Giant Manta Ray Consultation Framework
NOAA Fisheries Southeast Region

Revised August 2022

PURPOSE AND SCOPE

In order to inform the Southeast Region's consultation activities regarding the giant manta ray (*Mobula birostris*), this document consolidates and interprets existing information available from a host of sources including, but not limited to, Endangered Species Act (ESA) listing documents (Table 1), previous consultations, and existing literature. This collection of information provides Section 7 assistance, and identifies early conservation/recovery concepts for consideration during consultation. The contents summarize best available information as well as facilitate integration of conservation/recovery considerations into our routine consultation practices. This document is a job aid and used as general guidance only.

Table 1: Giant manta ray ESA listing documents

ESA Status	Listing Rule/Date	Critical Habitat	Recovery Outline
Threatened	83 FR 2916/January 22, 2018	Not Prudent (84 FR 66652; December 5, 2019)	December 2019

SPECIES LIFE HISTORY

Species Description

Image 1: Dorsal surface. Image credit Josh Stewart

Image 2: Ventral surface. Image credit G.P Schmahl

Manta rays are filter-feeding rays in the family Mobulidae, characterized by a terminal mouth, diamond-shaped bodies with wing-like pectoral fins, and cephalic fins. The dorsal surface of the giant manta ray is predominantly black with white shoulder patches on the upper back (Image 1). These white shoulder patches are bright and prominent and look like distinct triangles. The ventral surface (belly) on a giant manta ray is generally white, with a distinct black/gray spot pattern, which is mostly located around the lower abdomen (Image 2). The ventral surface remains largely unchanged throughout their lives, and the unique pattern of spots may be used to identify individuals.

The taxonomic history of the genus Manta is complex (Couturier et al. 2012; Herman et al. 2000; Adnet et al. 2012; Naylor et al. 2012; Kitchen-Wheeler 2013; Paig-Tran et al. 2013; Ashliman et al. 2012; Poortvliet et al.

2015) with some studies supporting a split of the Manta genus into two species: *M. birostris* and *M. alfredi* (Marshall et al. 2009), and synonymizing the genus Manta with the genus Mobula (White et al. 2018). Of the two-manta species, only giant manta rays (*Mobula birostris*) occur in the Southeast. A putative species or subspecies of the giant manta ray has been suggested (referred to as *M. cf. birostri*s, Marshall et al. 2009; Hosegood et al. 2020) to occur off southeastern Florida (Pate and Marshall 2020), FGBNMS (Stewart et al. 2018a), the Yucatan peninsula (Hinojosa-Alvarez et al. 2016, Brazil (Bucair et al. 2021), and the Caribbean (N. Pelletier, unpublished data). While typical giant manta rays are dark grey/black on their backs and mostly white on their ventral surfaces, color polymorphisms do occur (Images 3–4). While rare, individuals can be almost entirely black or almost entirely white on both their dorsal and ventral surfaces, which can also be used to identify individuals (Venables et al. 2019)

Image 3: Color morph. Image credit Stephanie Venables, MMF

Adult giant manta rays typically have a wingspan, termed disc width (DW), that reaches about 13 feet (4 meters) (Marshall et al. 2009), with anecdotal reports of up to 29 feet (8.8 meters) (Compango 1999). Pups born in captivity measured at about 6 feet (1.8 meters) in DW at birth (Okinawa Churaumi Aquarium, cited in Deakos 2012).The closely related reef manta ray (*M. alfredi*) has been recorded as small as 3.3 feet (1 meter) DW (Miller and Klimovich 2017).

Image 4: Color morph and rolled cephalic fins. Image credit Jen Jakush, FWC

Giant manta rays have two cephalic fins and a wide terminal mouth, located at the front of the head. When swimming, the cephalic fins are rolled up like spirals and give the appearance of horns (Image 4). During feeding, the cephalic fins unfurl and help funnel zooplankton into their months (Image 5).

