



UNITED STATES DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office

263 13th Avenue South

St. Petersburg, Florida 33701-5505

<http://sero.nmfs.noaa.gov>

F/SER31: TWD

JUN 13 2017

Chief, Environmental Branch
Planning and Policy Division
Jacksonville District Corps of Engineers
Department of the Army
701 San Marco Boulevard
Jacksonville, Florida 32207-8175

Dear Sir or Madam:


The enclosed Biological Opinion ("Opinion") responds to your request for consultation with us, the National Marine Fisheries Service (NMFS), pursuant to Section 7 of the Endangered Species Act (ESA) for the following action.

Reference	Applicant	PCTS Number	Project Types
CAP Section 14	Mount Sinai Medical Center	SER-2016-18319	Seawall Construction

The Opinion considers the effects of construction of a new 3,070 linear foot seawall and installation of a new concrete riser on an existing seawall on the following listed species and critical habitat: green sea turtles (North and South Atlantic distinct population segments [DPSs], hawksbill sea turtles, Kemp's ridley sea turtles, loggerhead sea turtles (Northwest Atlantic Ocean DPS), smalltooth sawfish, and Johnson's seagrass critical habitat. NMFS concludes that the proposed action is not likely to adversely affect green, hawksbill, Kemp's ridley, or loggerhead sea turtles, or smalltooth sawfish. NMFS also concludes that the proposed action is not likely to result in the destruction or adverse modification of designated critical habitat for Johnson's seagrass.

We look forward to further cooperation with you on other USACE projects to ensure the conservation and recovery of our threatened and endangered marine species. If you have any questions regarding this consultation, please contact Dr. Thomas Dolan, Consultation Biologist, at (727) 551-5741, or by email at thomas.dolan@noaa.gov.

Sincerely,


for Roy E. Crabtree, Ph.D.
Regional Administrator

Enc.: Biological Opinion
File: 1514-22.F.4



**Endangered Species Act - Section 7 Consultation
Biological Opinion**

Action Agency: United States Army Corps of Engineers, Jacksonville District

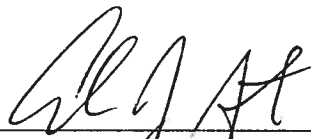
Applicant: Mount Sinai Medical Center

Activity: Construction of a new seawall and installation of a concrete riser on an existing seawall in Miami Beach, Miami-Dade County, Florida

Consulting Agency: Protected Resources Division
Southeast Regional Office
National Marine Fisheries Service

Consultation Number SER-2016-18319

Approved by:



For Roy E. Crabtree, Ph.D., Regional Administrator
NMFS, Southeast Regional Office
St. Petersburg, Florida

Date Issued:

JUNE 13, 2017

Table of Contents

1	CONSULTATION HISTORY	4
2	DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA	5
3	STATUS OF LISTED SPECIES AND CRITICAL HABITAT	7
4	ENVIRONMENTAL BASELINE	14
5	EFFECTS OF THE ACTION ON JOHNSON'S SEAGRASS CRITICAL HABITAT	17
6	CUMULATIVE EFFECTS	17
7	CRITICAL HABITAT DESTRUCTION/ADVERSE MODIFICATION ANALYSIS	18
8	CONCLUSION	20
9	LITERATURE CITED	22

Figures

Figure 1.	Images of the Mount Sinai Medical Center seawall project site,	5
Figure 2.	Image showing the approximate action area	6
Figure 3.	Benthic habitats in and near the action area	7
Figure 4.	Johnson's seagrass critical habitat Unit J	13

Tables

Table 1.	Effects Determinations and Status for Species and Critical Habitat	7
Table 2.	Designated Critical Habitat Units for Johnson's Seagrass	11

Acronyms and Abbreviations

cSEL	cumulative sound exposure level
ESA	Endangered Species Act
IPCC	Intergovernmental Panel on Climate Change
MLLW	mean lowest low water
NMFS	National Marine Fisheries Service
RMS	root mean square
RPMs	reasonable and prudent measures
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

Units of Measurement

ac	acre(s)
dB	decibel(s)
ft	foot/feet
ft ²	square foot/feet
in	inch(es)
lin ft	linear foot/feet
m	meter(s)
mi	mile(s)
mi ²	square mile(s)

Background

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.), requires each federal agency to “insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species.” Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary on any such action. National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share responsibilities for administering the ESA.

