NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title:	Biological Opinion on the Bureau of Ocean Energy Management's Proposal to Fund a Study on the Behavioral and Spatial Ecology of the Threatened Giant Manta Ray (*Mobula birostris,* formerly *Manta birostris*)
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
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1 INTRODUCTION

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

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

The action agency for this consultation is the Bureau of Ocean Energy Management (BOEM). BOEM proposes to fund research activities on the behavioral and spatial ecology of the giant manta ray (*Mobula birostris,* formerly *Manta birostris*).

This consultation, opinion, and incidental take statement, were completed in accordance with section 7(a)(2) of the statute (16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§401-16), and agency policy and guidance was conducted by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we"). This opinion and incidental take statement were prepared by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division in accordance with section 7(b) of the ESA and implementing regulations at 50 C.F.R. §402.

This document represents the NMFS opinion on the effects of these actions on giant manta ray, smalltooth sawfish (*Pristis pectinata*), North Atlantic distinct population segment (DPS) green turtle (*Chelonia mydas*), Northwestern Atlantic DPS loggerhead sea turtle (*Caretta caretta*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*), hawksbill sea turtle (*Eretmochelys imbricata*), North Atlantic right whale (*Eubalaena glacialis*), and designated critical habitat for North Atlantic right whale, and Northwestern Atlantic DPS loggerhead sea turtle. A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

BOEM oversees conventional and renewable energy and marine mineral resources on the nation's Outer Continental Shelf (OCS). BOEM sponsors environmental and socioeconomic studies needed to understand and manage the environmental impacts caused by offshore energy and marine minerals activities.

The range of the giant manta ray overlaps spatially and temporally with activities conducted in association with BOEM's authorization for use of OCS sand resources in support of coastal restoration projects. Giant manta ray have been occasionally observed in the vicinity of dredging activities conducted offshore and anecdotal reports suggest the potential risk for incidental capture (non-lethal) in association with relocation trawling operations conducted in front of the dredge to mitigate risk of interaction with protected sea turtles. The fine scale movements and behavior of giant manta ray relative to dredging activities and relocation trawling interactions is largely unknown. BOEM is funding this research to increase understanding of giant manta ray movements, better describe the potential risk of interaction, and determine how to reduce risk of interaction with dredging and relocation trawling activities. The research will occur in the Cape Canaveral Shoals region offshore Florida. The study will leverage existing data sets collected by government, academia, and non-governmental organizations. Additional telemetry data collected as a component of this research will improve fine-scale and site-specific information. BOEM will use these data to inform future decisions and mitigation strategies.

1.2 Consultation History

This opinion is based on information provided in the biological assessment (BA) BOEM prepared for this consultation (BOEM 2021). Our communication with the BOEM regarding this consultation is summarized as follows:

- **August 19, 2021**: BOEM submitted initiation materials to the NMFS Southeast Region Office
- **September 30, 2021**: The consultation was transferred to the NMFS Office of Protected Resources in Silver Spring, Maryland
- **October 7, 2021**: The ESA Interagency Cooperation Division determined the initiation package was complete and initiated consultation with BOEM as of September 30, 2021.

2 THE ASSESSMENT FRAMEWORK

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

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

This ESA section 7 consultation involves the following steps:

Description of the Proposed Action (Section 3): We describe the proposed action and those aspects (or stressors) of the proposed action that may have effects on the physical, chemical, and biotic environment. This section also includes the avoidance and minimization measures that have been incorporated into the project to reduce the effects to ESA-listed species.

Action Area (Section 4): We describe the action area with the spatial extent of the stressors from the action.

Endangered Species Act-Listed Species and Proposed or Designated Critical Habitat Present in the Action Area (Section 5): We identify the ESA-listed species and designated critical habitat that are likely to co-occur with the stressors produced by the proposed action in space and time.

Potential Stressors (Section 6): We identify the stressors that could occur as a result of the proposed action and affect ESA-listed species and designated critical habitat. We include a section (Section 7.1) for stressors that are not likely to adversely affect the species that are analyzed further in this opinion.

We also identify those *Species and Critical Habitat Not Likely to be Adversely Affected* (Section 7) and detail our effects analysis for these species and critical habitats (Sections 7.2 and 7.3).

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

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

Effects of the Action (Section 10): We evaluate the effects of the action on ESA-listed species and designated critical habitat. Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. These are broken into analyses of exposure, response, and risk, as described below for the species that are likely to be adversely affected by the action.

Exposure, Response, and Risk Analyses (Section 10.2, 10.3, and 10.4): We identify the number, age (or life stage), and sex of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. We also identify the unit(s) of designated critical habitat that are likely to be exposed. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how designated critical habitat in terms of changes in function. This is our response analysis (Section 10.3). We assess the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. We also assess the consequences of responses of critical habitat to the critical habitat unit(s) and how changes in function may affect the conservation value of designated critical habitat. This is our risk analysis (Section 10.4).

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

Integration and Synthesis (Section 12): We integrate and synthesize by adding the effects of the action and cumulative effects to the environmental baseline in full consideration of the status of the species and critical habitat likely to be adversely affected, to formulate our opinion as to whether the action would reasonably be expected to:

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

The results of our jeopardy and destruction and adverse modification analyses are summarized in the *Conclusion* (Section 13). If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify Reasonable and Prudent Alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (see 50 C.F.R. §402.14(h)(3)).

An *Incidental Take Statement* (Section 14) is included for those actions for which take of ESA-listed species is reasonably certain to occur in keeping with the revisions to the regulations specific to ITSs (80 FR 26832, May 11, 2015: ITS rule). The ITS specifies the impact of the take, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures (ESA section 7 (b)(4); 50 C.F.R. §402.14(i)).

We also provide discretionary *Conservation Recommendations* (Section 15) that may be implemented by action agency (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which *Reinitiation of Consultation* (Section16) is required (50 C.F.R. §402.16).

2.1 Evidence Available for the Consultation

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

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

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

3 DESCRIPTION OF THE PROPOSED ACTION

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies.

BOEM proposes to fund a study on the behavior and spatial ecology of giant manta rays off the Atlantic coast of Florida near Cape Canaveral. The purpose of this study is to understand how movements and site fidelity of giant manta ray affect the risk of the species interacting with marine mineral extraction and/or associated mitigation activities (e.g., relocation trawling). This study is a cooperative agreement between BOEM and Georgia Aquarium, Incorporated (GAI). The proposed study includes aerial and in-water components to achieve the overall study objectives.

The information presented here is based primarily on the BA provided by BOEM as part of the initiation package (BOEM 2021).

3.1 Proposed Activities

In order to achieve the research objectives, BOEM and GAI will conduct aerial and vessel surveys, and will capture, sample, and attach tags to giant manta rays.

3.1.1 Duration and Timing of Research

Fieldwork would be conducted in the late spring and early summer (March to July) of 2022, most likely in one or two 10-to-14-day increments, when giant manta rays are known to occur in the study area.

3.1.2 Aerial Surveys

Aerial surveys would be conducted within the action area from the Spruce Creek Airport in Florida (west of Ponce Inlet) to the vicinity of Melbourne, Florida, to identify giant manta ray abundance and distribution. Incidental sightings of other protected species such as sea turtles would also be recorded. Surveys are standardized and flown 1.5 miles offshore heading south and turning around north of Melbourne and flown about 0.5 miles offshore heading back north. To comply with private Canaveral airspace requirements, the aircraft would travel 3 miles offshore (Figure 1).

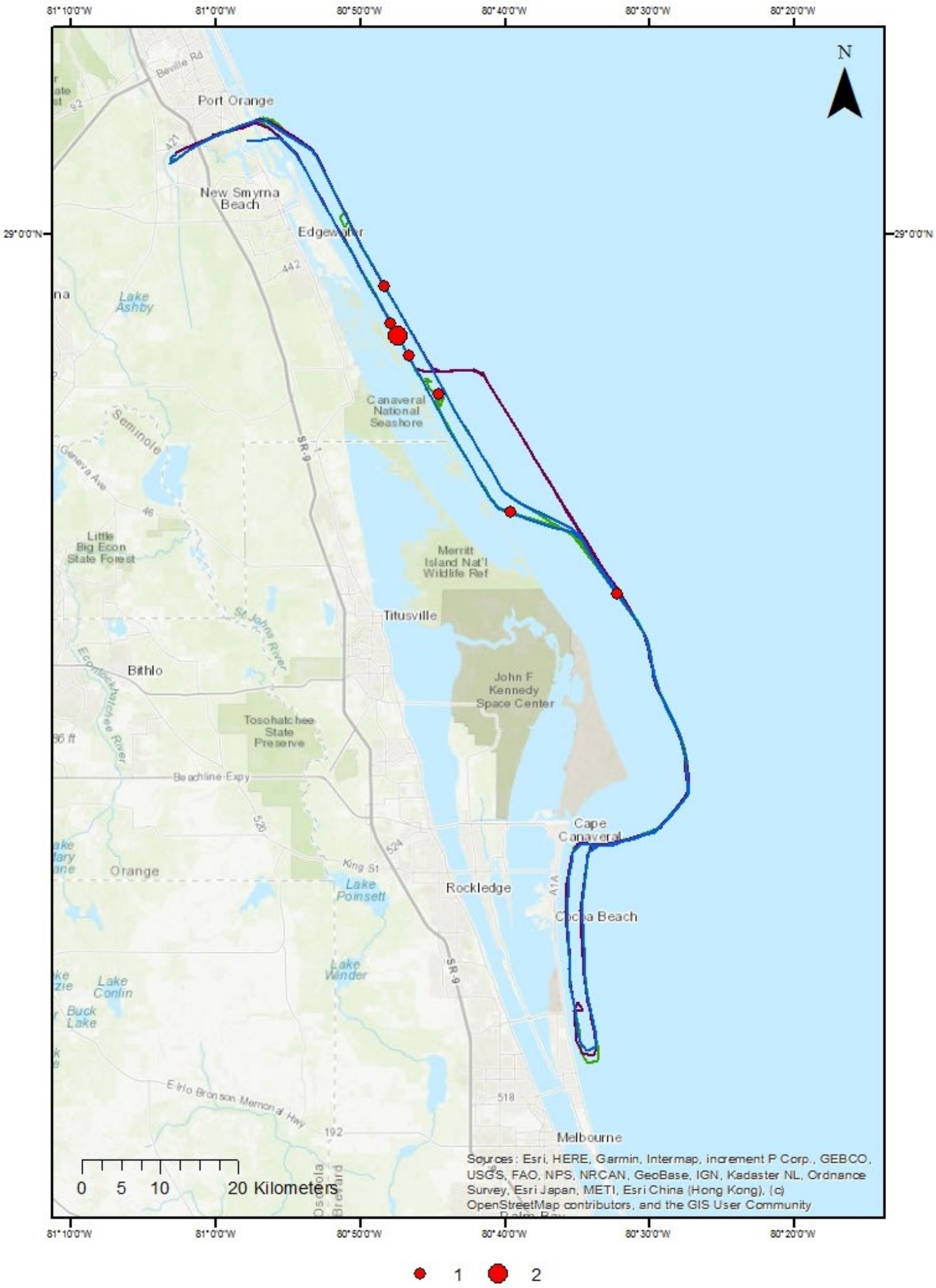

Figure 1. Example path of aerial surveys based on 2021 aerial survey paths. Red dots represent giant manta ray sightings.

The specific aircraft that would be used during the surveys can vary based on availability, but would most likely be a Robinson 66 helicopter or a Lockwood aircam, a twin-engine aircraft. The minimum altitude of the aircraft during aerial surveys would be 183 meters (600 feet).

3.1.3 Capture Methods

In order to carry out the tagging portion of the proposed study, researchers would use different methods to capture (using nets or other gear) or closely approach (without nets or other gear) giant manta rays for tagging and sampling.

Non-capture methods for this study would involve use of a small boat to approach a free-swimming animal and tag with a tagging pole or approach the animal from within the water, using a tag mounted on a suction cup. This approach would be used when feasible as it allows the animal to freely swim with no restraint while putting the tag in place; however, it does not offer the opportunity for surgically implanting specific tag types resulting in a possible reduction in tag duration and data volume. As a result, the researchers would primarily use the capture methods described below to achieve the project objectives.

The action agency presented the capture methods in order of preference of use, starting with the capture methods that are the least logistically challenging. If the first capture method did not allow for enough captures, the researchers would attempt the secondly-preferred capture method, and so on.

All staff and vessels participating in the proposed action would be properly identified with research logos. A GAI Public Relations staff member would be available to address any public concern that may arise from the fieldwork activities.

3.1.3.1 Compass Netting

Compass netting is most effectively implemented in shallow water depths (less than nine feet deep [2.7 meters]) to avoid the animal escaping out the bottom of the net. The method involves identifying and circling the animal with a seine net.

Researchers would use a 28-foot (8.5 meters) mullet boat equipped with a 1,500-foot (457 meters) seine net (Figure 2). Once an onboard observer visually identifies the animal, one end of the seine net would be released into the water and the vessel would quickly encircle the animal while releasing the net. Designated observers would keep eyes on the animal while the vessel is in motion to avoid vessel strike risk and ensure safe capture.

Figure 2. Example of compass netting (from Mote Marine Laboratory).

The researchers anticipate a sample size of 20 to 30 individuals via compass netting. If this method yields a diverse range of animal size and age that is adequate for the data needed, it would be the only capture method used.

3.1.3.2 Free Hooking

Free hooking would be implemented in deeper offshore waters (greater than nine feet deep [2.7 meters]) to target larger animals. Trained scientists would follow previously established free hooking methods successfully implemented by GAI, Kessel et al. (2017), and Knochel et al (submitted). If this method were used, researchers who have expertise in free hooking would be present to implement it.

This capture method would physically hook the animal in the mouth in the center of the upper jaw and use floats to create drag on the animal (similar to large whale disentanglement methods) to promote fatigue prior to handling.

Kessel et al. (2017) studied reef manta rays in the Red Sea using a capture method of free hooking mantas (n=3) with a hook and line rig with two floats attached. Similar methods would be used for this study to capture manta rays found offshore or in water too deep to safely operate the seine net. A giant manta ray located at the surface would be slowly approached from the rear and, once the manta is in close range, a two-meter long aluminum pole would be maneuvered over the head to position the 20/0 breakaway circle hook in the center of the upper jaw. When hooked, the animal is expected to dive and increase swimming speed; the floats would then be thrown overboard to create drag on the animal, similar to large whale disentanglement methods. Hooked individuals would be allowed to tow the floats for 10 to 15 minutes until swim speed slows slightly. This facilitates capture and handling and reduces chances of injury to the animal and the research team. The individual would be maneuvered to the side of the boat by hand, and a rope would be placed over the tail and dorsal fin to secure the animal alongside the vessel for tagging and sampling. Post-tagging and sampling, the hook would be removed, the posterior line loosened, and the animal would be released and monitored by a snorkeler, if conditions permit, until it is no longer in sight.

If free hooking is used, the researchers anticipate a sample size of 10 to 15 individuals. This method would only be used if compass netting does not yield a diverse enough size and age group of individuals in shallower water.

3.1.3.3 M/V OCEARCH

OCEARCH is a non-profit organization that conducts ocean research (particularly on sharks), which owns and operates the motor vessel (M/V) OCEARCH. The M/V OCEARCH contains a 75,000-pound (34,019 kilogram) capacity hydraulic platform designed to safely lift marine animals out of the ocean for access to sample and tag the animals. The GAI would collaborate with OCEARCH to leverage ship time aboard the M/V OCEARCH.

Animals would be captured using previously described free hooking techniques and guided by hand in the water on and off the lift platform. The hydraulic platform would be raised and adjusted accordingly to allow for animal buoyancy and avoid or minimize the risk of impacts to internal organs. Once animals are restrained and hoses of water have been set to enable a continuous flow of fresh seawater over the gills for proper oxygenation, the science team would perform sampling and tagging methods.

The use of the M/V OCEARCH would be the costliest capture method and would only be used if the previous two methods do not yield enough individuals to provide sufficient sample size. The researchers anticipate a sample size of five to ten individuals.

3.1.4 Handling Methods

Once captured, a giant manta ray would be held for a maximum of 30 minutes, although researchers expect the research procedures would typically take less time than that, usually around 15 minutes. Researchers would use a handheld blood analyzer/monitoring device (iStat) to monitor physiological stress markers (lactic acid and bicarb) throughout handling (immediately after capture, once during sampling, and prior to release, if possible) to monitor the physical state and stress response of the animal. If these physiological indicators reveal higher than expected stress levels, a decision would be made whether to immediately cease sampling and release; modify sampling to prioritize certain samples and release; or continue as planned.

Depending on the capture method, the handling and release procedures for giant manta rays would differ slightly.

For handling after compass netting, staff members would enter the water to safely guide the animal to the side of the vessel for sampling to begin. Staff would remain in the water throughout the sampling process and would assist with the safe release of the animal by guiding the animal to a safe distance (about ten feet) from the vessel and releasing simultaneously via a countdown cue among in-water staff.