Image 5: Cephalic fins unfurled during feeding. Image credit, FWC

Distribution

Globally, giant manta rays inhabit tropical, subtropical, and temperate bodies of water and are commonly found offshore, in oceanic waters, and near productive coastlines (Bucair et al. 2021; Freedman and Roy 2012; Medeiros et al. 2015) including in estuarine waters near oceanic inlets (Milessi et al., 2003; Miller and Klimonvich 2017; J. Pate, unpublished data). Within the Southeast, giant manta rays have been observed along the U.S. 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 (Figure 1; Farmer et al., 2022).

Farmer et al. (2022) integrated decades of sightings and survey effort data from multiple sources in a comprehensive species distribution-modeling framework to evaluate the distribution of giant manta rays off the U.S. east coast and Gulf of Mexico. Giant manta rays were most commonly detected at productive nearshore and shelf-edge upwelling zones at surface thermal frontal boundaries within a temperature range of approximately 20–30°C. SDMs predicted highest nearshore occurrence off northeast Florida during April, with the distribution extending northward along the shelf-edge as temperatures warm, leading to higher occurrences north of Cape Hatteras, North Carolina from June to October, and then south of Savannah, Georgia from November to March as temperatures cool. In the Gulf of Mexico, the highest nearshore occurrence was predicted around the Mississippi River delta from April to June and again from October to November. The distribution model predictions will allow resource managers to more effectively protect giant manta rays from fisheries bycatch, boat strikes, oil and gas activities, contaminants and pollutants, and other threats (Farmer et al., 2022).