Consultation is required when a federal action agency determines that a proposed action “may affect” listed species or designated critical habitat. Consultation is concluded after NMFS determines that the action is not likely to adversely affect listed species or critical habitat or issues a Biological Opinion (“Opinion”) that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat. The Opinion states the amount or extent of incidental take of the listed species that may occur, develops measures (i.e., reasonable and prudent measures - RPMs) to reduce the effect of take, and recommends conservation measures to further the recovery of the species. Notably, no incidental destruction or adverse modification of designated critical habitat can be authorized, and thus there are no RPMs—only reasonable and prudent alternatives that must avoid destruction or adverse modification.

This document represents NMFS’s Opinion based on our review of impacts associated with the proposed action to issue a permit within Miami-Dade County, Florida. This Opinion analyzes the project’s effects on threatened and endangered species and designated critical habitat, in accordance with Section 7 of the ESA. We based it on project information provided by the USACE and other sources of information, including the published literature cited herein.

1 CONSULTATION HISTORY

NMFS received a request for ESA consultation from the U.S. Army Corps of Engineers (USACE) on October 31, 2016. We requested additional information on November 30, 2016, to which the USACE responded on December 6, 2016. We initiated consultation the same day. On December 22, 2016, we requested additional information regarding the presence of the olive ridley sea turtle in the action area, and the USACE responded the same day, withdrawing the olive ridley sea turtle from the consultation. Between December 22, 2016, and May 12, 2016, numerous communications were exchanged between NMFS and USACE regarding pile driving methods and noise abatement measures, due to the large area that would be affected by driving metal sheet piles using an impact driver with no noise abatement. The USACE agreed to require a ramp-up/soft-start procedure, deployment of a bubble curtain, and use of cushion blocks in conjunction with impact pile driving.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

The site currently consists of an approximately 3,000 linear foot (lin ft) seawall running along the shoreline of the Mount Sinai Medical Center on Biscayne Bay (Figure 1). The seawall is encrusted with various organisms, including turf algae, macroalgae, sponges, hydroids, tunicates, anemonae, fanworms, barnacles, bivalves, limpets, and corals. Species of coral present include *Siderastrea siderea*, *Oculina diffusa*, and *O. robusta*. No federally listed endangered or threatened corals are present. The nearshore benthos consists of areas of sand, rubble, muck, and mixed sand/muck matrix. A mixed seagrass bed, composed of paddle grass, shoalgrass, manatee grass, and turtle grass, occupies most of the area within 400 feet (ft) of the existing seawall, though the densities of the seagrasses vary. The distance of the nearshore bed edge to the bulkhead ranges between 0-28 ft and is closest to the bulkhead toward its middle. A photograph provided by the USACE shows that some of the benthos near the seawall is intertidal, exposed to air at low tides, which may prevent colonization by some seagrasses.



Figure 1. Images of the Mount Sinai Medical Center seawall project site, showing its location in Biscayne Bay (left) and the local environment and existing structures (right) (©2017 Google Earth, TerraMetrics, data SIO, NOAA, U.S. Navy, NGA, GEBCO; Figure ES-2: Recommended Plan from, "Mount Sinai Medical Center, Continuing Authorities Program (CAP) Section 14, Project: Draft Integrated Feasibility Report and Environmental Assessment," USACE)

The applicant proposes to construct a new 3,070 lin ft, steel, sheet pile seawall, 3 ft waterward of an existing seawall, with a concrete T wall cap, overhanging the water by 1.5 ft; back fill with clean stone landward of the new seawall; and add a 1.5 ft high concrete lift to 130 lin ft of extant seawall that is still structurally sound. Pile installation will consist of driving 12.56 inch (in), steel sheet piles using barge-mounted equipment. The method of pile driving has not been specified, so could use either a vibratory hammer or impact driver. If an impact driver is used, it is expected that each pile will require 300 strikes to reach final depth. Up to 10 piles will be driven each day. Completion of the project is expected to require 266 days.

All construction activity will take place during daylight hours. Turbidity curtains will only enclose small areas at any one time in the project area, and will be removed upon project completion. If an impact driver is used for pile driving, the applicant will be required to use a ramp-up/soft-start procedure in which the force exerted by the hammer is gradually increased to maximum power, which is intended to provide a stimulus for mobile species, including sea turtles and smalltooth sawfish, causing them to leave the area before the single strike sound exposure level reaches an injury-causing threshold. If an impact driver will be used for pile driving, the applicant will also be required to deploy a bubble curtain and to use cushion blocks as noise abatement measures. Additionally, the applicant will adhere to NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006, including stopping work if a sea turtle or smalltooth sawfish is observed within 50 ft of construction equipment, and resumption of work only after the animal departs the area of its own volition.