For handling after free hooking, the animal would be brought to the side of the vessel via reeling in after the animal has tired itself. Once the animal is alongside the vessel, a line would be placed over the tail and dorsal fin to provide safe control for sampling and the hook would remain in the mouth throughout sampling to control head movement. The animal would be sampled (e.g., flipping to ventral side then back to dorsal side). Once sampling is complete or the maximum time limit is reached, the hook would be removed and the posterior line around the tail and dorsal fin would be loosened and the animal released.

For handling on the M/V OCEARCH platform after free hooking, the platform would be slightly lowered to aid staff in flipping the animal over to expose the ventral side. Once the ventral side is exposed, sampling procedures would be the same as above. As with the previous methods, a hose would be used for water flow over the gills to aid in ventilation. Once sampling has concluded or the maximum time limit has been reached, the platform would again be slightly lowered to flip the animal, so the dorsal side is again right side up. After the animal has been flipped, the platform would be lowered more for the animal to safely swim away. Though M/V OCEARCH has not had mantas on the hydraulic lift platform, they regularly handle large sharks and veterinary-guided ultrasounding of the internal organs showed no tissue damage as a result of being lifted out of the water.

3.1.5 Tagging Methods

Once captured and properly handled as described above, a maximum of 30 animals would be tagged with an individual or combination of satellite, acoustic, and/or inertial measurement unit (IMU) tags. A total of 50 tags would be used on the 30 animals (30 acoustic, 10 satellite, and 10 IMU). After tagging and sampling are complete, animals would be immediately released, as described above. As described in the following sections, the different tags collect different data, so applying more than one tag to an individual would allow for the tags to transmit additional information about the individual's movement patterns and habitat use.

To induce tonic immobility, the giant manta ray would be rolled onto its back to expose the ventral surface. Post-surgical insertion, the animal would be flipped so the dorsal side is right side up. The three tag types and their application methods are described below.

3.1.5.1 Acoustic Tags

Acoustic tags would be surgically implanted (in juveniles) or externally attached (to adults).

Acoustic tags would be surgically implanted in the coelom (body cavity) via a small (two to four centimeter) incision on the ventral side or externally attached to the dorsal side of the pectoral fin. Vemco V16 acoustic tags (Figure 3) would be surgically inserted in juvenile animals (less than 1.5-meter disc width) and the incision would be closed with tissue glue or sutures. Tag battery life is up to ten years and would remain inside the animal after the battery has expired. Inserting in juvenile animals allows for tracking movements as they grow and mature into adulthood, including any ontogenetic changes in habitat usage.

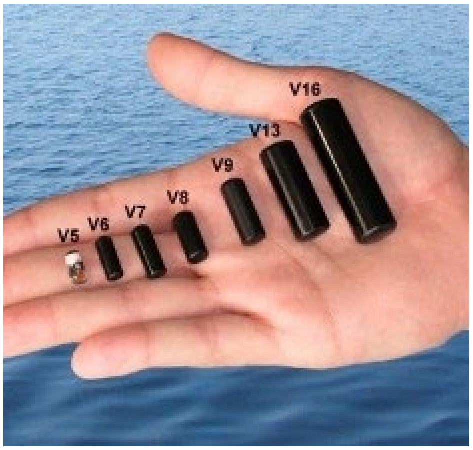

Figure 3. Vemco acoustic tags proposed for use in giant manta rays (V9 and V16).

Vemco V9 acoustic tags (Figure 3) would be externally attached to adult animals (greater than 1.5-meter disc width) by a staff member on the pulpit of a boat using a pole spear and an intradermal dart tag connected via a polyethylene fiber (e.g., Dyneema ®) tether. Vemco V9 tags are smaller than V16 with a shorter mission time of 800 to 900 days. Animals would carry internal tags for the duration of their life; however, external tags would naturally be expelled by the animal over time, via shedding.

If the above two approaches for tagging juvenile and adult animals fail, field scientists would surgically insert acoustic tags inside adult manta rays with the assistance of the M/V OCEARCH. Adult animals would be raised using a hydraulic lift deck and surgery would be conducted on the ventral side with insertion via a two to four centimeter incision site; the site would be closed with sutures or tissue glue.

3.1.5.2 Satellite Tags

After turning the giant manta ray dorsal side up, a satellite tag would be attached to the dorsal fin via the four-point bolt-on method. Satellite tags similar to the Wildlife Computers fin-mounted SPOT/SPLASH tag (Figure 4) would be mounted to the dorsal fin using bolts designed for planned obsolescence via bolt corrosion at four points of attachment to minimize the potential for pigmentation scarring, deformation of the dorsal fin, and infection. The bolts are attached with a power drill through pre-drilled holes in the fin. The tag is mounted to the pre-drilled holes and attached using a wing nut. There are no nerve endings in the dorsal fin; therefore, holes can be drilled through the fin without pain management. The bolts are expected to corrode after approximately 12 months, causing the tag to fall off. This method is similar to that used in other elasmobranchs, including smalltooth sawfish (NMFS 2019a). If this method is not possible, an alternative single point tether attachment method (i.e. "looping" method) would be used based on prior experience and successful implementation by NMFS staff (N. Farmer, personal communication, August 11, 2021). This method requires looping a 12-inch vinyl-coated wire line securely around the dorsal fin. The looping method would release via corroding after 12-months. This method does present potential issues involving biofouling and entanglement; see discussion in Section 10.3.3. Biofouling is also a concern for tag operation, since it is possible for the organisms growing on the tag to compromise the tag housing, allowing saltwater to intrude and causing tag failure (Hays et al. 2007).

Figure 4. Fin-mounted Satellite tag (SPOT/SPLASH tag).

3.1.5.3 Inertial Measurement Tags

In addition to satellite tags, inertial measurement (IMU) tags would also be attached if possible. IMU tags would be attached via a suction cup on the pectoral fin. IMU tags used would be Arduino-based Open Tag (Loggerhead Instruments, Sarasota FL) or Daily Diary tags from Wildlife Computers, and CATScam IMU (Customized Animal Tracking Solutions) (Figure 5). CATScam includes a high-definition video that can be used to ground-truth the Open Tag fine-scale data. Both IMU tags would be attached to the dorsal surface using suction cups aided by smooth peanut butter, petroleum jelly, or honey. IMU tags can be equipped with a variety of sensors to collect multiple data points, including depth, temperature, light, and speed. IMU tags have been applied to a variety of species to better understand fine-scale movements such as dive behavior, fluke rate, feeding behavior, and bioenergetics. Tag duration is short, approximately three to five days, and would detach from the animal.

Figure 5. Inertial measurement tag.

Prior to field application, IMU tag attachment methodology would be tested and refined on both giant manta rays and lesser devil rays (*Mobula hypostoma*) housed at Georgia Aquarium. Using a controlled environment to refine the methodology would maximize tag retention time and data collection with free-ranging manta rays in the field, while minimizing their handling time during field operations due to prior application experience. Using Georgia Aquarium manta rays would establish baseline IMU sensor data that can be ground-truthed with behavioral observation data. This baseline would assist with data analysis of free-ranging giant manta rays.

3.1.6 Measurement, Photography, and Biological Sampling

In addition to tagging, a variety of additional sampling techniques would be conducted to gather supplementary information on the giant manta rays. These include standard morphometrics measurements (disc width, total length), photographs and video (for photo ID), fin clip (for genetics), muscle biopsy (for diet studies), mucus swabs (for microbiome and DNA barcoding), and a blood sample (for health and diet studies) may be taken. The additional sampling would occur while an individual is being tagged.

Blood samples (13 to 20 milliliters based on animal size and not to exceed one percent of total blood volume) would be drawn either from the ventral caudal vein or the pectoral wing using 16 to 18 gram needles. Blood gas and chemistry values (lactate, bicarbonate, PO2, PCO2) would be evaluated using an iStat clinical analyzer at the time of blood draw. This allows for real-time information on the physiological state of the animal in response to capture and handling.

After tagging, and before an animal is righted, mucus swabs would be taken from the gills and cloaca for microbiome studies. During surgical tag insertion, a small muscle sample (for diet studies) would be taken using a biopsy punch.

3.1.7 Vessel Activity

There are three research vessels that would be used as part of the proposed action.

- 325 Conquest Boston Whaler
    - Length overall: 32 feet 3 inches (9.8 meters).
    - Maximum capacity: 14 people, however for tagging operations fewer than six would be on board.
- Net boat (Mote Marine Lab mullet boat).
    - Length overall: 28 feet (8.5 meters).
    - Maximum capacity: Nine people, however for tagging operations capacity would be limited to fewer than six individuals.
- OCEARCH
    - Length overall: 126 feet (38.4 meters).
    - To be used only if necessary; see Section 3.1.3.3.

Transit speed for all vessels is not anticipated to exceed 25 knots. When performing capture and tagging methods, boat speeds would be significantly reduced. For example, when performing the free hooking capture method, boat speeds would be less than two knots while positioning the vessel relative to the animal. Once in position, for the safety of the animal and passengers, boat speed would be idle. When using the compass net method in shallow waters, boat speed would be less than five knots while observing animals for possible capture. Once encompassing has been initiated, boat speed would immediately increase to full throttle to quickly encircle the animal and deploy the net while observers watch the animal to avoid risk of vessel strike and ensure safe capture of the animal. Once the net is fully deployed, speed would immediately be reduced to five knots or less before decreasing to an idle speed while handling, sampling, and release occur.

3.1.8 Mitigation Measures

Experienced animal handlers would keep the animal calm and safe while tagging and sampling is underway (see “handling methods” section). All field staff would be trained and up to date on animal handling, sampling methods, and experimental procedures according to GAI’s International Animal Care and Use Standard (BOEM 2021).

The Mote Marine Laboratory vessel is a mullet style boat for operating in shallow waters (less than two meters depth). Mote’s well-established techniques for minimizing impacts described below have never resulted in incidental captures of protected species such as sea turtles (Kim Bassos-Hull, pers. comms, 2021):

- Observation from vessel flybridge prior to setting capture net to ensure no non-targeted species are visible in the research area.
- Maintain a dedicated flybridge observer after setting the seine net.
- If a non-target animal is found to be entrapped in the net, standard operating procedures are to immediately open the net and release the animal.

Once the targeted species is on board or alongside the vessel, the net is quickly removed from the water to decrease the risk of interactions with other species.

Adverse impacts would be avoided or minimized when implementing free hooking capture methods by leveraging previously established techniques successfully used to capture GAI's three manta rays and deeper water captures associated with Kessel et al. (2017) and Knochel et. al. (submitted). To date, this free hooking method has not been documented to have any long-term negative impacts on the target species and is unlikely to impact non-target species due to the highly targeted nature of the method. The three manta rays housed at Georgia Aquarium were all captured via free hooking 11, 12, and 13 years ago, respectively, and all are healthy with no remaining impacts from the method of capture.

Project personnel would take the following steps to avoid the accidental capture of non-target species:

- Restrict netting activities to daylight hours (i.e., one hour after sunrise/one hour before sunset).
- Use experienced observers on the capture boat and at least one experienced dedicated observer on the net boat watching for non-target species (e.g., smalltooth sawfish, sea turtles, and North Atlantic right whale). Netting would not be deployed if a non-target species were observed in the area.
- Monitoring net and float lines constantly and maintaining gear to minimize entanglement (e.g. lines kept taut, etc.).
- If the net is deployed and non-target species are observed, netting operations would be immediately discontinued, and boat engines would be turned off or idled. If the net boat were clear of the non-target species, it would engage its motor and open the set, creating as large a window as possible allowing the non-target to swim out of it.
- In the unlikely event of accidental entanglement of non-target species (e.g., smalltooth sawfish and sea turtles), the animal(s) would be immediately disentangled from the capture net and released. No incidental captures of non-target species have been documented using this method in 12 years of operation by Mote Marine Laboratory.
- A drone would be employed as needed to provide an aerial view to ensure non-target species are not captured.

The drone that would most likely be used in the proposed action is the DJI Mavic 3 with multi-rotary motors. The drone would operate at no more than 304.8 meters (1,000 feet), and no lower than 20 meters (65.6 feet).

Prior to execution of any of the previously described capture methods, including deployment of seine nets in shallow water, an observer would scan for North Atlantic right whales and other non-target species during vessel transit and implementation of capture methods. In the unlikely event that a smaller non-target species is captured with these mitigation measures in place, it is most likely to be a sea turtle and would be immediately released and, if possible, monitored.

4 ACTION AREA

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

The proposed action would take place off the east coast of Florida, from Flagler to St. Lucie Counties and include the Cape Canaveral Shoals region. Field activities would be conducted within 20 nautical miles (37 kilometers) from the shoreline, in waters 20 meters deep or less (Figure 6).

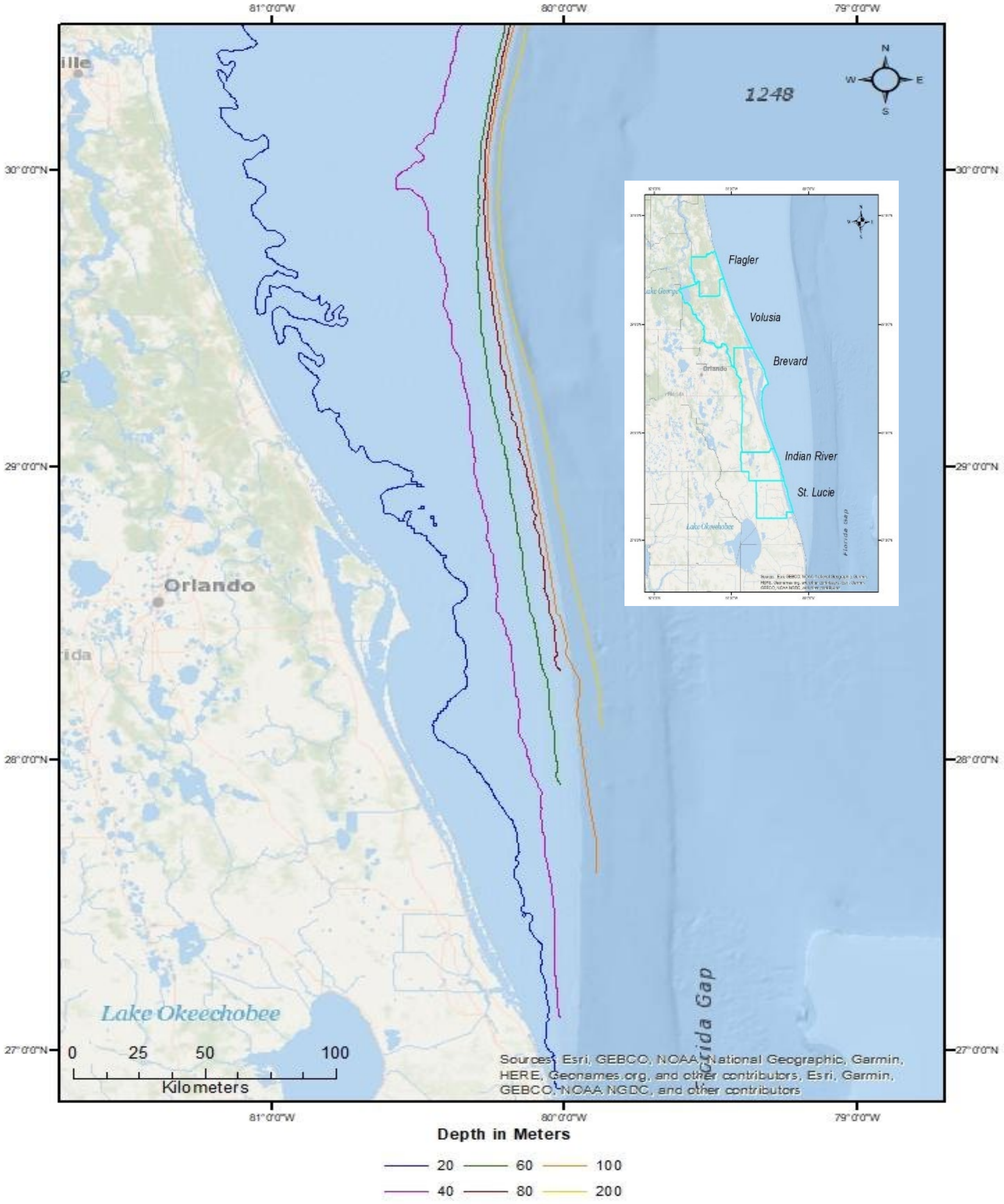

Figure 6. Location of fieldwork off the east coast of Florida, from Flagler to St. Lucie Counties, including the Cape Canaveral Shoals region (within less than 20 meters).

The Canaveral Shoals area (offshore of Brevard County) was selected for this study in part due to the presence of networks of existing acoustic arrays that researchers can use to support the collection of location data on tagged giant manta rays (Figure 7).