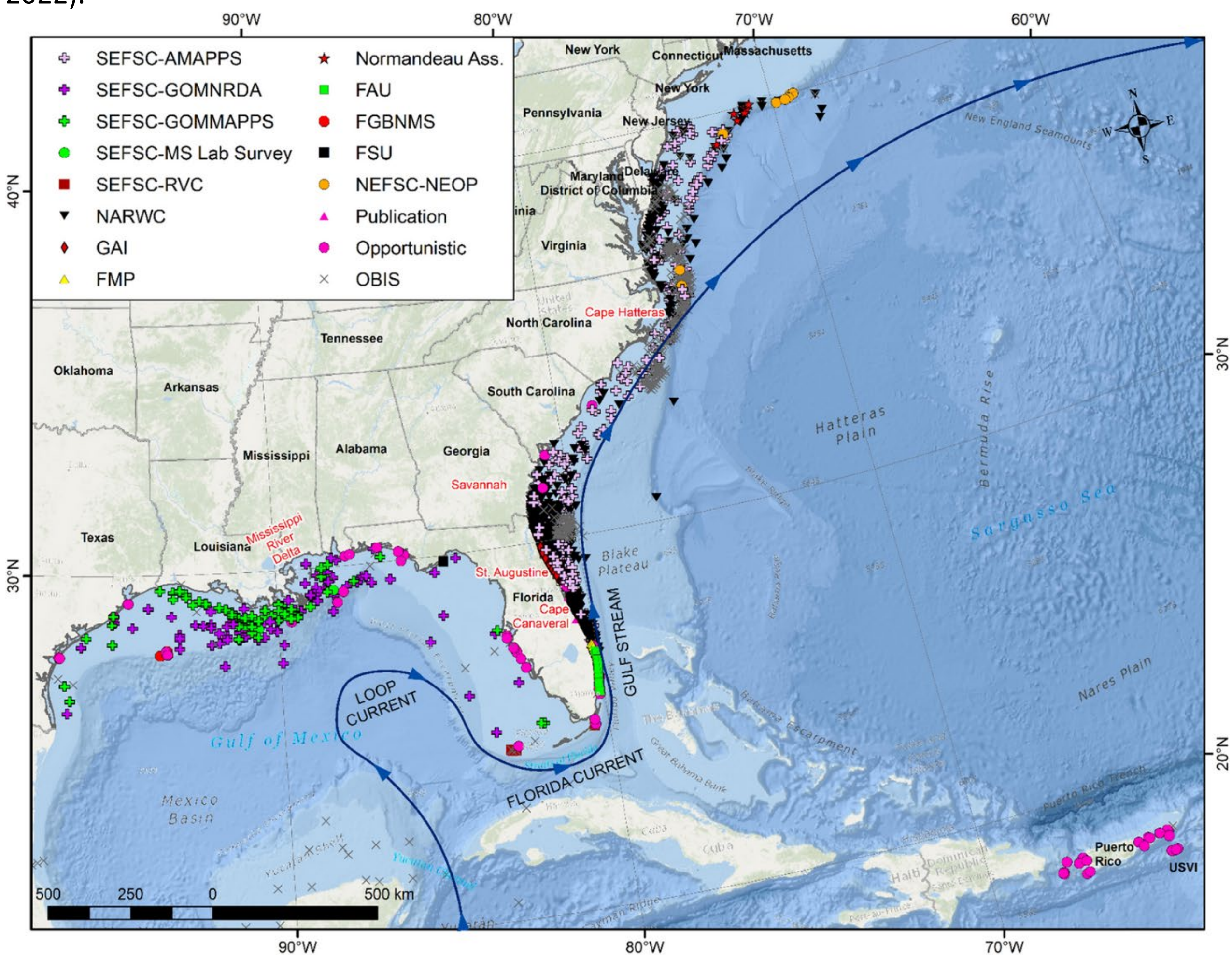

Figure 1: Reported sightings of manta rays (1925–2020) relative to regional landmarks and ocean currents, from Farmer et al. (2022). Sightings from Southeast Fisheries Science Center (SEFSC) Atlantic Marine Assessment Program for Protected Species (AMAPPS), Gulf of Mexico Marine Assessment Program for Protected Species (GOMAPPS), Gulf of Mexico Natural Resource Damage Assessment (GOMNRDA) aerial surveys, Mississippi Lab pelagic longline surveys (MS Lab Survey), and Reef Visual Census (RVC) SCUBA-based survey; Florida Atlantic University (FAU) Kajiura Lab aerial elasmobranch surveys, Flower Garden Banks National Marine Sanctuary (FGBNMS) staff sightings, boat-based and aerial surveys by trained Florida Manta Project (FMP) staff, Florida State University (FSU) Grubbs Lab elasmobranch gillnet surveys, Georgia Aquarium (GAI) aerial surveys,

Ocean Biodiversity Information System (OBIS) open-access data, North Atlantic Right Whale Consortium (NARWC) ship-based and aerial surveys, Northeast Fisheries Science Center (NEFSC) Northeast Observer Program (NEOP) trawl encounters, APEM and Normandeau Associates Aerial Digital Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy for New York State Energy Research and Development Authority (NYSERDA) and U.S. Bureau of Ocean Energy Management, and verified opportunistic sightings reported to the authors or pulled from social media and news reports. Basemap used with permission from ESRI Ocean Base map and its partners, showing marine water body names, undersea feature names, and derived depth values in meters.

In addition, Freedman and Roy (2012) used Ocean Biogeographic Information System (OBIS) data to examine the spatial distribution of the species along the U.S. east coast. They also found a higher number of observations near the continental shelf edge and bordering the Gulf Stream and suggested a seasonal distribution of the species driven mainly by temperature, with giant manta rays primarily observed in waters from 19°C to 22°C (Freedman and Roy 2012). Seasonal upwelling events concentrate zooplankton, creating patches of high productivity, which in turn may drive the seasonal occurrence and peaks in giant manta ray sightings. Small-scale movements also appear to be associated with exploiting local prey patches in addition to refuging and cleaning activities (O'Shea et al. 2010; Marshall et al. 2011; Graham et al. 2012; Rohner et al. 2013; Stewart et al. 2016a; Stewart et al. 2016b).

Movement and Habitat Use

The giant manta ray is considered migratory, conducting long distance movements, but recent studies also suggest a high degree of residency in some regions (Stewart et al. 2016a; Stewart et al. 2016b). The giant manta ray is solitary, but does aggregate at cleaning sites and to feed and mate. When giant manta rays are sighted, they are frequently over the continental shelf in depths <656 feet (<200 meters) and in productive coastal areas. Giant manta rays seem to prefer areas where upwelling occurs, most likely due to the increase in primary productivity, which in turn promotes abundant zooplankton, their main prey. Giant manta rays also appear to exhibit a high degree of plasticity in terms of their use of depths within their habitat. They conducts deep dive during feeding, commonly 656-1476 feet (200-450 meters), but are capable exceeding 3280 feet (1,000 meters) depths. Diving behavior is likely influenced by season and shifts in prey location associated with the thermocline. Surface basking is also a technique giant manta rays use to maintain optimum body temperature before and after deep dives (Canese et al. 2011; Thorrold et al. 2014).