2.2 Action Area

50 CFR 404.02 defines action area as “all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action.” The project site is located at latitude 25.870854°N, longitude 80.127942°W (North American Datum 1983). The action area includes the waters and submerged lands within and in the immediate vicinity of the project site, and within a radius of approximately 2,070 ft (0.392 miles [mi]) around each pile, within which endangered species could be exposed to potentially harmful noise levels caused by pile driving (Figure 2). The southern extent of the action area is limited to the straight-line paths that sound waves travel through the cuts between land areas.



Figure 2. Image showing the approximate action area, outlined in red (©2017 Google, TerraMetrics, data SIO, NOAA, U.S. Navy, NGA, GEBCO)

The action area is at the southeastern extreme of an approximately 7.5-square-mile (mi^2) (4,800 acres [ac]), open area of Biscayne Bay, bounded to the south by the Julia Tuttle Causeway and to the north by the North Bay Causeway (Figure 3). This larger area includes approximately 3,154 ac of continuous seagrass beds and 475 ac of patchy seagrass beds, composed primarily of turtle grass, manatee grass, paddle grass, and shoalgrass (Figure 3) (FWRI 2011). The remainder of the bottom is primarily unconsolidated sand and silt. There are 2 clusters of artificial reef

structures approximately 1.5 mi west of the proposed seawall, and an isolated artificial reef structure approximately 2.4 mi northwest of the proposed seawall that support a growth of sponges, soft corals, and algae (FWRI and DMFM 2017). Several deep channels cross the action area, including the Atlantic Intracoastal Waterway. No hardbottom, coral reefs, or significant mangrove stands are located in this part of the bay (FWRI 2013; FWRI 2014; FWRI 2017), although the Julia Tuttle Causeway supports a narrow fringe of mangroves. Within this larger area, the action area occupies approximately 245 ac, approximately half of which is covered by seagrass beds (245 ac / 2 = 122.5 ac of seagrasses).

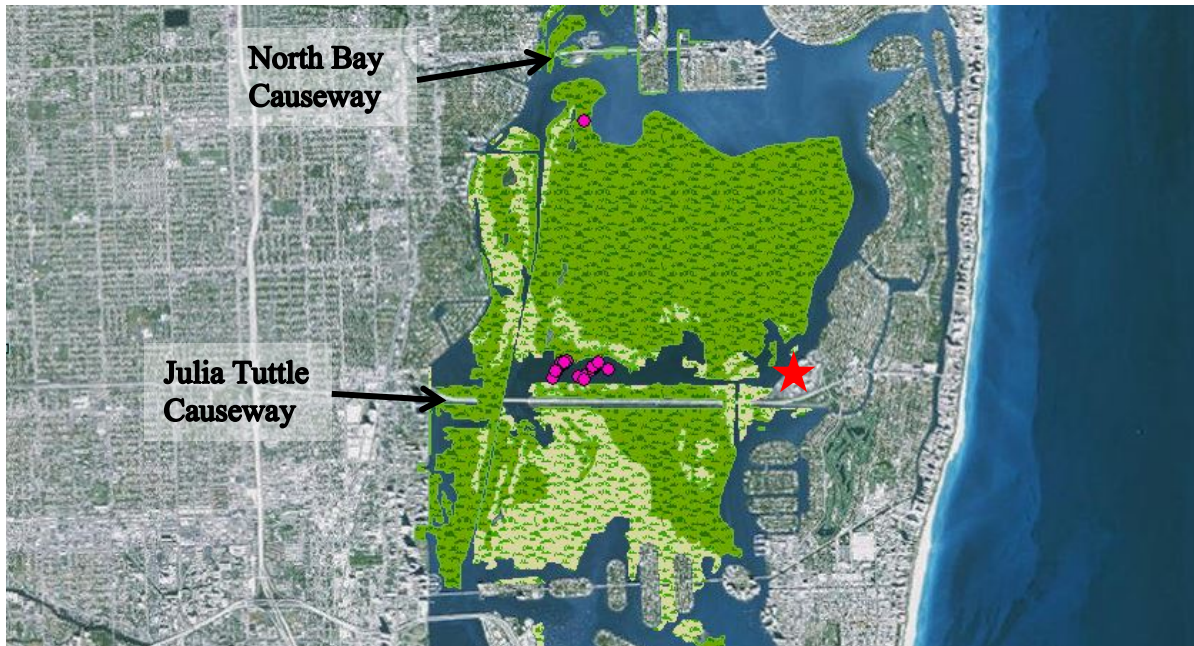


Figure 3. Benthic habitats in and near the action area: continuous seagrass beds (dark green); patchy seagrass beds (light green), artificial reefs (pink dot), proposed construction site (red star) (Basemap © Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community; data layers provided by Florida Wildlife Research Institute)