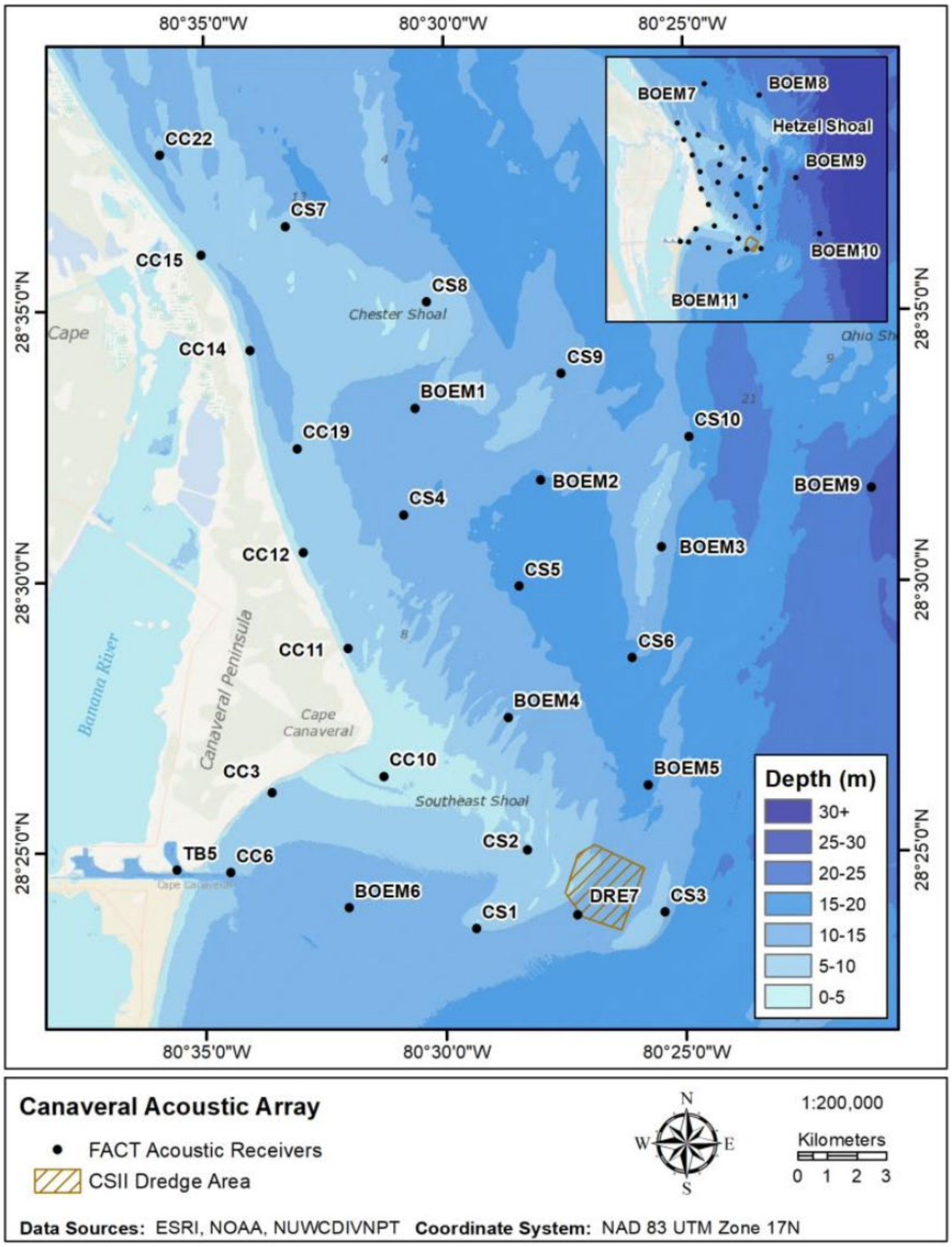

Figure 7. Locations of the Bureau of Ocean Energy Management/Navy acoustic array and Florida Atlantic Coast Telemetry network acoustic receivers located within Canaveral Shoals, Florida.

5 Endangered Species Act-Listed Species and Designated Critical Habitat Present in the Action Area

This section identifies the ESA-listed species and designated and proposed critical habitat that potentially occur within the action area (Table 1) that may be affected by the proposed action.

Table 1. Threatened and endangered species and designated critical habitat that may be affected by the proposed action.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693*	FR Not Available 10/1991 – U.S. Atlantic
Hawksbill Turtle (*Eretmochelys imbricata*)	E – 35 FR 8491	63 FR 46693*	57 FR 38818
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710* and 77 FR 4170*	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39855	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic
Fishes			
Giant Manta Ray (*Mobula birostris*, formerly *Manta birostris*)	T – 83 FR 2916	-- --	-- --
Smalltooth Sawfish (*Pristis pectinata*) – U.S. portion of range DPS	E – 68 FR 15674	74 FR 45353*	74 FR 3566 01/2009

*Indicates that critical habitat exists for this species, but does not overlap with the action area.

5.1 Smalltooth Sawfish

Smalltooth sawfish occur in the action area. Small juveniles (less than three meters long) mostly occur in waters less than ten meters deep (Poulakis and Seitz 2004), while large juveniles and adults use a broad range of water depths (less than ten meters deep, to 70 meters deep or more) (Poulakis and Seitz 2004; Wiley and Simpfendorfer 2010). While small juveniles have a smaller home range and tend to stay in nursery areas (Simpfendorfer 2006), some large juveniles and adults travel further distances. Recent evidence demonstrates that tagged individuals leave areas where they were tagged and go to other areas (e.g., tagged in the Everglades or in the Florida Keys and moving to Cape Canaveral) (Graham et al. 2021). Based on tracking data, Graham et al. (2021) identified Cape Canaveral waters from zero to twenty meters deep as important habitat for large juvenile and adult smalltooth sawfish. According to their study, smalltooth sawfish used the Cape Canaveral area in spring (March through May), summer (June to August), and fall (September through November) (Graham et al. 2021). The proposed action would take place from March to July.

5.2 North Atlantic Right Whales

The proposed action would begin in March, and take place off Cape Canaveral, overlapping spatially and temporally with the range of the North Atlantic right whale. Calving season for North Atlantic right whales in the southeastern United States runs from mid-November to mid-April, although in recent years, the timing of the occupancy of North Atlantic right whales in the region has shifted with no individuals sighted past March (or earlier, in some years) (Surrey-Marsden et al. 2018; Pettis et al. 2021). In the event a North Atlantic right whale is present in the action area, it would likely be during the beginning of the research season, which runs from March to July.

5.3 ESA-Listed Sea Turtles

The proposed action spatially and temporally overlaps with ESA-listed sea turtles species and/or DPSs (see Table 1), including North Atlantic DPS green turtle, hawksbill turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic DPS loggerhead turtle. As part of the proposed research for activities directed at giant manta rays, ESA-listed marine sea turtles may occasionally be present with targeted species.

Leatherback, green, and loggerhead sea turtles nest on the beach near Canaveral Air Force Station[1], within the action area. In Florida, green turtles nest from June to late September. Loggerhead turtles nest from April to September, and leatherbacks nest from March through July. The proposed action would not take place on the nesting beach; the activities would mostly be vessel-based, so we do not expect the proposed action to impact nesting. Any sea turtles that were encountered during the proposed action would likely be female sea turtles going to or returning from nesting. Incubation time varies slightly by species, but generally is about 60 days.

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[1] https://myfwc.maps.arcgis.com/apps/webappviewer/index.html?id=8e6e45efc47a4c69941ddcb097cb195a

Based on the timing, the proposed action could occur when hatchlings are emerging from their nests and entering the ocean.

6 POTENTIAL STRESSORS

The proposed action involves multiple activities, each of which can create stressors. Stressors are any physical, chemical, or biological entity that may induce an adverse response either in an ESA-listed species or their designated critical habitat. During consultation, we deconstructed the proposed action to identify stressors that are reasonably certain to result from the proposed activities. These can be categorized as pollution (e.g., exhaust, fuel, oil, and trash), vessel strikes, acoustic and visual disturbance from the research vessels and aircraft, entanglement of non-target species in research equipment (nets), and directed research activities. Below we provide information on these potential stressors. Furthermore, the proposed action includes several conservation measures described in Section 3.1.8. that are designed to minimize effects that may result from these potential stressors. While we consider all of these measures important and expect them to be effective in minimizing the effects of potential stressors, they do not completely eliminate the identified stressors. Nevertheless, we treat them as part of the proposed action and fully consider them when evaluating the effects of the proposed action (Section 3).

6.1 Pollution

The operation of the research vessels permitted under the proposed research permit may result in pollution from exhaust, fuel, oil, trash, and other debris. Air and water quality are the basis of a healthy environment for all species. Emissions pollute the air, which could be harmful to air-breathing organisms and lead to ocean pollution (Duce et al. 1991; Chance et al. 2015). Emissions also cause increased greenhouse gases (carbon dioxide, methane, nitrous oxide, and other fluorinated gases) that can deplete the ozone, affect natural earth cycles, and ultimately contribute to climate change (see https://www.epa.gov/ghgemissions/overview-greenhouse-gases for additional information). The release of marine debris such as paper, plastic, wood, glass, and metal associated with vessel operations can also have adverse effects on marine species most commonly through entanglement or ingestion (Gall and Thompson 2015). The lethal and non-lethal effects to air breathing marine animals such marine mammals, sea turtles, and birds are well documented, and marine debris is known to also adversely affects marine fishes (Gall and Thompson 2015).

6.2 Vessel Strike

Vessel surveys necessarily involve transit within the marine environment, and the transit of any research vessel in waters inhabited by cetaceans carries the risk of striking an animal. Responses to a vessel strike can involve death, serious injury, or minor, non-lethal injuries. The probability of a vessel collision and the associated response depends, in part, on the size and speed of the vessel. The majority of vessel strikes of large cetaceans occur when vessels are traveling at speeds greater than approximately 18.5 kilometers per hour (10 knots), with vessels traveling faster, especially large vessels (80 meters [262.5 feet] or greater), being more likely to cause serious injury or death (Laist et al. 2001; Jensen and Silber 2004; Vanderlaan and Taggart 2007; Conn and Silber 2013).

The only ESA-listed species that would be deliberately approached by a vessel would be giant manta rays during vessel surveys and the subsequent capture and sampling of manta rays. Other ESA-listed whales or sea turtles might be present during those activities, but researchers would avoid these species using dedicated observers (see Section 3.1.8).

6.3 Operational Noise and Visual Disturbance from Vessels

Research vessels associated with the proposed action may cause visual or auditory disturbances to ESA-listed species and more generally disrupt their behavior, which may negatively influence essential functions such as breeding, feeding, and sheltering. Cetaceans react in a variety of ways to close vessel approaches. Responses range from little to no observable change in behavior to momentary changes in swimming speed and orientation, diving, surface, and foraging behavior, and respiratory patterns (Watkins et al. 1981; Hall 1982; Baker et al. 1983; Malme et al. 1983; Richardson et al. 1985; Au and Green. 2000; Baumgartner and Mate 2003; Jahoda et al. 2003; Koehler 2006; Scheidat et al. 2006; Isojunno and Miller 2015). Changes in cetacean behavior can correspond to vessel speed, size, and distance from the animal, as well as the number and frequency of vessel approaches (Baker et al. 1988; Beale and Monaghan 2004). Reactions by ESA-listed sea turtles and fishes to operational noise and visual disturbance from vessels are expected to be similar—changes in or disruptions to behavior, which may negatively influence essential functions such as breeding, feeding, or sheltering.

6.4 Operational Noise and Visual Disturbance from Aircraft

Manned aerial surveys (i.e., helicopter or twin-engine aircraft) that would be take place under the proposed action may cause visual disturbance and/or auditory disturbance (i.e., noise) that may affect ESA-listed species within the action area. Species responses to aircraft depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging, or traveling) as well as the altitude and lateral distance of the aircraft to the animals (Luksenburg and Parsons 2009b). Unmanned aerial surveys (i.e., the use of a drone) that would take place under the proposed action may also cause visual and/or auditory disturbances to ESA-listed species.

6.5 Incidental Capture of Non-Target Species

The proposed action involves the use of nets used to capture giant manta rays, the target species. However, gear or equipment associated with the proposed action may pose a risk of entanglement to non-target ESA-listed species (e.g., smalltooth sawfish, North Atlantic right whale, ESA-listed sea turtles). Entanglement can result in death or injury of cetaceans, sea turtles, and fishes (Moore et al. 2009a; Moore et al. 2009b; Deakos and H. 2011; Van Der Hoop et al. 2013a; Van der Hoop et al. 2013b; Duncan et al. 2017).

6.6 Directed Research Activities

The proposed action includes a number of research and sampling activities to be conducted on giant manta rays, the species targeted for research. The directed research activities include capture (via netting), handling, measuring, biological sampling, and tagging. The capture, handling, and other research activities could result in stressors like in stress, injury, infection, and behavioral responses. Because of the nature of the directed research activities, we do not expect other ESA-listed species in the action area to be exposed to those stressors, because they are not the species targeted for research.

7 SPECIES AND CRITICAL HABITAT NOT LIKELY TO BE ADVERSELY AFFECTED

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

The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that co-occurs with a stressor of the action but is not likely to respond to the stressor is also not likely to be adversely affected by the proposed action. We applied these criteria to the species ESA-listed in Table 1 and we summarize our results below.

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

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

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur (NMFS and USFWS 1998).

7.1 Stressors Not Likely to Adversely Affect Species

There are a number of stressors that could result from the proposed action as described in Section 6. We consider several of these stressors not likely to adversely affect species, and provide our rationale in the sections below. We also discuss the effects of these stressors on designated critical habitat in Section 7.3 below.

7.1.1 Pollution

Discharges from research vessels in the form of leakages of fuel or oil are possible, though effects of any spills to ESA-listed species considered in this opinion would be minimal, if they occur at all. The potential for fuel or oil leakages is extremely unlikely. An oil or fuel leak could pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessels is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the research vessel) that would impact ESA-listed species directly or pose hazards to their food sources. Given the experience of the researchers and vessel operators in conducting research and enhancement activities and maintaining research vessels in the action areas, it is unlikely that spills, leaks, or discharges would occur. If a discharge does occur, the amounts of leakage would be small, and would be expected to disperse quickly in the water and not affect ESA-listed species directly. To our knowledge, none of these leakages has occurred during BOEM's prior research activities. Therefore, we conclude that the effects on ESA-listed species that may result from this stressor (discharge) are discountable and thus vessel discharges may affect but are not likely to adversely affect ESA-listed species, and will not be carried forward in this consultation.

Furthermore, because the potential for oil or fuel leakage is extremely unlikely to occur, we find that the risk from this potential stressor is discountable. Therefore, we conclude that pollution by oil or fuel leakage is not likely to adversely affect ESA-listed species, and will not be carried forward in this consultation.

7.1.2 Vessel Strike

Transit of any research vessel in waters inhabited by cetaceans carries the risk of striking an animal. Responses to a vessel strike can involve death, serious injury, or minor, non-lethal injuries. The probability of a vessel collision and the associated response depends, in part, on the size and speed of the vessel. The majority of vessel strikes of large cetaceans occur when vessels are traveling at speeds greater than approximately 18.5 km per hour (10 knots), with vessels traveling faster, especially large vessels (80 meters [262.5 feet] or greater), being more likely to cause serious injury or death (Laist et al. 2001; Jensen and Silber 2004; Vanderlaan and Taggart 2007; Conn and Silber 2013).

Two of the vessels proposed for use in the proposed action will be less than ten meters long (the 325 Conquest Boston Whaler, and the Mote Marine Lab mullet boat). The M/V OCEARCH vessel (to be used only if necessary) is 38.4 meters in length. The maximum speed the vessels would reach is 25 knots (46.3 km per hour) during transit. During research activities like capture, and netting, vessels would be travelling much slower, between two and five knots (3.7 and 9.3 km per hour). While tagging and sampling a captured animal, the vessel would be idle.

The research vessels would be traveling at generally slow speeds, reducing the amount of noise produced by the propulsion system and the probability of vessel strikes (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). While vessel strikes during research and enhancement activities are possible, we are aware of only two instances of a research vessel striking a large cetacean in thousands of hours at sea (Wiley et al. 2016). One of these vessel strikes involved the NOAA research vessel (R/V) *Auk* while transiting to port on April 9, 2009 in Massachusetts Bay. The R/V *Auk* struck a North Atlantic right whale (Wiley et al. 2016). The vessel was traveling at 10.6 km per hour (19.7 knots), which, while not required for a vessel of its size (15 meters [49.2 feet]), is well above the 18.5 km per hour (10 knots) restrictions that were active at the time within the area for larger vessels (greater than 19.8 meters [65 feet]). Six marine mammal observers were on the lookout when the mate spotted a large cetacean. The North Atlantic right whale exhibited minor bleeding from seven to eight lacerations on the tip of its left tail fluke, which follow up photographs show eventually healed with the tip of the fluke falling off. Since the event, the North Atlantic right whale has been seen at least 46 times, with the injury being fully healed by day 719 after the vessel strike and the animal appearing to be healthy (Wiley et al. 2016).