Regional observations suggest that giant manta rays are frequently associated with nearshore habitats; as such, they are at elevated risk for exposure to a variety of threats (Farmer et al., 2022). In the Southeast, giant manta rays are sighted nearshore and in intracoastal waterways, coastal bays, tidal outflows, inlets, river mouths (feeding around outfall plumes), and estuaries (Adams and Amesbury 1998; Milessi and Oddone 2003; Pate and Marshall 2020; Farmer et al. 2022). There is a strong management interest in understanding the inshore extent of giant manta movements in bays and tidal inlets. Farmer et al (2022)'s distribution model predictions suggest seasonal trends with high probability of occurrence in large bays (e.g., Tampa Bay, Chesapeake Bay); however, reported sightings in bays are extremely limited. It is unclear if this is due to reduced water clarity, rarity of use, or very low levels of survey effort. Giant manta rays have been reported in bays and inlets in Brazil (Bucair et al. 2021; Medeiros et al. 2015), and we verified several anecdotal reports of use of shallow tropical bays in the U.S. Caribbean. Inshore sighting have also been documented in: Choctawhatchee Bay, Apalachicola Bay, Sarasota Bay, Tampa Bay, Indian River Lagoon, Port Canaveral (Florida); Garden Island Bay, East and West Bay, Chandeleur Sound (Louisiana); Mississippi Sound (Mississippi), and Laguna Madre (Texas) (Farmer et al. 2022). In the U.S. Caribbean, giant manta rays have been sighted in Puerto Rico and the U.S Virgin Islands. In the U.S. Virgin Islands, giant manta rays have been sighted in shallow coastal bays, including Cane's Bay, Maho Bay, and Francis Bay (Farmer et al. 2022). In Puerto Rico, the majority of giant manta sightings are from the area surrounding Culebra, Vieques, and Mona Islands (Farmer et al. 2022).

Nursery Habitat

Documenting nursery habitats is a priority in manta ray research and conservation (Stewart et al. 2018a), yet the juvenile life stages remain particularly understudied. To date, only three nursery areas for giant manta rays have been described worldwide, two of which occur within the Southeast (*M. birostris* and *M. cf. birostris:* Stewart et al. 2018a; Pate and Marshall 2020). Stewart et al. (2018a) described juvenile nursery habitat within the Flower Garden Banks National Marine Sanctuary (FGBNMS) in the Gulf of Mexico and Pate and Marshall (2020) identified a nursery habitat along a highly developed coastline in southeast Florida. These nursery areas were described based on the frequent observations of juveniles, high site fidelity, and extended use (Heupel et al. 2017).

Diet and Feeding

Giant manta rays primarily feed on planktonic organisms such as euphausiids, copepods, mysids, decapod larvae, and shrimp, with some studies noting their consumption of small and moderate sized fishes as well (Bigelow and Schroeder 1953; Carpenter and Niem 2001; Graham et al. 2012; Rohner et al. 2017; Stewart et al. 2016; Burgess et al. 2017). When foraging, giant manta rays swim with their mouths open, continuously filtering prey items from the water.

Gill-rakers filter out water, leaving behind food particles that are then directed to the esophagus through cross-flow (Paig-Tran 2013) without clogging (Divi et al. 2018). This ricochet separation filtration allows giant manta rays to retain prey of various sizes, even if they are smaller than the filter pores, which means they can effectively feed on mixed plankton assemblages, where prey ranges in size from small calanoid copepods to larger mysids and euphausiids (Stewart et al. 2016).