3 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

Table 1. Effects Determinations and Status for Species and Critical Habitat in or Near the Action Areas that Either the Action Agency or NMFS Believes May Be Affected by the Proposed Action

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Sea Turtles			
Green (North and South Atlantic distinct population segment [DPS])	T	NLAA	NLAA
Kemp's ridley	E	NLAA	NLAA
Leatherback	E	NLAA	NE
Loggerhead (Northwest Atlantic Ocean DPSs)	T	NLAA	NLAA
Hawksbill	E	NLAA	NLAA

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Fish			
Smalltooth sawfish (U.S. DPS)	E	NLAA	NLAA
Critical Habitat			
Johnson's seagrass Unit J		NLAA	LAA/No DAM
E = endangered; T = threatened; DAM = destruction or adverse modification; LAA = likely to adversely affect; NLAA = may affect, not likely to adversely affect; NE = no effect			

We believe that smalltooth sawfish and green, hawksbill, Kemp's ridley, and loggerhead sea turtles may be within the action area and may be affected by the project. The USACE determined that leatherback sea turtles also may be affected. However, we believe this project will have no effect on leatherback sea turtles due to their very specific life history strategy, which is not supported at the project site. Leatherback sea turtles have a pelagic, deepwater life history, wherein they forage primarily on jellyfish. The action area is also within the boundary of Johnson's seagrass Critical Habitat Unit J, but Johnson's seagrass does not occur within the footprint of the proposed construction activity.

3.1 Species Not Likely to be Adversely Affected

Green, hawksbill, Kemp's ridley, and loggerhead sea turtles (hereafter referred to as sea turtles) and smalltooth sawfish and may be found in or near the action area and may be affected by the project. We have identified the following potential adverse effects to these species and concluded that they are not likely to be adversely affected by the proposed action for the reasons described below in Sections 3.1.1, 3.1.2, and 3.1.3.

3.1.1 Direct Physical Effects

Direct, physical injury to sea turtles and smalltooth sawfish is not expected from construction machinery or materials because we expect sea turtles and smalltooth sawfish to detect and move away from the types of construction activities that are proposed for this project. Additionally, required turbidity controls may act as a physical barrier to species presence during construction. The project will adhere to NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006 (enclosed), which will provide additional protection by requiring work to stop if a listed species is observed within 50 ft of operating machinery. Thus, direct physical impacts are considered extremely unlikely to occur and adverse effects are, therefore, discountable.

3.1.2 Noise Effects

Effects to listed species as a result of noise created by construction activities can physically injure animals in the affected areas or change animal behavior in the affected areas. Injurious effects can occur in 2 ways. First, immediate adverse effects can occur to listed species if a single noise event exceeds the threshold for direct physical injury. Second, effects can result from prolonged exposure to noise levels that exceed the daily cumulative exposure threshold for the animals, and these can constitute adverse effects if animals are exposed to the noise levels for sufficient periods. Behavioral effects can be adverse if such effects prevent animals from

migrating, feeding, resting, or reproducing, for example. All in-water noise levels discussed below are referenced to 1 micropascal. The NMFS-accepted noise thresholds for impact pile driving are 206 decibels (dB) for peak-pressure injury, 187 dB for cumulative sound exposure level (cSEL) injury, 150 dB root mean square (RMS) for behavioral disturbance of fishes, and 160 dB RMS for behavioral disturbance of sea turtles. Our evaluation of effects to listed species as a result of noise created by construction activities is based on the analysis prepared in support of the Opinion for SAJ-82 (NMFS 2014). Because the pile driving method has not been specified, the applicant could choose to use either a vibratory hammer or impact hammer. Therefore, this analysis includes both methods.