There was another instance of a NOAA Office of Coast Survey contractor vessel striking and killing a blue whale off the coast of California that occurred in October 2009. This event involved the R/V *Pacific Star* (161 feet [49 meters], 295 tons [267.6 metric tons]) traveling at 5.5 knots. There was no observer present on the ship. Later, the State of California analyzed the event and concluded that since the whale suddenly surfaced beneath the hull, the collision was unavoidable. It was determined that the propeller severed the whale's vertebrate (Peters 2009).

The R/V *Auk* and R/V *Pacific Star* vessel strike incidents are an important reminder that even with well-trained marine mammal observers and vessel operators, all vessels, even research vessels, have the potential to strike cetaceans. In the R/V *Auk* incident, there were six dedicated marine mammal observers, but no indication of the animal's presence prior to the initial sighting within 9 meters (29.5 feet) of the vessel by the mate. We consider this event extremely rare given that only two instances of research vessel strikes for cetaceans have ever been reported over the years of research and enhancement activities carried out under ESA/MMPA permits (Wiley et al. 2016).

We generally expect the movement of ESA-listed species including marine mammals to be away from or parallel to the research vessels. The generally slow movement of the research vessels during most of its travels reduces the risk of vessels reaching a speed where vessel strike could occur. Given the rarity of vessel strikes of large cetaceans during research and enhancement activities based on historical data, we believe the likelihood of a vessel strike on North Atlantic right whales from research vessel transits is extremely unlikely. Therefore, we conclude that the effects on ESA-listed North Atlantic right whales that may result from vessel strike are discountable.

Vessel strike poses an important injury and mortality risk for sea turtles, although the extent and frequency of its occurrence is not well known (Lutcavage et al. 1997). Based on behavioral observations of sea turtle avoidance of small vessels, green turtles may be susceptible to vessel strikes at speeds as low as 3.7 kilometers per hour (2 knots) (Hazel et al. 2007). If an animal is struck by a vessel, responses can include death, serious injury, and/or minor, non-lethal injuries, with the associated response depending on the size and speed of the vessel, among other factors (Laist et al. 2001; Jensen and Silber 2004; Vanderlaan and Taggart 2007; Conn and Silber 2013).

The likelihood of vessel strikes of sea turtles is expected to be unlikely given that researchers typically adhere to slow vessel transit speeds and the numerous observers on lookout for non-target species would also be able to spot sea turtles that surface for air, or which are basking, or feeding at the surface. Therefore, we conclude that the effects on ESA-listed sea turtles that may result from vessel strike are discountable.

A study on fish behavioral responses to vessels showed that most adults exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004), reducing the potential for vessel strikes. Misund (1997) found that fish ahead of a vessel showed avoidance reactions at ranges of 50 to 350 meters (160 to 490 feet). When the vessel passed over them, some fish responded with sudden escape responses consisting of movement away from the vessel laterally or downward compression of the school. We expect that ESA-listed fishes would be able to move away rapidly from the vessel, avoiding strike. Thus, we do not expect ESA-listed fishes to be exposed to the stressor of vessel strike. The likelihood of a vessel strike on smalltooth sawfish and giant manta rays from research vessel transits is extremely unlikely for the reasons described above. Therefore, we conclude that the effects on smalltooth sawfish and giant manta ray that may result from vessel strike are discountable.

7.1.3 Operational Noise and Visual Disturbance from Vessels

Research vessels associated with the proposed action may cause visual disturbances to ESA-listed species that spend time near the surface, such as marine mammals, sea turtles, and fishes, which may generally disrupt their behavior. Studies have shown that vessel operation can result in changes in the behavior of marine mammals, sea turtles, and fishes (Patenaude et al. 2002; Richter et al. 2003; Hazel et al. 2007; Smultea et al. 2008a; Holt et al. 2009; Luksenburg and Parsons 2009a; Noren et al. 2009). In many cases, particularly when responses are observed at great distances, it is thought that animals are likely responding to sound more than the visual presence of vessels (Evans et al. 1992; Blane and Jaakson 1994; Evans et al. 1994). Nonetheless, it is generally not possible to distinguish responses to the visual presence of vessels from those to the sounds associated with those vessels. Moreover, at close distances animals may not even differentiate between visual and acoustic disturbances created by vessels and simply respond to the combined disturbance.

Assessing whether sounds produced by vessels may adversely affect ESA-listed species involves understanding the characteristics of the sounds produced by the vessels, the species that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those species. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2003; NRC 2005), there are many unknowns in assessing impacts of sound, such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007). Other ESA-listed species, such as sea turtles, are often considered less sensitive to anthropogenic sound, but given that much less is known about how they use sound, the impacts of anthropogenic sound are difficult to assess (Popper et al. 2014; Nelms et al. 2016). Nonetheless, depending on the circumstances, exposure to anthropogenic sounds may result in auditory injury, changes in hearing ability, masking of important sounds, behavioral responses, and other physical and physiological responses.

Research vessels may cause auditory disturbance to ESA-listed species and more generally can disrupt their behavior. We expect that any research vessel used during the proposed action would add to the local noise environment in the action area due to the research vessel's propulsion and other noise characteristics of the research vessel's machinery.

We expect that the research vessels would not add significantly to the local noise environment in their operating area due to the propulsion and other noise characteristics of the vessel's machinery. Any contribution is likely small in the overall environment of regional ambient sound levels. A research vessel's transit past a marine mammal would be brief and is not likely to impact any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of marine mammals to move away from the research vessels, either as a result of engine noise, the physical presence of the research vessel, or both (Lusseau 2006). In addition, the research vessels would be traveling at relatively slow speeds, reducing the amount of noise produced by the propulsion system. The source levels of sounds that would be generated by research vessels (i.e., vessel noise) are below that which could cause physical injury or temporary hearing threshold shifts, and they are unlikely to mask cetaceans ability to hear mates and other conspecifics for any significant amount of time (Hildebrand 2009; NOAA 2018).

Very little research exists on sea turtle responses to vessel noise disturbance. Currently, there is nothing in the available literature specifically aimed at studying and quantifying sea turtle response to vessel noise. However, a study examining vessel strike risk to green sea turtles suggests that sea turtles may habituate to vessel sound and may be more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007). Regardless of the specific stressor associated with vessels to which turtles are responding, they only appear to show responses (i.e., avoidance behavior) at approximately 10 meters (32.8 feet) or closer (Hazel et al. 2007). Therefore, the noise from research vessels is not likely to affect sea turtles from further distances, and disturbance may only occur if a sea turtle hears a vessel nearby or sees it as it approaches. These responses appear limited to non-injurious, minor changes in behavior based on the limited information available on sea turtle response to vessel noise.

All fishes can detect vessel noise due to its low-frequency content and their hearing capabilities. Therefore, ESA-listed fishes could be exposed to a range of vessel noises, depending on the source and context of the exposure. In the near field, fish are able to detect water motion as well as visually locate an oncoming vessel. In these cases, most fishes located in close proximity that detect the vessel either visually, via sound and motion in the water would be capable of avoiding the vessel or move away from the area affected by vessel sound. Thus, fish are more likely to react to vessel noise at close range than to vessel noise emanating from a greater distance away. Because of the characteristics of vessel noise and fishes' tendency to move away from the vessels, the continuous, low-frequency sound produced from research vessels are unlikely to result in direct injury, hearing impairment, or other trauma to fishes.

The contribution of vessel noise by any research vessel is likely small in the overall regional sound field. Any research vessels passage past a cetacean, sea turtle, or fish would be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of marine mammals to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Mitson and Knudsen 2003; Lusseau 2006). Also, as stated, sea turtles may be likely to habituate and appear to be less affected by vessel noise at distances greater than 10 m (32.8 feet) (Hazel et al. 2007). In addition, during operations the research vessels would be traveling at slow speeds, reducing the amount of noise produced by the propulsions system (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). The distance between the research vessel and observed marine mammals, per avoidance protocols, would also minimize the potential for acoustic disturbance from engine noise.

Because the potential acoustic interference from engine noise would be so minor that it cannot be meaningfully evaluated, we find that the risk from this potential stressor is insignificant. Therefore, we conclude that acoustic interference from vessel sound sources and/or engine noise may affect, but are not likely to adversely affect ESA-listed North Atlantic right whales, sea turtles and fishes and will not be carried forward in this consultation.

7.1.4 Operational Noise and Visual Disturbance of Aircraft

There would be three types of aircraft operated during the proposed action—helicopter or twin-engine airplane and a drone (unmanned aircraft system). The stressors associated with the types of aircraft are similar, operational noise and visual disturbance, but owing to differences in the shape, size, and operation of the aircraft types, there could be differences in the degree of the stressors an exposed ESA-listed species might experience. Each aircraft type is discussed separately below.

7.1.4.1 Helicopter or Airplane Operation

Species responses to aircraft depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging, or traveling) as well as the altitude and lateral distance of the aircraft to the animals (Luksenburg and Parsons 2009b). The underwater sound intensity from aircraft is less than produced by waterborne vessels, and visually aircraft are more difficult for cetaceans to locate since they are not in the water and move rapidly (Richter et al. 2006). However, when aircraft fly below certain altitudes (about 500 meters [1,640.4 feet]), they have caused cetaceans to exhibit behavioral responses that might constitute a significant disruption of their normal behavioral patterns (Patenaude et al. 2002). Thus, aircraft flying at low altitude, at close lateral distances and above shallow water elicit stronger responses than aircraft flying higher, at greater lateral distances and over deep water (Patenaude et al. 2002; Smultea et al. 2008b). The sensitivity to disturbance by aircraft may also differ among species (Wursig et al. 1998). For example, sperm whales have been observed to respond to a fixed-wing aircraft circling at altitudes of 245 to 335 meters (803.8 to 1,099.1 feet) by ceasing forward movement and moving closer together in a parallel flank-to-flank formation, a behavioral response interpreted as an agitation, distress, and/or defense reaction to the circling aircraft (Smultea et al. 2008b). About 14 percent of bowhead whales approached during aerial surveys exhibited short-term behavioral reactions (Patenaude et al. 2002).

Owing to the timing of the proposed action (March through July), and the expected presence of North Atlantic right whales in the action area (until mid-April), exposure could potentially occur during the beginning of the proposed action’s field season.

While North Atlantic right whales exposed to aerial surveys may exhibit short-term behavioral reactions, data from the NMFS science centers, academic institutions, and other organizations from past permits indicate only mild behavioral responses, if any. It is expected the aerial surveys using manned aircraft conducted during the proposed research activities would result in no reaction or only mild short-term behavioral reactions, with no long-term behavioral changes or reduction in fitness anticipated. For these reasons, the effects that may result from potential stressors from manned aerial surveys on ESA-listed North Atlantic right whales are considered insignificant.

For ESA-listed fish species in the action area, we believe that the altitude of the aircraft during surveys (greater than 183 meters) would be high enough that the species would not exhibit any response (e.g., startle, avoidance). Furthermore, the ESA-listed fishes in the action area do not have aerial predators (that might resemble an aircraft and thus elicit a behavioral response from the fish); see discussion below for more details. We consider the operation of manned aircraft to have no effect on ESA-listed fishes.

The aircraft would stay at an altitude of 183 meters above the water’s surface, outside the level at which we expect sea turtles to react to the aircraft’s presence (Hazel et al. 2007). In the event a sea turtle is exposed to aircraft noise, exposure would likely be brief and temporary and result in short-term behavioral reactions, such as swimming away from the aircraft, which is not expected to have fitness consequences. The effects that may result from potential stressors from manned aerial surveys on ESA-listed sea turtles are considered insignificant.

We conclude that the effects from the stressors associated with the operational noise and visual disturbance from manned aircraft is not likely to adversely affect any ESA-listed species, and will not be considered further.

7.1.4.2 Drone Operation (Unmanned Aerial Systems)

Despite being conducted at much lower altitudes than the aircraft surveys, the aircraft used to conduct unmanned aerial (drone) surveys would be much smaller and quieter, so less of a behavioral response is expected. While the use of unmanned aerial systems to study marine species is still somewhat new, current data support the notion that there is less disturbance compared to the use of manned aircraft and indicate that cetaceans exhibit no behavioral response to unmanned aerial systems when they are flown at certain altitudes. In a study examining the effects of the use and close approach of an unmanned aerial system to southern right whales (*Eubalaena australis*), researchers observed no behavioral response to the drone at altitudes of 5, 10, or 30 meters (Christiansen et al. 2020). During the proposed action, the drone would be flown between altitudes of 304.8 and 20 meters. The results of this study are similar to those examining the effects of drones to other species of whales (Christie et al. 2016; Marine Mammal Commission 2016; Smith et al. 2016).

Adult sea turtles exhibited no response to a quadcopter UAS operating at heights of 30 to 50 meters (Bevan et al. 2015). Further studies showed no behavioral response from sea turtles to drones flying between 20 to 30 meters altitude, or as low as 10 meters (Bevan et al. 2018). The drone in the proposed action would be flown at no lower than 20 meters. We would similarly expect no response (e.g., startle, avoidance) from sea turtles to the drone used in the proposed action.

A response from the fish would likely occur if the individual perceived the unmanned aircraft as a predator, in this case, a bird (raptor) (Lukas et al. 2021). Predators of smalltooth sawfish include large sharks, crocodiles, and dolphins (NMFS 2018), while sharks and killer whales (*Orcinus orca*) prey upon giant manta rays (Miller 2017). Since the unmanned aerial systems do not resemble the predators of ESA-listed fishes in the action area, we do not expect that the species would exhibit any response (e.g., startle, avoidance).

Based on the available information, we anticipate that in most cases, there would be no response to unmanned aircraft systems, but in some cases, mild, short-term behavioral responses can occur. We do not anticipate any effects to the fitness of individuals from these behavioral responses. Given the nature of these responses, we do not expect they would significantly disrupt the normal behavioral patterns of ESA-listed species including cetaceans, sea turtles, and fishes. Therefore, we conclude that this stressor (disturbance from drone activity) is insignificant and is not likely to adversely affect ESA-listed North Atlantic right whales, sea turtles, or fishes, and will not be carried forward in this consultation.

7.1.5 Incidental Capture of Non-Target Species

The research activities would only take place during daylight hours, and the research and netting activities would be conducted under constant observation by project personnel. The operation of the drone during netting would also provide an additional view from a different vantage point than a vessel-based observer, further facilitating researchers' ability to avoid non-target species. Researchers would not purposefully approach or pursue ESA-listed non-target species if encountered and would stop research activities and move to another area or wait until they have left the area if they are observed.

Nets and float lines would be tended constantly, allowing netting operations to be discontinued immediately if a non-target species is present. Project personnel have twelve years of experience implementing these protocols, and have not incidentally captured any non-target species in previous research.

Although the gear used for capture and sampling of giant manta rays could come in direct contact with an ESA-listed species, entanglements are considered highly unlikely for non-target species. Based upon extensive deployment of this type of equipment with no reported entanglement and the monitoring that is likely to prevent it from occurring, we find the probability of adverse impacts to ESA-listed species to be discountable. Therefore, we conclude that this stressor (gear entanglement) may affect, but is not likely to adversely affect ESA-listed North Atlantic right whales, sea turtles, and smalltooth sawfish, and will not be carried forward in this consultation.

7.1.6 Stressors Considered Further

The potential stressors associated with the proposed action that are likely to adversely affect ESA-listed giant manta rays are the research activities directed at the targeted research species.

The proposed action would fund directed research activities for ESA-listed giant manta rays. These activities include capture, handling, measuring, restraint, biological sampling, and tagging. The capture, handling, restraint, and other research activities could result in stressors like injury, disruption of normal activities, stress responses, and infection, some of which might lead to mortality for the individual. Because of the nature of the directed research activities, we do not expect other ESA-listed species in the action area to be exposed to those stressors, because they are not the species targeted for research. These potential stressors are further analyzed and evaluated in Section 10 below.

7.2 Species Not Likely to be Adversely Affected

There are a number of ESA-listed species, as well as designated and proposed critical habitat, that could potentially be in the action area and possibly be exposed to the stressors associated with the proposed action. The stressors associated with the proposed action, as discussed in Section 7.1, were determined to not likely to adversely affect the ESA-listed species because the effects on those species would be insignificant or discountable.

Therefore, we conclude that the proposed action is not likely to adversely affect ESA-listed North Atlantic right whales, North Atlantic DPS green, hawksbill, Kemp's ridley, leatherback, and Northwest Atlantic Ocean DPS sea turtles, or smalltooth sawfish. As a result, these species will not be considered further in this consultation.

7.3 Critical Habitat Not Likely to be Adversely Affected

The action area includes the waters of the Atlantic Ocean, off Cape Canaveral, Florida, where the research would occur, as well as the locations where the research vessels and aircraft would transit to and from the survey area. There are a number of critical habitat areas that overlap with the action area that are not likely to be adversely affected by the proposed action, and we present our rationale for this effects conclusion below.