Giant manta rays have a complex foraging depth profile, and appear to be supplement their diet with opportunistic feeding in near-surface waters (Couturier et al. 2013; Burgess et al. 2016). In addition, giant manta rays are occasionally observed feeding within inlets and tidal currents, around river outflows and plumes, and within intracoastal waterways along the U.S. east coast and Gulf of Mexico (J. Pate and C. Horn, unpublished data).

Growth and Reproduction

Giant manta rays are viviparous (i.e., give birth to live young), with a gestation period of around one year (Matsumoto and Uchida 2008; Uchida et al. 2008), and a reproductive periodicity of anywhere from 1 to 5 years. No information is available on the age at maturity for giant manta rays, but they are presumed to have similar life history characteristics to reef manta rays (Marshall et al. 2011). The age at first maturity for reef manta ray is estimated at 3–6 years for males, and 8–10 years for females (Dulvy et al. 2014). Giant manta rays have been reported to live at least 40 years (Marshall and Bennett 2010b; Marshall et al. 2011b; Kitchen-Wheeler 2013). The giant manta ray's long life span, time to maturity, and low reproductive rates mean that a female will be able to produce only 5–15 pups in her lifetime (CITES 2013). The generation time for giant manta ray (based on reef manta ray life history parameters) is estimated to be 25 years (Marshall et al. 2011a; Marshall et al. 2011b).

SECTION 7 CONSIDERATIONS

This section provides information to assist biologists with section 7 consultations. This examination considered published scientific literature, as well as unpublished data provided by non-governmental, state, and federal agencies. The best available information indicates that giant manta rays are distributed throughout the Southeast U.S., occurring in the Western North Atlantic, Gulf of Mexico, and Caribbean. Within these areas, they are sighted at continental shelf-edges, upwelling areas, and in productive coastal areas, including inshore locations such as inlets, Intracoastal Waterways, bays, and estuaries. Please refer to the SERO Section 7 Mapper for more detailed information on the on where to consult on giant manta rays in the Southeast Region: ESA Section 7 Mapper web app viewer.

No Effect Determination

When making a "no effect" determination, it is not necessary to mention the species in the consultation. Below are common activities that could conclude "no effect" for giant manta rays. Giant manta rays do not occur in freshwater environments, such as rivers or lakes, therefore it is not necessary consider them within consultations that occur within rivers or other primarily freshwater systems.

Turbidity

Short term, discrete projects (e.g., shoreline stabilization, pile-supported structures, and boat ramps) can result in a temporary increase in turbidity, turbidity curtains should be used to control and reduce turbidity, and projects must adhere to state water quality standards. Giant manta rays are able to swim through or avoid any temporary increase in turbidity without harm, as they exposed to turbidity and lower water clarity throughout their environments. Therefore, we believe any potential exposure to a short-term increase in turbidity because of the construction will have no effect on giant manta rays. However, projects that have the potential to increase turbidity long-term maybe considered NLAA (Table 2)

Movement and access to foraging habitat

We believe the following structures will have no effect on giant manta rays (will not limit their movement or ability to access foraging habitat). Activities that occur along the shoreline: shoreline stabilization, pile-supported structures, and boat ramps. The placement of such materials along the shoreline would not create an obstruction for species to move around these features to access foraging and refuge habitat in surrounding areas. The placement of a single pile or buoy for an ATON also would not create an obstruction when placed in open water. Note: no effect determinations refer to the presence of the structures and the effects of installation may be different.

Entanglement

The presence of flexible materials in the water (e.g., turbidity curtains, in-water lines, mooring lines, ATONs) could create an entanglement risk to giant manta rays. Manta rays are obligate ram ventilators, meaning that they need to swim constantly to "breathe." Therefore, entanglement in line rapidly leads to asphyxiation. While these entanglements can be lethal, there are no reports of entanglement in turbidity curtains, non-looping in-water lines, or in-water lines enclosed in plastic or rubber sleeves. Therefore, if the following Project Design Criteria (PDC) are used, we believe that there will be no effect to giant manta rays from entanglement in construction material.

- All in-water lines (e.g., mooring lines, rope, chain, and cable, including the lines to secure the turbidity curtains) must be stiff, taut, properly secured, and non-looping to minimize excess line and the risk of entanglement. If flexible lines are used, they must be enclosed in plastic or rubber sleeves/tubes that add rigidity and prevent the line from looping and tangling.
- Turbidity curtains and in-water equipment must be placed in a manner that does not entrap species within the construction area or block access for them to navigate around the construction area.