Vibratory installation of steel sheet piles:

Based on our noise calculations, installation of metal sheet piles by vibratory hammer will not result in any form of injurious noise effects. Yet, this installation method could result in behavioral effects at radii of 52 ft (16 meters [m]) for sea turtles and 243 ft (74 m) for smalltooth sawfish. Given the mobility of these species, we expect them to move away from noise disturbances. Because there is similar habitat nearby, we believe this effect will be insignificant. If an individual chooses to remain within the behavioral response zone, it could be exposed to behavioral noise impacts during pile installation. Since installation will occur only during the day, these species will be able to resume normal activities during quiet periods between pile installations and at night. Therefore, installation of metal sheet piles by vibratory hammer will not result in any injurious noise effect, and we anticipate any behavioral effects will be insignificant.

Installation of up to 10 steel sheet piles per day by an impact hammer using a ramp-up procedure, bubble curtain, and cushion block:

Based on our noise calculations, installation of steel sheet piles by impact hammer will cause single-strike or peak-pressure injurious noise effects to sea turtles and smalltooth sawfish within 5.2 ft of the pile driving impact. However we expect this effect to be discountable for the following reasons. Sea turtles and smalltooth sawfish are highly mobile and are expected to leave areas disturbed by construction activity. The ramp-up procedure is intended to provide a stimulus for mobile species, including sea turtles and smalltooth sawfish, causing them to leave the area before the single strike sound exposure level reaches an injury-causing threshold. Once they have left the area, it is expected that they will continue to avoid it. In the unlikely event that a sea turtle or smalltooth sawfish approaches the pile driving operation in spite of the construction activity, the applicant has agreed to cease all in-water activity until the animal is observed to leave the area. In accordance with NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006, all construction workers will be required to continuously watch for sea turtles and smalltooth sawfish. If a sea turtle or smalltooth sawfish is observed within 50 ft of the construction site, all in-water activities, including pile driving, will cease until the animal is observed to leave the area of its own accord. Because the area monitored for listed species is larger than the physical injury zone, we feel that observers will provide adequate protection for listed species in the area, making adverse effects extremely unlikely to occur.

The cumulative sound exposure level of multiple pile strikes over the course of a day may cause physical injury to sea turtles and smalltooth sawfish up to 430 ft from the impact location. Due

to the mobility of smalltooth sawfish, and because the project occurs in open water, we expect them to move away from construction activity and noise disturbances. Because we anticipate that sawfish and turtles will move away from the project area during the ramp-up period, we believe that an animal's suffering physical injury from cumulative noise exposure is extremely unlikely to occur. The project has adequate avenues for a sawfish or sea turtle to leave or avoid the project area during pile-driving activities, and there is similar habitat outside of the cumulative sound exposure injury zone. Thus, we believe the risk of injury is extremely unlikely and is discountable. However, an animal's movement away from the injurious impact zone is a behavioral response, with the effects discussed below.

The installation of piles using an impact hammer could also result in behavioral effects for sea turtles at a distance of 446 ft from the impact location and for smalltooth sawfish at a distance of 2,070 ft from the impact location. Due to the mobility of sea turtles, we expect them to move away from noise disturbances in this open-water environment. Because there is similar habitat nearby and because there are no other barriers to movement around the area, we believe any behavioral effect will be insignificant. Because pile driving will occur only during the day, these species will be able to resume normal activities during quiet periods between driving piles and at night. Therefore, we anticipate any behavioral effects to sea turtles or smalltooth sawfish will be insignificant.

3.1.3 Foraging and Refuge

Sea turtles and smalltooth sawfish may be temporarily unable to use the project site for forage and shelter habitat due to avoidance of construction activities, related noise, and physical exclusion from areas blocked by turbidity curtains. We expect these effects will be temporary and intermittent (impact hammering and construction will only occur during daylight hours). Also, because these species are mobile, we expect that they will move away from the construction activities and forage in adjacent areas with similar available habitat. As described above, in the description of the Action Area (Section 2.2), this portion of Biscayne Bay includes extensive seagrass beds, large areas of silt and sand, and substrate for sponge, soft coral, and algae. The action area includes only about 3% of the seagrasses available in this portion of the bay ($100\% \times 122.5 \text{ ac} / [3,154 \text{ ac continuous seagrass} + 475 \text{ ac patchy seagrass}] \approx 3.3756\%$), and 10% of sand and silty bottom ($100\% \times 122.5 \text{ ac} / [4800 \text{ ac total area} - (3,154 \text{ ac} + 475 \text{ ac seagrasses})] \approx 10.461\%$). Therefore, the effects to sea turtles and smalltooth sawfish from the impacts of temporary loss of foraging and refuge habitat will be insignificant.