7.3.1 North Atlantic Right Whale Designated Critical Habitat

In 1994, NMFS designated critical habitat for the Northern right whale population in the North Atlantic Ocean (59 FR 28805). This critical habitat designation included portions of Cape Cod Bay and Stellwagen Bank, the Great South Channel (each off the coast of Massachusetts), and waters adjacent to the coasts of Georgia and the east coast of Florida (Figure 8). These areas were determined to provide critical feeding, nursery, and calving habitat for the North Atlantic population of northern right whales.

In 2016, NMFS revised designated critical habitat for the North Atlantic right whale with two new expanded areas. The areas designated as critical habitat contain approximately 102,084.2 square kilometers (29,763 square nautical miles) of marine habitat in the Gulf of Maine and Georges Bank region (Unit 1) and off the Southeast U.S. coast (Unit 2) (Figure 8). Unit 2 is in the proposed action area, and will be considered here.

The physical and biological features essential to the conservation of North Atlantic right whale calving habitat that are essential to the conservation of the North Atlantic right whale, which provide calving area functions in Unit 2 are: (1) calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale; (2) sea surface temperatures from a minimum of seven degrees Celsius, and never more than 17 degrees Celsius; and (3) water depths of 6 to 28 meters (19.7 to 91.9 feet) where these features simultaneously co-occur over contiguous areas of at least 792.3 square kilometers (231 square nautical miles) of ocean waters during the months of November through April. When these features are available, they are selected by North Atlantic right whale cows and calves in dynamic combinations that are suitable for calving nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves (81 FR 4838).

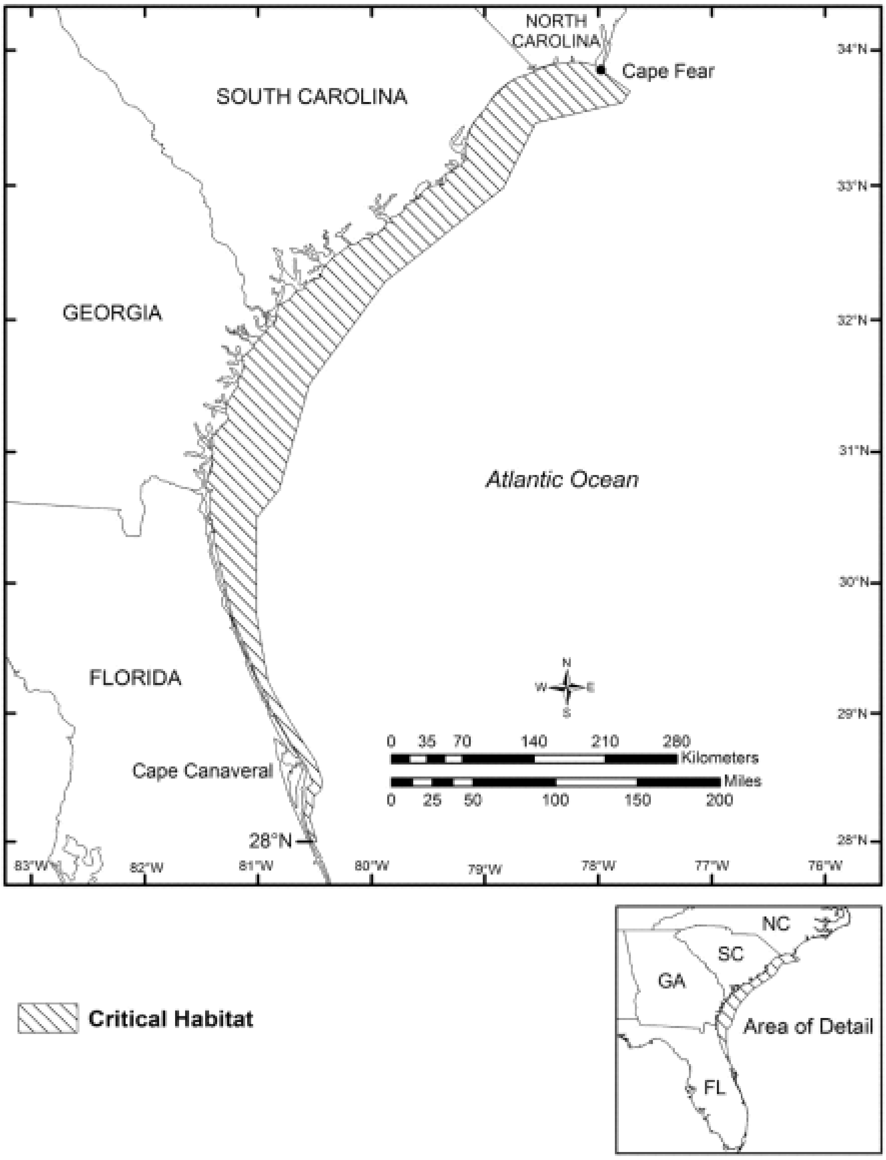

Figure 8. Map identifying designated critical habitat in the southeastern calving area for the endangered North Atlantic right whale.

The stressors associated with the proposed action that would occur in the designated critical habitat would be those associated with vessel traffic while the research vessels transit back to port. These stressors would include noise associated with vessel operation, pollution from the vessel, and the visual disturbance created by the vessel. The research activities would occur in the critical habitat (netting, sampling, tagging, etc.); the stressors associated with those activities are directed at the target species, giant manta ray. Aircraft would also occur above the designated critical habitat, causing the associated stressors of noise and visual disturbance. None of the identified stressors would have any effect on the sea surface conditions, sea surface temperatures, or the water depths within the designated critical habitat area.

The effects of all other stressors analyzed on the essential physical and biological features were found to have no effect and not likely to reduce the conservation value of designated critical habitat. In conclusion, we find that there will be no effects of the proposed action on the physical and biological features of the designated critical habitat described here. As such, the proposed action are not likely to destroy or adversely modify designated critical habitat under NMFS jurisdiction and will not be carried forward in this consultation.

7.3.2 Northwestern Atlantic Distinct Population Segment Loggerhead Sea Turtle Designated Critical Habitat

In 2014, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle along the U.S. Atlantic and Gulf of Mexico coasts, from North Carolina to Mississippi (79 FR 39856) (Figure 9). The final rule designated five different units of critical habitat, each supporting an essential biological function of loggerhead turtles. These units include nearshore reproductive habitat, winter area, *Sargassum*, breeding areas, and migratory corridors. In total, the critical habitat is composed of 38 occupied marine areas and 1,102.4 kilometers (685 miles) of nesting beaches. Loggerhead designated critical habitat occurs within the action area and the potential effects to each unit and its physical and biological features are discussed below (Table 2). Only two units of designated critical habitat occur in the action area—nearshore reproductive habitat, and breeding habitat, and thus only these units will be considered.

Table 2. Essential physical and biological features for loggerhead turtle designated critical habitat units.

Loggerhead Turtle Designated Critical Habitat Unit	Essential Physical or Biological Features
Nearshore Reproductive Habitat	1. Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 C.F.R. 17.95(c) to 1.6 kilometers (0.9 nautical miles) offshore. 2. Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water. 3. Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.
Breeding Habitat	1. High densities of reproductive male and female loggerheads.

	2. Proximity to primary Florida migratory corridor. 3. Proximity to Florida nesting grounds.

Nearshore Reproductive Habitat

Nearshore reproductive habitat is a portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during nesting season. Nearshore reproductive habitat units occur in 35 areas from North Carolina to Mississippi. These units extend from the shore to 1.6 kilometer (0.9 nautical mile) seaward. The physical and biological features for nearshore reproductive habitat are shown in Table 2.

Breeding Habitat

Breeding habitat is sites with high densities of both male and female adult individuals during the breeding season. Loggerhead turtle breeding critical habitat includes two areas along the Atlantic Ocean coast of Florida, and into the Florida Keys. The southern unit starts at the Martin County/Palm Beach County line and extends south to the Marquesas Keys. The northern portion of the breeding habitat unit is located from near Titusville, Florida, south to Florida Beach, from the shoreline to depths less than 60 meters (196.9 feet). The physical and biological features for breeding habitat are shown in Table 2.

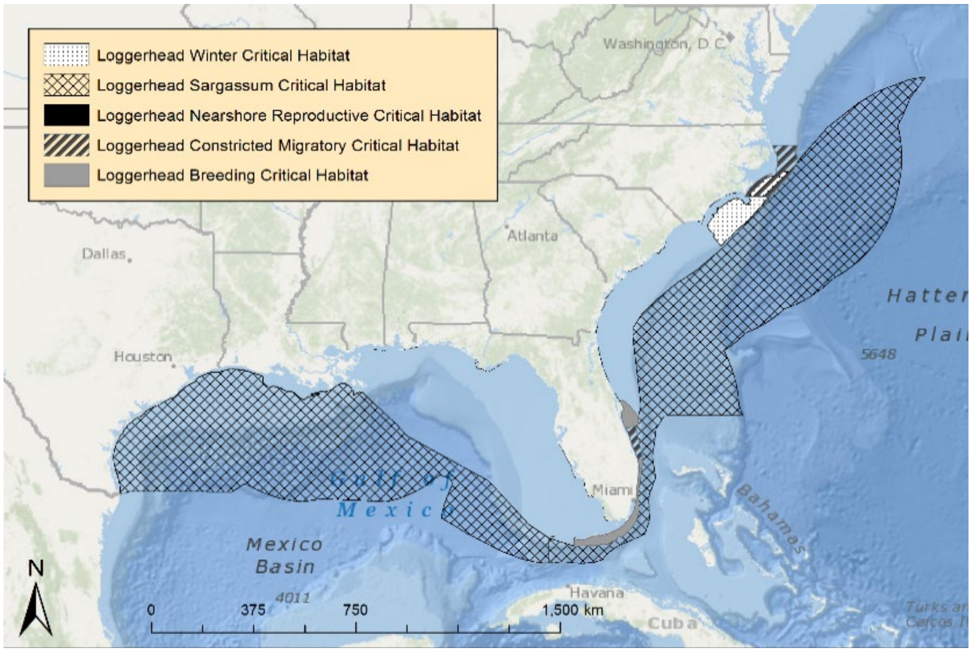

Figure 9. Map identifying designated critical habitat for the threatened Northwest Atlantic Ocean distinct population segment of loggerhead turtles.

The stressors associated with the proposed action that would occur in the designated critical habitat would be those associated with vessel traffic while the research vessels transit to and from port. These stressors would include noise associated with vessel operation, pollution from the vessel, and the visual disturbance created by the vessel. Aircraft would also occur above the designated critical habitat, causing the associated stressors of noise and visual disturbance. None of the identified stressors would have any effect on the essential physical or biological features of the nearshore reproductive habitat. The action would not install any manmade structures, create obstructions or add artificial lighting. The stressors would not have any effect on the breeding habitat—would not impact the high densities of reproductive loggerheads, or impact the proximity to the Florida migratory corridor or nesting grounds.

In conclusion, we find that there would be no effects of the proposed action on the physical and biological features of the designated critical habitat described here. As such, the proposed action are not likely to destroy or adversely modify Northwest Atlantic DPS loggerhead designated critical habitat under NMFS jurisdiction and will not be carried forward in this consultation.

8 STATUS OF SPECIES LIKELY TO BE ADVERSELY AFFECTED

This opinion examines the status of ESA-listed species and designated critical habitat that may be adversely affected by the proposed action.

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

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

8.1 Giant Manta Ray

The giant manta ray is the largest living ray, with a wingspan reaching a width of up to seven meters (23 feet), and an average size between four to five meters (15 to 16.5 feet). The giant manta ray is recognized by its large diamond-shaped body with elongated wing-like pectoral fins, ventrally placed gill slits, laterally placed eyes, and wide terminal mouth. In front of the mouth, it has two structures called cephalic lobes that extend and help to introduce water into the mouth for feeding activities (making them the only vertebrate animals with three paired appendages). Giant manta rays have two distinct color types: chevron (mostly black back dorsal side and white ventral side) and black (almost completely black on both ventral and dorsal sides).

Most of the chevron variants have a black dorsal surface and a white ventral surface with distinct patterns on the underside that can be used to identify individuals (Miller 2017). There are bright white shoulder markings on the dorsal side that form two mirror image right-angle triangles, creating a T-shape on the upper shoulders.

The giant manta ray is found worldwide in tropical and subtropical oceans and in productive coastal areas. They also occasionally occur within estuaries (e.g., lagoons and bays) and Intracostal Waterways. In terms of range, within the Northern hemisphere, the species has been documented as far north as southern California and New Jersey on the United States west and east coasts, respectively, and Mutsu Bay, Aomori, Japan, the Sinai Peninsula and Arabian Sea, Egypt, and the Azores Islands (Gudger 1922; Kashiwagi et al. 2010; Moore 2012; CITES 2013). In the Southern Hemisphere, the species occurs as far south as Peru, Uruguay, South Africa, New Zealand and French Polynesia (Mourier 2012; CITES 2013). Within its range, the giant manta ray inhabits tropical, subtropical, and temperate bodies of water and is commonly found offshore, in oceanic waters, and near productive coastlines (Figure 10) (Marshall et al. 2009; Kashiwagi et al. 2011).

Figure 10. The Extent of Occurrence (dark blue) and Area of Occupancy (light blue) for giant manta rays based on species distribution (Lawson et al. 2017).

NMFS listed the giant manta ray as threatened under the ESA (83 FR 2916, Publication Date January 22, 2018), because the giant manta ray is likely to become an endangered species within the foreseeable future throughout a significant portion of its range (the Indo-Pacific and eastern Pacific portion). On December 19, 2019, NMFS published a recovery outline, which serves as an interim guidance to direct recovery efforts for giant manta ray (NMFS 2019c).

8.1.1 Life History

Giant manta rays make seasonal long-distance migrations, aggregate in certain areas and remain resident, or aggregate seasonally (Dewar et al. 2008; Graham et al. 2012; Girondot et al. 2015;

Stewart et al. 2016). The giant manta ray is a seasonal visitor along productive coastlines with regular upwelling, in oceanic island groups, and at offshore pinnacles and seamounts. The timing of these visits varies by region and seems to correspond with the movement of zooplankton, current circulation and tidal patterns, seasonal upwelling, seawater temperature, and possibly mating behavior. They have also been observed in estuarine waters inlets, with use of these waters as potential nursery grounds (Adams and Amesbury 1998; Milessi and Oddone 2003; Medeiros et al. 2015).

Giant manta rays are known to aggregate in various locations around the world in groups usually ranging from 100 to 1,000 (Notarbartolo-di-Sciara and Hillyer 1989; Graham et al. 2012; Venables 2013). These sites function as feeding sites, cleaning stations (areas where smaller fish and crustaceans eat parasites off giant manta rays), or sites where courtship interactions take place (Heinrichs et al. 2011; Graham et al. 2012; Venables 2013). The appearance of giant manta rays in these locations is generally predictable. For example, food availability due to high productivity events tends to play a significant role in feeding site aggregations (Notarbartolo-di-Sciara and Hillyer 1989; Heinrichs et al. 2011). Giant manta rays have also been shown to return to a preferred site of feeding or cleaning over extended periods of time (Dewar et al. 2008; Graham et al. 2012; Medeiros et al. 2015). In addition, giant and reef manta rays in Keauhou and Ho’ona Bays in Hawaii appear to exhibit learned behavior. These manta rays learned to associate artificially lighting with high plankton concertation (primary food source) and shifted foraging strategies to include sites that had artificially lighting at night (Clark 2010). While little is known about giant manta ray aggregation sites, the Flower Garden Banks National Marine Sanctuary and the surrounding region might represent the first documented nursery habitat for giant manta ray (Stewart et al. 2018). Stewart et al. (2018) found that the Flower Garden Banks National Marine Sanctuary provides nursery habitat for juvenile giant manta rays because small age classes have been observed consistently across years at both the population and individual level. The Flower Garden Banks National Marine Sanctuary may be an optimal nursery ground because of its location near the edge of the continental shelf and proximity to abundant pelagic food resources. In addition, small juveniles are frequently observed along a portion of Florida’s east coast, indicating that this area may also function as a nursery ground for juvenile giant manta rays. Since directed visual surveys began in 2016, juvenile giant manta rays are regularly observed in the shallow waters (less than five meter depth) from Jupiter Inlet to Boynton Beach Inlet (J Pate, Florida Manta Project, unpublished data). However, the extent of this purported nursery ground is unknown as the survey area is limited to a relatively narrow geographic area along Florida’s southeast coast.

The giant manta ray appears to exhibit a high degree of plasticity in terms of its use of depths within its habitat. Tagging studies have shown that the giant manta rays conduct night descents from 200 to 450 meter depths (Rubin et al. 2008; Stewart et al. 2016) and are capable of diving to depths exceeding 1,000 meters (A. Marshall et al. unpublished data 2011, cited in Marshall et al. (2011)). Stewart et al. (2016) found diving behavior may be influenced by season, and more specifically, shifts in prey location associated with the thermocline, with tagged giant manta rays (n=4) observed spending a greater proportion of time at the surface from April to June and in deeper waters from August to September. Overall, studies indicate that giant manta rays have a more complex depth profile of their foraging habitat than previously thought, and may actually be supplementing their diet with the observed opportunistic feeding in near-surface waters (Couturier et al. 2013; Burgess et al. 2016).