Not Likely to Adversely Affect Determination (NLAA)

For proposed actions that may affect giant manta rays, the biologist must carefully analyze the effects of the proposed action to confirm whether NLAA or Likely to Adversely Affect (LAA) is most applicable (Table 2). An activity that is typically NLAA for an activity could be LAA for a different consultation if circumstances are significantly different or certain BMPs are not incorporated. The biologist must carefully analyze the effects of the proposed action to confirm whether NLAA or LAA is most applicable. An activity that is typically NLAA for an activity could be LAA for a different consultation if circumstances are significantly different or certain PDC are not incorporated.

Table 2: Potential Threats that Pose "not likely to adversely affect" or "likely to adversely affect."

Activity	Route of Effects	Potential Impact	Considerations
Fisheries	• Potential hooking, entanglement, and capture in fishing gear, including, but not limited to, hook and line, trawls, gillnets, and seine gear types.	• Injury or mortality resulting from capture. Obligate ram ventilators are more likely to drown as a result of bycatch (Ellis et al. 2016; Dapp et al. 2015) • Post release mortality, if estimates are not available, a proxy species may be able to be used (e.g., Croll et al. 2016, Francis & Jones 2016, Ellis et al. 2017).	• Safe handling and release procedures, available for hook, line, and trawl gears. • Observers? If observers aboard, data collection and reporting, survivorship tag deployment, and tissue sampling. • Timing and location? Do operations occur during times and within areas of high manta ray abundance? For detailed information on the species distribution, see Farmer et al. (2022).
• Fishing pier – (i.e., Beach side piers only and inlets. ICW pier interactions are extremely unlikely to occur).	• Interaction within recreational fishing gears and entanglement. • Potential disturbance during construction.	• Injury resulting from foul hooking and/or entanglement. Several studies have reviewed recreational angler interactions with giant manta rays (Pate et al. 2020; Pate and Marshall 2020). • Interactions with construction equipment are typically extremely unlikely to occur due to species' mobility. • Noise associated with pile driving.	• Location? Is the pier located in an area of high manta ray abundance (Farmer et al., 2022). • Artificial lighting can concentrate zooplankton that may attract manta rays to the project area. • Require posting of educational signage, anglers outreach, and fishing line disposal receptacles. • Construction conditions and noise abatement measures.
Energy (e.g., oil and gas, wind farm, power plant).	• Exploration activities (e.g., sonar, exploratory drilling, noise, entanglement in lines) • Construction Activities • Direct fouling by oil/contaminants. • Habitat degradation, contaminants, including oil spills.	• Entrainment, incidental take associated with intake; see St. Lucie Plant, NRC. • Entanglement lines/hoses during diver surveys/ maintenance. • Vessel strike (McGregor et al. 2019; Pate and Marshall 2020).	• Does the action area occur within important nursery habitats? • Will visual surveys be conducted prior to activities? • Are there shutdown procedures in place if a listed species observed? BMPs. • BMPs and noise abatement measure.

