum height of 1,500 ft (457.2 m) above North Atlantic right whales

- ☐ Launch abort tests will not occur in designated critical habitat for the North Atlantic right whale, Seasonal Management Areas, or Slow Zones, and will not occur between November 1 through April 30

Additional requirements for projects that occur in the Caribbean (see Figure 7 and associated shapefiles for confirmation), as described in the Proposed Action and Action Area section (see section for details):

- ☐ Operations in Zone 4 are limited to vessel transit and barge landings only
- ☐ Operations in the Exuma Sound are limited to vessel transit, barge landings, and fairing recoveries

Appendix B – Annual Reporting Form

See Excel sheet AppendixB_OPR-2025-02196_AnnualReportingForm