Giant manta rays primarily feed on planktonic organisms such as euphausiids, copepods, mysids, decapod larvae and shrimp, but some studies have noted their consumption of small and moderately sized fishes (Miller 2017). While it was previously assumed, based on field observations, that giant manta rays feed predominantly during the day on surface zooplankton, results from recent studies (Couturier et al. 2013; Burgess et al. 2016) indicate that these feeding events are not an important source of the dietary intake. When feeding, giant manta rays hold their cephalic lobes in an "O" shape and open their mouth wide, which creates a funnel that pushes water and prey through their mouth and over their gill rakers. They use many different types of feeding strategies, such as barrel rolling (doing somersaults repeatedly) and creating feeding chains with other mantas to maximize prey intake.

The giant manta ray is viviparous (i.e., gives birth to live young). They are slow to mature and have very low fecundity and typically give birth to only one pup every two to three years. Gestation lasts approximately 10 to 14 months. Females are only able to produce between five and 15 pups in a lifetime (CITES 2013; Miller 2017). The giant manta ray has one of the lowest maximum population growth rates of all elasmobranchs (Dulvy et al. 2014; Miller 2017). The giant manta rays generation time (based on *M. alfredi* life history parameters) is estimated to be 25 years (Miller 2017).

Although giant manta rays have been reported to live at least 40 years, not much is known about their growth and development. Maturity is thought to occur between eight to ten years of age (Miller 2017). Males are estimated to mature at around 3.8 meter disc width (slightly smaller than females) and females at 4.5 meter disc width (Rambahiniarison et al. 2018).

8.1.2 Population Dynamics

There are no current or historical estimates of global abundance of giant manta rays, with most estimates of subpopulations based on anecdotal observations. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2013) found that only ten populations of giant manta rays had been actively studied, 25 other aggregations have been anecdotally identified, all other sightings are rare, and the total global population may be small. Subpopulation abundance estimates range between 42 and 1,500 individuals, but are anecdotal and subject to bias (Miller 2017). There is no available information on population trend for the species.

There is very little information on the abundance or spatial structure the species within the Atlantic portion of its range (Miller 2017). The population near St. Augustine, Florida, is estimated at between 90 and less than 500 individuals (Kendall 2010); this population closest to the action area for which we have information. In the U.S. Atlantic and Caribbean, giant manta ray sightings are concentrated along the east coast as far north as New Jersey, within the Gulf of Mexico, and off the coasts of the U.S. Virgin Islands and Puerto Rico. Because most sightings of the species have been opportunistic during other surveys, researchers are still unsure what attracts giant manta rays to certain areas and not others and where they go for the remainder of the time (NMFS 2019b).

The available sightings data indicate that giant manta rays occur regularly along Florida's east coast. In 2010, Georgia Aquarium began conducting aerial surveys for giant manta rays. The surveys are conducted in spring and summer and run from the beach parallel to the shoreline (zero to 2.5 nautical miles), from St. Augustine Beach Pier to Flagler Beach Pier, Florida, north of the action area. The numbers, location, and peak timing of the manta rays to this area varies by year (H. Webb unpublished data). In addition, juvenile giant manta rays have also been regularly observed inshore off the southeast Florida, approximately 95 miles (154 kilometers) south of the action area. Since 2016, researchers with the Marine Megafauna Foundation have been conducting annual surveys along a small transect off Palm Beach, Florida, between Jupiter Inlet and Boynton Beach Inlet (about 44 kilometers [24 nautical miles]) (J. Pate, MMF, pers. comm. to M. Miller, NMFS OPR, 2018). Results from these surveys indicate that juvenile manta rays are present in these waters for the majority of the year (observations span from May to December), with re-sightings data that suggest some manta rays may remain in the area for extended periods of time or return in subsequent years (J. Pate unpublished data). In the Gulf of Mexico, within the Flower Garden Banks National Marine Sanctuary, 95 unique individuals have been recorded between 1982 and 2017 (Stewart et al. 2016).

Clark (2010) suggests that giant manta rays may forage in less productive pelagic waters and conduct seasonal migrations following prey abundance. Satellite tracking studies using pop-up satellite archival tags registered movements of the giant manta ray from the Yucatan, Mexico, into the Gulf of Mexico (448 kilometers) (Marshall et al. 2016). Despite this large range, sightings are often sporadic. The timing of these sightings also varies by region (for example, the majority of sightings in Brazil occur during June and September, while in New Zealand sightings mostly occur between January and March) and seems to correspond with the movement of zooplankton, current circulation and tidal patterns, seawater temperature, and possibly mating behavior (Couturier et al. 2012; De Boer et al. 2015; Armstrong et al. 2016).

However, a study by Stewart et al. (2016) suggests that the species may not be as highly migratory as previously thought. Using pop-up satellite archival tags in combination with analyses of stable isotope and genetic data, the authors found evidence that giant manta rays may actually exist as well structured subpopulations off Mexico's coast that exhibit a high degree of residency (Stewart et al. 2016). Within its range, the giant manta ray inhabits tropical, subtropical, and temperate bodies of water and is commonly found offshore, in oceanic waters, and near productive coastlines (Marshall et al. 2009; Kashiwagi et al. 2011). As such, giant manta rays can be found in cooler water, as low as 19 degrees Celsius, although temperature preference appears to vary by region (Duffy and Abbott 2003; Marshall et al. 2009; Freedman and Roy 2012; Graham et al. 2012).

8.1.3 Status

Although manta rays have been reported to live for at least 40 years (Marshall and Bennett 2010; Kitchen-Wheeler 2013; Marshall et al. 2016) with low rates of natural mortality, the time needed to grow to maturity and the low reproductive rates mean that a female will be able to produce only five to fifteen pups in her lifetime. In the Atlantic, very little information on giant manta ray populations is available, but there is a known, protected population within the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. However, researchers are still trying to determine whether the manta rays in this area are only giant manta ray individuals or potentially also comprise individuals of a new, undescribed species (Marshall et al. 2009; Hinojosa-Alvarez et al. 2016). The best available data indicate that the giant manta ray has suffered population declines (up to 95 percent, in some areas), based on landings and market data, diver observations, and anecdotal sightings. The declines are largely believed to be caused by overfishing (Miller 2017). In areas where the species is not subject to fishing, populations may be stable. For example, Rohner et al. (2013) reported that giant manta ray sightings remained constant off the coast of Mozambique over a period of eight years. Given the migratory nature of this species, population declines in waters where the manta rays are protected have also been observed but attributed to overfishing of the species in adjacent areas within its large home range. With populations potentially ranging from around 100 to 1,500 individuals (see Table 4 in Miller (2017)), their life history traits and productivity estimates, particularly their low reproductive output and sensitivity to changes in adult survival rates, giant manta ray populations are inherently vulnerable to depletions, with low likelihood of recovery.

8.1.4 Critical Habitat

NMFS determined that the designation of critical habitat for giant manta ray was not determinable because data sufficient to perform the required analyses were lacking (NMFS 2019b).

8.1.5 Recovery Goals

On December 19, 2019, NMFS published a recovery outline, which serves as an interim guidance to direct recovery efforts for giant manta ray (NMFS 2019c). The initial focus of the interim recovery program is two-fold: 1) to stabilize population trends through reduction of threats, such that the species is no longer declining throughout a significant portion of its range; and 2) to gather additional information through research and monitoring on the species' current distribution and abundance, movement and habitat use of adult and juveniles, mortality rates in commercial fisheries (including at-vessel and post-release mortality), and other potential threats that may contribute to the species' decline.

Because the major threat currently contributing to the species' decline is overutilization in waters outside of U.S. jurisdiction, international coordination will be critical to ensuring recovery of the species. Therefore, to be effective, these actions would need to be undertaken throughout the species' range, both domestically and internationally.

9 ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02; 84 FR 44976 published August 27, 2019).

The giant manta ray faces many threats, including global climate change, commercial harvest (i.e., overfishing) and fisheries bycatch, vessel strike, pollution (microplastics, marine debris, petroleum products, etc.), and entanglement. Overall, that they are distinct in appearance and easily identified, combined with slow swimming speed, large size, and lack of fear towards humans, may increase their vulnerability to threats (e.g., fishing) (O'Malley et al. 2013; CMS 2014). The ESA status review determined that the greatest threat to the species results from fisheries related mortality (Miller 2017).

9.1 Climate Change

Because giant manta rays are migratory and considered ecologically flexible (e.g., low habitat specificity), they may be less vulnerable to the impacts of climate change compared to other sharks and rays (Chin et al. 2010). However, as giant manta rays frequently rely on coral reef habitat for important life history functions (e.g., feeding, cleaning) and depend on planktonic food resources for nourishment, both of which are highly sensitive to environmental changes (Brainard et al. 2011; Guinder and Molinero 2013), climate change is likely to have an impact on their distribution and behavior. Coral reef degradation from anthropogenic causes, particularly climate change, is projected to increase through the future. Ocean surface temperatures have increased on average by 0.88 (0.68 to 1.01) degrees Celsius from 1850 and 1900 to 2011 and 2020 (IPCC 2022). Specifically, annual, globally averaged surface ocean temperatures are projected to increase by approximately 0.7 degrees Celsius by 2030 and 1.4 degrees Celsius by 2060 compared to the 1986 to 2005 average (IPCC 2014), with climate models predicting annual coral bleaching for almost all reefs by 2050 (Heron et al. 2016). Declines in coral cover have been shown to result in changes in coral reef fish communities (Jones et al. 2004; Graham et al. 2008). Therefore, the projected increase in coral habitat degradation may potentially lead to a decrease in the abundance of fish that clean giant manta rays (e.g., *Labroides* spp., *Thalassoma* spp., and *Chaetodon* spp.) and an overall reduction in the number of cleaning stations available to manta rays within these habitats. Decreased access to cleaning stations may negatively affect the fitness of giant manta rays by hindering their ability to reduce parasitic loads and dead tissue, which could lead to increases in diseases and declines in reproductive fitness and survival rates.

Changes in climate and oceanographic conditions, such as acidification, are also known to affect zooplankton structure (size, composition, and diversity), phenology, and distribution (Guinder and Molinero 2013). As such, the migration paths and locations of both resident and seasonal aggregations of giant manta rays, which depend on these animals for food, may similarly be altered (Couturier et al. 2012). As research to understand the exact impacts of climate change on marine phytoplankton and zooplankton communities is still ongoing, the severity of this threat has yet to be fully determined (Miller 2017).

9.2 Commercial Harvest and Fisheries Bycatch

Commercial harvest and incidental bycatch in fisheries is cited as the primary cause for the decline in the giant manta ray and threat to future recovery (Miller 2017). We anticipate that these threats will continue to affect the rate of recovery of the giant manta ray. Worldwide, giant manta ray catches have been recorded in at least 30 large and small-scale fisheries covering 25 countries (Lawson et al. 2017). Demand for the gills of giant manta rays and other mobula rays has risen dramatically in Asian markets. With this expansion of the international gill raker market and increasing demand for manta ray products, estimated harvest of giant manta rays, particularly in many portions of the Indo-Pacific, frequently exceeds numbers of identified individuals in those areas and are accompanied by observed declines in sightings and landings of the species of up to 95 percent (Miller 2017).

In the U.S., bycatch of giant manta rays has been recorded in the coastal migratory pelagic gillnet, gulf reef fish bottom longline, Atlantic shark gillnet, pelagic longline, pelagic bottom longline, and trawl fisheries. Incidental capture of giant manta ray is also a rare occurrence in the elasmobranch catch within U.S. Atlantic and Gulf of Mexico, with the majority that are caught released alive.

In addition to directed harvest and bycatch in commercial fisheries, the giant manta ray is incidentally captured by recreational fishers using vertical line (i.e., handline, bandit gear, and rod-and-reel). Researchers frequently report giant manta rays having evidence of recreational gear interactions along the east coast of Florida (i.e., manta rays have embedded fishing hooks with attached trailing monofilament line) (J. Pate, Florida Manta Project, unpublished data). Internet searches also document recreational interactions with giant manta rays. For example, recreational fishers will search for giant manta rays while targeting cobia, as cobia often accompany giant manta rays (anglers will cast at manta rays in an effort to hook cobia). In addition, giant manta rays are commonly observed swimming near or underneath public fishing piers where they may become foul-hooked. The current threat of mortality associated with recreational fisheries is expected to be low, given that we have no reports of recreational fishers retaining giant manta ray. However, bycatch in recreational fisheries remains a potential threat to the species.

9.3 Vessel Strike

Vessel strikes can injure or kill giant manta rays, decreasing fitness or contributing to non-natural mortality (Deakos et al. 2011; Couturier et al. 2012). Giant manta rays do not surface to breathe, but they can spend considerable time in surface waters, while basking and feeding, where they are more susceptible to vessel strikes (McGregor et al. 2019). They show little fear toward vessels which can also make them extremely vulnerable to vessel strikes (Deakos et al. 2011); C. Horn, NMFS, personal observation). Five giant manta rays were reported to have been struck by vessels from 2016 through 2018; individuals had injuries (i.e., fresh or healed dorsal surface propeller scars) consistent with a vessel strike. These interactions were observed by researchers conducting surveys from Boynton Beach to Jupiter, Florida (J. Pate, Florida Manta Project, unpublished data). The giant manta ray is frequently observed in nearshore coastal waters and feeding within and around inlets. As vessel traffic is concentrated in and around inlets and nearshore waters, this overlap exposes the giant manta ray in these locations to an increased likelihood of potential vessel strike. Yet, few instances of confirmed or suspected mortalities of giant manta ray attributed to vessel strike injury (e.g., via strandings) have been documented. This lack of documented mortalities could also be the result of other factors that influence carcass detection (i.e., wind, currents, scavenging, decomposition etc.). In addition, manta rays appear to be able to heal from wounds very quickly, and while high wound healing capacity is likely to be beneficial for their long-term survival, the fitness cost of injuries and number vessel strikes occurring may be masked (McGregor et al. 2019).

9.4 Pollution: Microplastics

Filter-feeding megafauna are particularly susceptible to high levels of microplastic ingestion and exposure to associated toxins due to their feeding strategies, target prey, and, for most, habitat overlap with microplastic pollution hotspots (Germanov et al. 2019). Giant manta rays are filter feeders, and, therefore can ingest microplastics directly from polluted water or indirectly through-contaminated planktonic prey (Miller 2017). The effects of ingesting indigestible particles include blocking adequate nutrient absorption and causing mechanical damage to the digestive tract. Microplastics can also harbor high levels of toxins and persistent organic pollutants, and introduce these toxins to organisms via ingestion. These toxins can bioaccumulate over decades in long-lived filter feeders, leading to a disruption of biological processes (e.g., endocrine disruption), and potentially altering reproductive fitness (Germanov et al. 2019). Jambeck et al. (2015) found that the Western and Indo- Pacific regions are responsible for the majority of plastic waste. These areas also happen to overlap with some of the largest known aggregations of giant manta rays. For example, in Thailand, where recent sightings data have identified over 288 giant manta rays (MantaMatcher 2016), mismanaged plastic waste is estimated to be on the order of 1.03 million tons annually, with up to 40 percent of this entering the marine environment (Jambeck et al. 2015). Approximately 1.6 million tons of mismanaged plastic waste is being disposed of in Sri Lanka, again with up to 40 percent entering the marine environment (Jambeck et al. 2015), potentially polluting the habitat used by the nearby Maldives aggregation of manta rays. While the ingestion of plastics is likely to negatively affect the health of the species, the levels of microplastics in manta ray feeding grounds and frequency of ingestion are presently being studied to evaluate the impact on these species (Germanov et al. 2019).

9.5 Entanglement: Mooring and Anchoring Lines

Mooring and boat anchor line entanglement may also wound giant manta rays or cause them to drown (Deakos et al. 2011; Heinrichs et al. 2011). There are numerous anecdotal reports of giant manta rays becoming entangled in mooring and anchor lines (C. Horn, NMFS, unpublished data), as well as documented interactions encountered by other species of manta rays (C. Horn, NMFS, unpublished data). For example, reef manta rays on occasion entangle themselves in anchor and mooring lines. Deakos et al. (2011) suggested that manta rays become entangled when the line makes contact with the front of the head between the cephalic lobes, the animal's reflex response is to close the cephalic lobes, thereby trapping the rope between the cephalic lobes, entangling the manta ray as the animal begins to roll in an attempt to free itself. In Hawaii, on at least 2 occasions, a reef manta ray was reported to have died after entangling in a mooring line (A. Cummins, pers. comm. 2007, K. Osada, pers. comm. 2009; cited in Deakos et al. (2011)). In Maui, Hawaii, Deakos et al. (2011) observed that 1 out of 10 reef manta rays had an amputated or disfigured non-functioning cephalic lobe, likely a result of line entanglement. Mobulid researchers indicate that entanglements may significantly affect the manta rays fitness (Deakos et al. 2011; Heinrichs et al. 2011; Couturier et al. 2012; CMS 2014; Germanov and Marshall 2014; Braun et al. 2015). However, there is very little quantitative information on the frequency of these occurrences and no information on the impact of these injuries on the overall health of the species.