Activity	Route of Effects	Potential Impact	Considerations
	• Wind farms – possible magnetic displacement (Keller et al. 2021). • Power plant entrainment at intake canals. • Vessel traffic	• Habitat degradation, avoidance, and displacement from an action area. • Noise associated with construction activities is typically NLAA if it is below the injury threshold level of > 2g fish.	• What is the average speed of support vessels and deployment frequency? Are vessel speed restrictions in place? • Pollution / spill safeguards/ reporting requirements.
Aquaculture	• Potential interactions with construction equipment • May be a physical barrier • May pose an entanglement risk • May alter water quality and/or habitat • Vessel traffic	• Interaction with equipment is extremely unlikely to occur due to species' mobility • Physical barrier could block or impede movement in the area? • Entanglement could result in injury or mortality • Water quality/habitat degradation could reduce foraging habitat • Vessel strike could result in injury or mortality	• Type of equipment and duration of in-water construction? • Duration of the permit (i.e., how long will the project be in operation so we know how long any structures would be in the water)? • What is the configuration and design of the aquaculture equipment? • What are the maintenance plans for the facility (e.g., how often will nets/lines be inspected) • What is the average speed of support vessels and how frequently they are deployed?
Dredging (e.g., hopper, clamshell, or cutter head)	• Potential disturbance during construction • Short and/or long-term habitat alteration • Drowning in trawl net (if there is relocation trawling prior to dredging) • Vessel traffic	• Interaction with equipment is extremely unlikely to occur due to species' mobility • Vessel strike could result in injury or mortality • If relocation trawling is proposed, there is potential injury and mortality.	• What is the average speed of support vessels and how many vessels will be in the project area at a given time? • Type of equipment to be used and the duration of dredging? • Are there shutdown procedures in place if a listed species is observed? • Will there be tow time limits for relocation trawls? • Will trained observers be present? If so, include tissue sampling and possible tagging.
Marina, dock, ramp, and additional slips	• Potential impacts during construction • Vessel traffic • Entanglement	• Interaction with construction equipment is extremely unlikely to occur due to species' mobility • Noise associated with construction activities is typically NLAA if it is below the injury threshold level of > 2g fish.	• Type of equipment and duration of in-water construction? • Construction conditions and noise abatement measures. • Number and vessel speed. Are speed restrictions in place?

Activity	Route of Effects	Potential Impact	Considerations
		• Vessel strike could result in injury or mortality (McGregor et al. 2019; Pate and Marshall 2020). • Flexible in water lines (e.g., mooring lines) pose an entanglement risk.	• Will educational signs or other boater outreach be include in the project? • If in water lines, will PDCs be implemented?
Beach nourishment	• Potential interaction with construction equipment • Vessel traffic • Entanglement • Short and/or long-term habitat alteration	• Interactions with equipment is extremely unlikely to occur due to species' mobility • Vessel strike could result in injury or mortality (McGregor et al. 2019; Pate and Marshall 2020). • Flexible in water lines (e.g., mooring lines) pose an entanglement risk. • Habitat avoidance or displacement from the action area.	• Type of equipment and duration of in-water construction? • Project duration (temporary or long-term) • What is the average speed of support vessels? • If in water lines, will PDCs be implemented? • Project location and habitat type. Is there similar habitat nearby?
Habitat restoration	• Potential interactions with construction equipment • Habitat alteration • Vessel traffic	• Interaction with equipment is extremely unlikely to occur due to species' mobility • Habitat avoidance or displacement from the action area. • Vessel strike could result in injury or mortality (McGregor et al. 2019; Pate and Marshall 2020)	• Type of habitat affected. Are there any beneficial effects? Creation or restoration reef habitat or other positive water quality / habitat enhancements. • Type of equipment and duration of in-water construction. • What is the average speed of support vessels and deployment frequency?
Outfalls, water releases, and effluent discharge	• Long term habitat alteration • Foraging energetic	• Inability to use habitat or reduction in prey because water quality parameters are not suitable? • Habitat degradation and avoidance or displacement from the action area.	• Project location and habitat type. Is there similar habitat nearby? • Project duration (temporary or long-term) • Reduction in habitat and prey availability
Artificial Reef	• Potential for entanglement in fishing line that gets wrapped around the structure	• These projects are typically NLAA, but need to consider potential for entanglement (if entanglement is not,	• Project location and habitat type. Is there similar habitat nearby? • Noise abatement measures?

Activity	Route of Effects	Potential Impact	Considerations
	• Blasting impacts, if explosives are used to sink vessels • Physical injury from placed material.	extremely unlikely to occur, it may be LAA) • Use of explosives typically LAA • Noise associated with construction activities is typically NLAA if it is below the injury threshold level of > 2 g fish. • Interaction with construction equipment and placement of material is extremely unlikely to occur due to species' mobility	• Type of equipment to be used and duration of in-water construction? • Duration of the permit (consider how often USACE may request reauthorization since most artificial reef permits are ongoing leading to an increase in structures placed in the marine environment over time)?

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