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

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed giant manta rays in the action area likely to be adversely affected by the proposed action. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strikes, incidental bycatch, entanglement), whereas others result in more indirect (e.g., climate change that impacts prey availability) or non-lethal (e.g., plastic ingestion) impacts.

We consider the best indicator of the environmental baseline on ESA-listed resources to be the status and trends of those species. As noted in Section 7, for the species considered in this consultation, there is uncertainty about its status. If the species is declining in abundance, it is possible that the suite of conditions described in this *Environmental Baseline* section is limiting their recovery. However, it is also possible that their populations are at such low levels (e.g., due to overfishing) that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself. A thorough review of the status and trends of each species for which NMFS has found the action is likely to cause adverse effects is discussed in the *Status of Species Likely to be Adversely Affected* section of this opinion.

10 EFFECTS OF THE ACTION

Section 7 regulations define "effects of the action" as all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur (50 C.F.R. §402.02). Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 C.F.R. §402.17).

This effects analyses section is organized following the stressor, exposure, response, risk assessment framework.

10.1 Definition of Take, Harm, and Harass

Section 3 of the ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. We categorize two forms of take, lethal and sublethal take. Lethal take is expected to result in immediate, imminent, or delayed but likely mortality. Sublethal take is when effects of the action are below the level expected to cause death, but are still expected to cause injury, harm, or harassment. Harm, as defined by regulation (50 C.F.R. §222.102), includes acts that actually kill or injure wildlife and acts that may cause significant habitat modification or degradation that actually kill or injure fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering. Thus, for sublethal take we are concerned with harm that does not result in mortality but is still likely to injure an animal.

NMFS has not defined "harass" under the ESA by regulation. However, on October 21, 2016, NMFS issued interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." For this consultation, we rely on this definition of harass when assessing effects to all ESA-listed species.

The ESA does not prohibit the taking of threatened species unless special regulations have been promulgated, pursuant to ESA Section 4(d), to promote the conservation of the species. ESA Section 4(d) rules have not been promulgated for giant manta rays; therefore, ESA section 9 take prohibitions do not apply to this species. In our biological opinions, we estimate take of these threatened species, we determine whether the action may jeopardize the continued existence of these species, and we work with the action agency to minimize take. We do not, however, authorize take of threatened species for which take is not prohibited under the ESA.

In the following sections, we consider the exposures that could cause an effect on ESA-listed species that are likely to co-occur with the stressors we have determined are likely to adversely affect these species in space and time, and identify the nature of that co-occurrence. We consider the frequency and intensity of exposures that could cause an effect on ESA-listed species and, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the population(s) or subpopulation(s) those individuals represent. We also consider the responses of ESA-listed species to exposures and the potential reduction in fitness associated with these responses.

10.2 Exposure Analysis

In this section, we quantify the likely exposure of giant manta rays to the activities and associated stressors that may result from the proposed action. BOEM estimated the number of ESA-listed giant manta rays that may be exposed to the proposed action.

BOEM has explained the take number estimates in their consultation materials. BOEM is targeting 30 individuals to have an adequate sample size to meet the research objectives. Based on this explanation, and the conservative assumption that all the planned research activities *could* occur, we adopt the exposure numbers for giant manta rays that are reasonably certain to occur as the number of animals specified likely to be affected by the specific research activities. These take numbers and resulting effects are discussed below:

- 30 individual giant manta rays of either sex, adults or juveniles, would be closely approached via vessel, captured (compass net or free hooking), handled, restrained, measured, biologically sampled, monitored, and tagged.
- A total of 50 tags would be used, with some individuals receiving two tags.
    - 30 acoustic tags, 10 satellite tags, 10 inertial measurement (IMU) tags.

Smaller acoustic tags would be surgically implanted in juveniles (less than 1.5-meter disc width), while larger acoustic tags would be externally attached to adults via a dart tag. IMU tags are attached externally by suction cup. Satellite tags are attached externally through the dorsal fin via the four-point bolt-on method.

10.3 Response Analysis

As discussed in *The Assessment Framework* (Section 2) of this opinion, response analyses determine how ESA-listed resources are likely to respond after exposure to an action's effects on the environment or directly on ESA-listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might result in reduced fitness of ESA-listed individuals. Ideally, response analyses will consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

There is little information available about the response of giant manta rays specifically to the proposed research activities. Where we can find studies documenting the effects of research activities on giant manta rays, we use those studies in our analysis. However, we also rely on studies documenting the effects of other similar species (e.g., elasmobranchs) to the techniques in the proposed action. We assume that as elasmobranchs, giant manta rays would respond similarly as other types of sharks or rays would to the same research activities.

We expect that mostly short-term behavioral responses from disturbance would be from capture, handling, restraint, sampling and tagging. In addition, we expect that energetic costs (from tag attachments) that may result from research activities would not likely lead to disruption of essential behaviors such as feeding, mating, or rearing, to a degree that the individual's likelihood of successful reproduction or survival would be substantially reduced. The sections below present an in-depth review of each research activity BOEM proposes to conduct and their corresponding effects on giant manta rays.

10.3.1 Potential Response of Giant Manta Rays to Capture Methods

During capture, the captured giant manta ray could experience stress and discomfort at being entangled by the compass net or the hook used in the free hooking method. If the stress response is severe enough, mortality might occur.

Compass netting would be the primary means of capture. Seine net fishing gear closely approximates the compass netting to be used in the proposed action. High survival rates (98.8 percent, n=15) of two species of cownose rays (Rhinopteridae) reported in another study (Rangel et al. 2018) confirm that seine net fishing gear does not appear to have an immediate impact on the physiological condition of the rays.

Free hooking would be used in deeper waters than compass netting (greater than 2.7 meters), and only if compass netting did not provide enough individuals for sampling. The free hooking capture technique is a fairly new method for giant manta rays. The technique has been previously implemented successfully on reef manta rays (*Manta alfredi*) by Kessel et al. (2017), Knochel et al. (submitted), and scientists from GAI. The three tagged individuals in the Kessel et al. (2017) study were observed by divers behaving normally immediately after tagging, and later photographed in a feeding aggregation the day after tagging, suggesting a rapid return to normal behavior. The tags transmitted data from 32 to 366 days.

Rod and reel capture is similar to free hooking, and can serve as a comparison when examining potential responses of giant manta rays to free hooking capture. Skomal et al. (2007) used animal-borne images to observe post-release behavior of grey reef sharks caught by rod and reel, in addition to blood chemistry samples to analyze stress response. The study concluded that animals subjected to short fight time via rod and reel capture, and short handling times (less than six minutes on average), were more likely to exhibit natural behaviors upon release than longer fight and handling times. The rod and reel capture technique did not cause significant physiological disturbances that impacted post-release behavior. Blood chemistry regression analysis found that blood pH and gases were not significantly influenced by total fight time, but blood lactate and bicarbonate increased and decreased significantly with total fight time, respectively.

Kneebone et al. (2013) examined stress response to rod and reel capture methods in juvenile sand tiger sharks (*Carcharius taurus*). A controlled environment allowed simulation of rod and reel capture methods while allowing the researchers to collect blood samples at designated time intervals to examine stress response pre- and post-capture, as well as to determine chances of post-release survivability via acoustic transmitter insertion prior to release. Three (3) minute angler simulations revealed rapid and significant disruptions to blood chemistry, an indicator of stress response. Recovery occurred within 12 to 24 hours. Acoustic transmitters revealed high degrees of immediate, short, and long-term post-release survivorship. Physiological disruptions as a result of stress response did not appear to reduce immediate survivability (five days post-release). The study concluded juvenile sand tiger sharks can cope with and survive the physiological stress associated with rod and reel capture.

Based on the response of other elasmobranchs to similar capture methods, and the protective measures in place in the proposed action, we expect no more than short-term stress responses from handled giant manta rays. We do not expect giant manta rays to experience long-term detrimental effects from capture.

10.3.2 Potential Response of Giant Manta Rays to Handling Methods

During handling, the captured giant manta ray could experience stress and discomfort at being held for sampling and tagging. This would occur in addition to the stress of being captured. If the stress response is severe enough, mortality might occur.

For handling (and tagging and other additional sampling procedures), giant manta rays would be turned upside down (ventral side up) to induce tonic immobility. There would be no anesthesia or other sedation techniques used. Henningsen (1994), mentioning tonic immobility in elasmobranchs as "animal hypnosis," "death feigning," or "catalepsy," described it as an unlearned response of immobility and torpor, lasting from under a minute to several hours. Kessel and Hussey (2015) recognized the reduced potential for negative sub-lethal effects as a result of using tonic immobility over a chemical anesthetic during surgical implantation procedures, including: no risk of overdose, no uptake of chemicals to body tissues, minimal disruption to respiration, and immediate and full recovery.

During handling, researchers would monitor the giant manta ray with a blood analyzer to monitor the physiological stress markers (lactic acid and bicarb) to track the physical state and stress response of the individual. By doing this, researchers would have the information necessary to cease sampling and release the animal if it became apparent that the individual was responding poorly. Lactate is a reliable marker of post-release survival in other elasmobranch species (Jerome et al. 2018), and so we consider the blood monitoring and release protocols proposed in the research activities would be effective at preventing mortality.

In a study examining physiological responses of capture and handling from American cownose ray (*Rhinoptera bonasus*) and spotted eagle ray (*Aetobatus narinari*), researchers found a gradual increase in lactate (stress response hormone) over time, and the elevated levels continued for as long as the animal was held in confinement. The results indicate that releasing rays promptly after research activities is protective for the animal (10 to 20 minutes, and less than 30 minutes) (Rangel et al. 2021).

All handling procedures are designed to mitigate potential impacts associated with handling animals, sampling, etc., and would be implemented to promote efficiencies and minimize stress individuals during the proposed action. According to the proposed action, an individual would be held for a maximum of 30 minutes; due to prior experience, researchers expect that the total time to conduct the research activities would be closer to 15 minutes.

In cases where the researchers are compass netting or free hooking while on the Boston Whaler or the mullet boat, all handling of captured giant manta rays would take place in the water alongside the boat. For giant manta rays captured while using the M/V OCEARCH, individuals would be guided by researchers to the lift platform on the vessel. A hose would be used for water flow over the gills to aid in ventilation during sampling.

Batoids (i.e., rays) exhibit plastic responses to capture, e.g. surviving several hours out of water and generally have remarkably high post-capture survival (Wosnick et al. 2019). Since the giant manta rays in this action would be kept out of the water for a maximum of 30 minutes and tended to continuously during the procedures, we do not expect giant manta rays to experience long-term detrimental effects from handling. Based on the responses of other batoids and elasmobranch undergoing similar handling procedures, and the conservative methods to be used in handling during research, we expect no more than short-term stress responses from handled giant manta rays.

10.3.3 Potential Response of Giant Manta Rays to Tagging Methods

The proposed action would entail the use of three different tags, each inserted or attached in a different way. Each method of tag attachment or insertion could elicit a different response from a giant manta ray. A tagged giant manta ray could experience stress and discomfort at being tagged. If the stress response is severe enough, mortality might occur. In addition, because of the invasive nature of the tagging methods, there is a possibility of infection, injury, or even delayed mortality if the individual experiences severe effects from tagging. The shape and weight of an external tag could potentially cause drag while the animal is swimming, causing the animal to exert more energy to move, impeding foraging or other essential activities possibly leading to fitness consequences.

10.3.3.1 Acoustic Tags: Internal Implantation

Vemco V16 acoustic tags would be surgically inserted into juveniles (less than 1.5 meter disc width), while the acoustic tags would be externally attached to adults, with the tags being eventually shed. The internal acoustic tag would remain in the individual juvenile throughout its life. The surgical insertion of an acoustic tag in juveniles is the most invasive tagging technique and would likely cause short term stress and pain to the animal. Only individuals in good condition would be tagged.

Heupel and Simpfendorfer (2002) reported individual black tip reef sharks (*Carcharhinus limbatus*) had no responses to incision, tag insertion or suturing and were found in good condition at release. Other research by Snow et al. (1993) concluded that since elasmobranch fishes lack complete myelination of neural tissues, "sharks and rays lack the neural apparatus essential for the sensation of pain" (Rose 2002; Rose 2007). The American Fisheries Society has also supported this finding. Therefore, no pain response would be expected from giant manta rays when the incision is made for tag implantation.

Internal tagging involving invasive surgery could also result in improper healing of wounds. Two factors affecting the healing rate of wounds in fish after invasive surgery would include secondary infection and inflammation. Because fish epidermal cells at all levels are capable of mitotic division, during wound healing there is a loss of the intracellular attachments, causing cells to migrate rapidly to the injury to cover the defect and provide some waterproof integrity (Wildgoose 2000). This response leads to a reduction in the thickness of the surrounding epidermis, producing a thin layer of epidermis at least one cell thick over the wound. However, the process can also sometimes be inhibited by secondary infection and inflammation (Wildgoose 2000). Thorstad et al. (2000) found that surgical incisions were not fully healed in 13 farmed-raised Atlantic salmon surgically implanted with transmitter devices. Two of these animals had signs of inflammation and necrotic tissue developing from a resulting infection. The selection of suture material may affect healing rate. Juvenile largemouth bass implanted with micro- radio transmitters exhibited short-term (five days) inflammation around incisions and suture insertion points for both non-absorbable braided silk and non-absorbable polypropylene monofilament (Cooke et al. 2003). However, longer-term healing was found complete at 20 days post-surgery in these same animals; almost all sutures were shed and the incisions had healed (Cooke et al. 2003). Similarly, Chapman and Park (2005) examined the healing rate of Gulf of Mexico sturgeon following surgical gonad biopsy, finding both absorbable and non-absorbable suture material used to close incisions gave good results. All sturgeon survived the procedure and wounds had healed at 30 days post-surgery. However, Wagner et al. (2000) found that the use of dummy radio transmitters in test animals compounded the inflammatory effect that silk sutures had on the healing rate of incisions compared to surgeries without implanted transmitters.

There is no published information documenting the long-term survival rate of giant manta rays after invasive surgeries to implant transmitters. However, researchers have evaluated post-surgery conditions of several elasmobranchs species after similar surgeries. Little harm was attributed to individual recaptured animals surgically implanted with transmitters (e.g., for bat ray – (Matern et al. 2000); blacktip shark –(Heupel et al. 2004); lemon shark –(Morrissey and Gruber 1993)). In the case of 38 juvenile lemon sharks (47 to 100 centimeter PCL) tagged internally with acoustic tags, all had normal color and muscle tone and appeared healthy when recaptured 20 days post-surgery; only thin black lines at the incision site were evident (Morrissey and Gruber 1993). In another lemon shark study, Wetherbee et al. (2007) similarly found that sutures were absent three weeks post-surgery, with only faint scars remaining where incisions had been made. Holland et al. (1999) observed that the healing of incisions in tiger sharks implanted with acoustic transmitters were not as qualitatively severe in comparison to naturally occurring wounds on such animals.

Further information has been gained on the long-term health and survival rates of recaptured elasmobranches after surgical implanting of internal tags. For example, Morrissey and Gruber (1993) recaptured 17 internally tagged juvenile lemon sharks after 1055 days post-surgery. These animals exhibited growth ranging from 0.3 to 28.2-centimeter precaudal length (6.4 to 9.9 centimeter/year), an amount of growth expected for the species and the individuals' time at liberty. Holland et al. (1999) recaptured two tiger sharks after 377 days at liberty, after the 12-month internal tags' battery had run out, indicating that the tagged individuals suffered no long-term adverse effects from tagging.

If tags are too heavy or cumbersome, a tagged individual could experience difficulty swimming, which could in turn inhibit an animal's ability to conduct essential life functions (migrating, foraging, etc.) The tag weight relative to a fish body weight has also received attention in studying the effects of an internal tagging procedure (Jepsen et al. 2002). Two factors directly affecting a tagged fish have been reported, including tag weight in water (excess mass) and tag volume. Winter (1996) recommends that the tag/body weight ratio in air should not exceed 2 percent. The Vemco V16 tags weigh less than 37 grams in air (less than 18 grams in water). Giant manta rays weigh 12.5 kilograms at birth (1.15 meter disc width (Miller 2017), so the juvenile manta rays (less than 1.5 meter disc width) targeted for study in the proposed action would be large enough such that the acoustic tags would not exceed the 2 percent ratio.

10.3.3.2 Acoustic Tags: External Attachment

Vemco V9 acoustic tags would be externally attached to adult giant manta rays (individuals larger than 1.5-meter disc width) with an intradermal dart tag connected via a polyethylene fiber (e.g., Dyneema ®) tether. The tag is designed to fall off naturally over time (800 to 900 days). The Vemco V9 tags weigh less than 5 grams in air (less than 3 grams in water).

There has not been a formal assessment of the effects of dart tags on giant manta rays. These effects have been studied on other elasmobranchs and it is reasonable to assume the effects of dart tags on sharks and giant manta rays would be similar because they have similar skin and muscle structure. The effects of dart tags on sharks were analyzed by Heupel and Bennett (1997), who sampled the dermal and epidermal tissues and examined them histologically. Tissues from around tag sites were removed at time intervals ranging from 100 minutes to 284 days post-tagging. These samples showed acute and chronic responses to tagging. Acute responses consisted of localized tissue breakdown and hemorrhaging and occurred within the first few hours after tag insertion. At 10 hours, post-tagging an intermediate response was apparent. This phase was characterized by further hemorrhaging and red and white blood cell movement into the wound area. The chronic response observed in the 10 to 284 day post-tagging samples was characterized by fibrous tissue formation to sequester the tag. This tissue presumably protects the adjacent musculature from further trauma produced by movement of the tag. Tissue repair appeared to progress consistently in all specimens and no secondary infections at the tag site were seen. Tagging produced only localized tissue disruption and did not appear to be detrimental to the long-term health of individual sharks in that study. Therefore, we believe similar results should be expected when dart tagging adult giant manta rays.

Biofouling, or the colonization by marine organisms on the external tag, can be problematic. Biofouling can cause detrimental effects to the tagged individual itself, with the encrusting organisms increasing hydrodynamic drag (Dicken et al. 2011). The external acoustic tags are expected to operate for 800 to 900 days. Although it is difficult to predict how long an external dart tag can remain attached, the results of other shark-tagging studies indicate that the timeframes of 10 to 284 days (Heupel and Bennett 1997) and more than one year (Hammerschlag et al. 2011) are possible comparison attachment times for the proposed activities.

In one study of recaptured ragged tooth sharks (*Carcharius taurus*), externally tagged with dart tags in a manner similar to the proposed action, researchers first saw epibionts colonizing the tags as soon as 47 days after release (Dicken et al. 2011). As such, it is possible that biofouling could be expected to occur during the period when the tag is attached. However, given the small size of the V9 tag (less than 2 inches long), and the short length of the attachment dart tag and fiber (less than a few inches), there is a limited amount of surface area upon which marine organisms could colonize. We expect there could be some biofouling of the external tag, but likely causing an additional weight of around a few grams (Dicken et al. 2011), and thus not enough exceed the 2 percent tag/body weight ratio.

As described above, the tag weight relative to the animal's body weight is an important consideration. The acoustic tags that would be externally attached to adult giant manta rays weigh less than five grams in air, and with adult giant manta rays weighing several hundred kilograms (or more) (Miller 2017), the external acoustic tags would not exceed the 2 percent ratio.

Being on the exterior of the animal, the external tag apparatus could pose an entanglement risk. However, given the overall small size of the external tag and its close placement to the body of the giant manta ray, we do not think entanglement is likely.

10.3.3.3 Satellite Tags

A satellite tag would be attached to the dorsal fin via the four-point bolt-on method, or an alternative single point tether attachment ("looping method"). In both methods, the bolt or the vinyl-coated wire line would naturally corrode, and the tag and attachment pieces would fall away from the individual after about a year. The tag would be attached to the dorsal fin, where there are no nerve endings, so we would not expect the animal to experience pain during the attachment procedure.

Eight giant manta rays were similarly tagged with pop-off satellite tags in 2010 and 2011 by GAI, with no apparent detrimental effects, with the movement data animals behaving in an expected manner (i.e., habitat use) (BOEM 2021). Heupel et al. (1998) monitored the effects of similar method of attaching tags through the dorsal fins of carcharhinids, which is comparable to giant manta rays as they are also cartilaginous fishes. No infection was observed in tissues surrounding the wound. Disruption of the fin surface was observed due to abrasion by the tag, but did not appear to cause a severe tissue reaction. Even though the tags caused continued tissue disruption (until they fall off) no signs of infection were found in the tissue samples. The dorsal tag attachment method is also used in smalltooth sawfish research (NMFS 2019a). Results of previous research have reported no detrimental effects from the use of this tag attachment method (NMFS 2020; NMFS 2021). Since the transmitters are attached to the giant manta ray via wires or bolts that are designed to erode, the transmitter/tag apparatus is expected to eventually fall away out of the fin, leaving no long-term damage.

The fin-mounted tags are meant to stay attached for 12 months, which could be long enough for biofouling organisms to attach to the tags (Dicken et al. 2011). In a similar study, the amount of weight added by organisms attached to external tags was up to almost 8 grams. (Dicken et al. 2011). We do not expect that the additional weight of biofouling organisms to the weight of the tag to exceed the 2 percent tag weight/body ratio threshold.

The fin-mounted SPOT/SPLASH tags proposed for use weigh less than 100 grams, and would not exceed the 2 percent tag weight/body weight ratio threshold. Even if combined with the weight of other tags (some individuals would be tagged with more than one tag), the individual tags are light enough that the combined weight would still not exceed the threshold.

Like the external acoustic tags, the externally-attached satellite tags could also pose an entanglement risk to the individual. However, because of the small size of the tag and its close attachment to the dorsal fin, we do not think entanglement is likely.

10.3.3.4 Inertial Measurement Tags

Inertial measurement (IMU) tags would be attached externally to the pectoral fin via suction cup. These tags would remain attached temporarily, for three to five days, before they fall off. The IMU tags weigh 110 grams in air, and would not exceed the 2 percent tag weight/body weight threshold.

Due to their shape, IMU tags may present different hydrodynamic concerns than the other low-profile tags proposed for use in the action. Suction-cup mounted IMU tags, similar to other animal-borne video and environmental data collection systems (AVEDS) or “Crittercams©”, would cause hydrodynamic drag for the giant manta rays while tags are attached. However, we believe that they would have negligible effects on the movements of giant manta rays. The IMU tags would detach within about three to five days indicating that any effects would be very short-term. Due to the short duration of the IMU tag attachment, biofouling is unlikely occur; that is, the tag would not stay on long enough for organisms to attach and grow. Similarly, due to the brief attachment time, entanglement is unlikely to occur.

As part of other previous studies, giant manta rays have been previously externally tagged with satellite, acoustic, and IMU tags had no documentation of long-term adverse impacts associated with each tag type; short-term impacts like the stress and pain at the time of attachment (Graham et al. 2012; Braun et al. 2015; Stewart et al. 2016; Kessel et al. 2017; Stewart et al. 2018; Stewart et al. 2019; Andrzejaczek et al. 2021).

Any unanticipated effects would be short-lived, and are not likely to translate to significant impacts, such as a permanent shift in habitat use or reduced reproductive success, to the tagged giant manta ray.

Tagging would only be carried out on individuals in excellent condition. Researchers would forego performing these procedures on compromised individuals. The researchers carrying out the activities have experience in performing them on captive giant manta rays and on related elasmobranch species, and possess the judgement to assess the condition of a giant manta ray.

10.3.4 Potential Response of Giant Manta Rays to Measurement, Photography, and Biological Sampling

Additional sampling such as photographs, morphometrics (measurements), fin clips, muscle biopsy, mucus swabs, and blood sampling would occur at the same time the animal is being handled for implanting or attaching tags. For sampling and tagging, the animal would be flipped onto its ventral side to induce tonic immobility. In this state, the individual remains still and it is possible to safely perform the sampling and tagging activities.

We expect no responses from the measuring or photography. The captured animal would be being handled at the time these procedures are carried out, and because these activities are not invasive and require minimal (or no) contact, we expect that any response would be from the handling.

The researchers would take a small tissue sample clipped with disinfected scissors from the dorsal fin for genetic analysis. The procedure is common and accepted practice in elasmobranch research. Research has shown that it does not impair the animal's ability to swim and is not thought to have any long-term adverse impact. An extensive tagging program for small sharks has been underway at Mote Marine Laboratory since the early 1990s. Based on recapture data there has been no difference in recapture rate between clipped and unclipped blacktip sharks. This suggests that the survival of these animals is the same, and that fin clips do not have a significant long-term impact on the health of elasmobranchs. NMFS would expect that the collection of a tissue sample would not cause any significant additional stress or discomfort to the animal beyond what is experienced during other research activities.

Muscle biopsy sites (with diameters up to 5 centimeters) are known to heal quickly and completely when used on a variety of vertebrates such as sharks, teleosts, and marine mammals (Weller et al. 1997; Krützen et al. 2002). While we do not have records of the response of muscle biopsies from giant manta rays, based on the similarity of the procedure and the responses by other species, they are not expected to result in any long-term effects, such as reduced growth or swimming ability.

The mucus swab sampling requires a brief direct contact with a giant manta ray by using cotton-tipped sampling swab to the sampled area (nasal cavity, mouth, etc.), but the contact is only expected to last for seconds. The sampling swab is sterile and would not contain any hazardous materials. This procedure would not result in skin breakage, and therefore we do not expect any potential for serious injury or long-term effects.

Blood samples would be drawn from the ventral caudal vein or the pectoral wing using 16 to 18 gram needles. Blood sampling has been performed for over 20 years by Mote Marine Laboratory Center for Shark Research staff on over 1,000 sharks, skates, and rays in a laboratory setting allowing for post-handling observation (Hull et al. 1994; Manire et al. 1995). No harmful side effects have been observed from the blood draws and no known mortalities have resulted from the process. During field collection of blood from over 50 bull sharks (*Carcharhinus leucas*) in the Caloosahatchee River all sharks were quickly sampled and successfully released (Gelsleichter 2009).

Measuring, photographing, and biological sampling of giant manta rays may cause short-term stress responses, but those responses are not likely to result in pathologies because of the short duration of the handling. The proposed methods of sampling giant manta rays are the same as have been carried out in previous permits and consistent with the handling of other elasmobranchs (e.g., smalltooth sawfish). Mitigation measures built into the proposed action such as brief procedures carried out by experienced personnel, should negate the chance of adverse effects during sampling. We expect that individual giant manta rays would normally experience no more than short-term stresses as a result of these activities. No lasting or major injury would be expected from these activities.

10.4 Risk Analysis

In this section, we assess the consequences of the responses of the individuals that have been exposed, the populations those individuals represent, and the species those populations comprise.

We measure risks to individuals of threatened or endangered species based upon effects on the individual's fitness, which may be indicated by changes to the individual's growth, survival, annual reproductive fitness, and lifetime reproductive success. We expect the numbers of the following species to be exposed to the research activities:

- 30 juvenile and adult giant manta rays, either sex.

As described above, the proposed action would result in temporary effects, largely behavioral or physiological (stress response) but with some potential for injury or mortality to the exposed giant manta rays. The potential for adverse effects to result in injury or mortality is low in part due to the required minimization measures (e.g., brief handling time, blood monitoring) in the proposed action. As such, we believe the fitness consequences to ESA-listed giant manta rays exposed to the research activities would have a minimal effect on the population of the species.

11 CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We expect that those aspects described in the *Environmental Baseline* (Section 9) will continue to impact ESA-listed resources into the foreseeable future. We expect climate change, vessel strikes, fisheries (fisheries interactions and overfishing), pollution (microplastics), entanglement, and scientific research activities to continue into the future with continuing impacts to giant manta rays. Climate change and its effects on corals could mean detrimental impacts to species that rely on reefs for essential life functions (feeding, cleaning), like giant manta rays. Because of recent trends and based on available information, we expect the amount and frequency of fishing activity to persist in the action area, and that giant manta rays will continue to be impacted, in the action area, and throughout its range.

During this consultation, we searched for information on future state, tribal, local or private (non-Federal) actions that were reasonably certain to occur in the action area. We conducted electronic searches of *Google* and other electronic search engines for other potential future state or private activities that are likely to occur in the action area.

Future tribal, state, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Activities occurring in the action area are primarily those conducted under state management. These actions may include changes in ocean policy and increases and decreases in the types of activities currently seen in the action area, including changes in the types of fishing activities, resource extraction, and designation of marine protected areas, any of which could influence the status of listed species in the action area in the future. Government actions are subject to political, legislative and fiscal uncertainties. As a result, any analysis of cumulative effects is difficult, particularly when taking into account the geographic scope of the action area, the various authorities involved in the action, and the changing economies of the region.

Future activities could include BOEM-related dredging activities. Giant manta rays have been occasionally observed in the vicinity of dredging activities conducted offshore and anecdotal reports suggest the potential risk for incidental capture (non-lethal) in association with relocation trawling operations conducted in front of the dredge to mitigate risk of interaction with protected sea turtles. This research in the proposed action can increase understanding of giant manta ray movements, better describe the potential risk of interaction, and determine how to reduce risk of interaction with BOEM-dredging and relocation trawling activities. Such activities would be subject to future ESA section 7 consultation.

12 INTEGRATION AND SYNTHESIS

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 10) to the *Environmental Baseline* (Section 9) and the *Cumulative Effects* (Section 11) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species Likely to be Adversely Affected* (Section 8).

Below we summarize the probable risks the proposed action poses to threatened and endangered species. This summary integrates the exposure profile presented previously with the results of our response analysis for each of the activities considered in this opinion.

12.1 Jeopardy Analysis

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both the survival and recovery of the species.

Based on our effects analysis, adverse effects to giant manta rays are likely to result from the action. The following discussions summarize the probable risks that research activities pose to giant manta rays. These summaries integrate our exposure, response, and risk analyses from Section 10.

12.1.1 Giant Manta Rays

Adult and juvenile giant manta rays are present in the action area and are expected to be exposed to the research activities. The severity of an animal's response to disturbance associated with the capture and handling would depend on the duration and severity of exposure.

Population estimates for giant manta rays in the Atlantic Ocean range from around 100 to 1,500 individuals (Miller 2017). The population near St. Augustine, Florida (the population nearest the action area for which we have data), is estimated at between 90 and less than 500 individuals (Kendall 2010). There are no estimates of growth rate. We expect that adults and juveniles may be affected by take in the form of harm, or behavioral changes from activities associated with the research. The anticipated take of animals is not expected to result in the loss of reproduction at an individual level or to have a measurable effect on reproduction at the population level.

No reduction in the distribution of giant manta rays from the Atlantic Ocean or changes to the geographic range of the species are expected because of BOEM and GAI research activities.

No reduction in numbers is anticipated due to the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Non-lethal take of 30 individuals, adults and juveniles of both sexes, is expected as a result of the proposed research activities. We anticipate temporary behavioral responses, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of giant manta rays, the proposed research activities would not be expected to appreciably reduce the likelihood of giant manta ray survival.

The interim Recovery Plan for the giant manta rays lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Stabilize population trends through reduction of threats, such that the species is no longer declining throughout a significant portion of its range
- Gather additional information through research and monitoring on the species' current distribution and abundance, movement and habitat use of adults and juveniles, mortality rates in commercial fisheries (including at-vessel and post-release mortality), and other potential threats that may contribute to the species' decline.
- Coordinate domestic and international efforts to implement recovery actions related to reducing overutilization of giant manta rays.

Because no mortalities or effects on the abundance, distribution, and reproduction of giant manta ray populations are expected as a result of the proposed actions, we do not anticipate the proposed research activities will appreciably reduce the likelihood of recovery of giant manta rays in the wild. The objectives of the research in the proposed action will provide data that is identified in the interim recovery plan. In conclusion, we believe the non-lethal effects of take associated with the proposed actions will not jeopardize the continued existence of giant manta rays.

13 CONCLUSION

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of giant manta rays. No critical habitat has been designated or proposed for this species; therefore, none will be affected.

14 INCIDENTAL TAKE STATEMENT

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

In the case of threatened species, section 4(d) of the ESA leaves it to the Secretary's discretion whether and to what extent to extend the statutory 9(a) ''take'' prohibitions, and directs the agency to issue regulations it considers necessary and advisable for the conservation of the species. At the time of this consultation, take prohibitions have not been extended to the giant manta ray, a threatened species.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

All research activities associated with the funding of the giant manta ray research involve directed take for the purposes of scientific research. Therefore, NMFS does not expect the proposed action will incidentally take any threatened or endangered species.

15 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 threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

- We request that BOEM report to us whether the take specified in opinion actually occurs and the actual numbers of take in comparison to the requested take numbers at the cessation of the research activities, as well as any available information on the response animals exhibited to those takes, including health and survival rates of tagged animals, for as long as the tags are transmitting data. Such information will be used to inform the *Environmental Baseline* and *Effects of the Action* for future consultations for other similar research activities.
- We request that BOEM provide a copy of any report generated by GAI or associated researchers about the results of the research activities, to aid NMFS in future consultations.

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

16 REINITIATION NOTICE

This concludes formal consultation for BOEM's funding of research activities on the behavioral and spatial ecology of giant manta rays. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

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

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