Sea turtles and smalltooth sawfish may also be affected by the permanent loss of approximately 9,210 ft² of forage habitat (3,070 lin ft seawall \times 3 ft offset). We expect this effect to be insignificant, given the large amount of similar habitat nearby, described above, that will not be affected by the action.

3.2 Status of Critical Habitat Likely to be Adversely Affected

The term "critical habitat" is defined in Section 3(5)(A) of the ESA as (i) the specific areas within the geographic area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (1) essential to the conservation of the species and (2) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by a species at the time it is listed, upon a

determination that such areas are essential for the conservation of the species. “Conservation” is defined in Section 3(3) of the ESA as “...the use of all methods and procedures that are necessary to bring any endangered or threatened species to the point at which listing under the ESA is no longer necessary.”

3.2.1 Johnson’s seagrass critical habitat

Description

NMFS designated Johnson’s seagrass critical habitat on April 5, 2000 (65 FR 17786; see also, 50 CFR 226.213). The specific areas occupied by Johnson’s seagrass and designated by NMFS as critical habitat are those with 1 or more of the following criteria:

1. Locations with populations that have persisted for 10 years
2. Locations with persistent flowering populations
3. Locations at the northern and southern range limits of the species
4. Locations with unique genetic diversity
5. Locations with a documented high abundance of Johnson’s seagrass compared to other areas in the species’ range

Ten areas (Units) within the range of Johnson’s seagrass (approximately 200 kilometers) of coastline from Sebastian Inlet to northern Biscayne Bay, Florida) are designated as Johnson’s seagrass critical habitat (Table 2). The total range-wide acreage of critical habitat for Johnson’s seagrass is roughly 22,574 ac (NMFS 2002).

Table 2. Designated Critical Habitat Units for Johnson’s Seagrass

Unit A	A portion of the Indian River, Florida, north of the Sebastian Inlet Channel
Unit B	A portion of the Indian River, Florida, south of the Sebastian Inlet Channel
Unit C	A portion of the Indian River Lagoon, Florida, in the vicinity of the Fort Pierce Inlet
Unit D	A portion of the Indian River Lagoon, Florida, north of the St. Lucie Inlet
Unit E	A portion of Hobe Sound, Florida, excluding the federally marked navigation channel of the Intracoastal Waterway
Unit F	A portion of the south side of Jupiter Inlet, Florida
Unit G	A portion of Lake Worth, Florida, north of Bingham Island
Unit H	A portion of Lake Worth Lagoon, Florida, located just north of the Boynton Inlet
Unit I	A portion of northeast Lake Wyman, Boca Raton, Florida, excluding the federally marked navigation channel of the Intracoastal Waterway
Unit J	A portion of northern Biscayne Bay, Florida, including all parts of the Biscayne Bay Aquatic Preserve excluding the Oleta River, Miami River, and Little River beyond their mouths, the federally marked navigation channel of the Intracoastal Waterway, and all existing federally authorized navigation channels, basins, and berths at the Port of Miami to the currently documented southernmost range of Johnson’s seagrass, Central Key Biscayne

The physical habitat that supports Johnson's seagrass includes both shallow intertidal and deeper subtidal zones. The species thrives either in water that is clear and deep (2-5 m) or in water that is shallow and turbid. In tidal channels, it inhabits coarse sand substrates. The spread of the species into new areas is limited by its reproductive potential. Johnson's seagrass possesses only female flowers; thus vegetative propagation, most likely through asexual branching, appears to be its only means of reproduction and dispersal. If an established community is disturbed, regrowth and reestablishment are extremely unlikely. This species' method of reproduction impedes the ability to increase distribution as establishment of new vegetation requires considerable stability in environmental conditions and protection from human-induced disturbances.

Essential Features of Critical Habitat

NMFS identified 4 habitat features essential for the conservation of Johnson's seagrass: (1) adequate water quality, defined as being free from nutrient over-enrichment by inorganic and organic nitrogen and phosphorous or other inputs that create low oxygen conditions; (2) adequate salinity levels, indicating a lack of very frequent or constant discharges of fresh or low-salinity waters; (3) adequate water transparency, which would allow sunlight necessary for photosynthesis; and (4) stable, unconsolidated sediments that are free from physical disturbance. All 4 essential features must be present in an area for it to function as critical habitat for Johnson's seagrass.

Critical Habitat Unit Impacted by this Action

This consultation focuses on an activity that occurs in Unit J, which encompasses the northern portion of Biscayne Bay from Northeast 163rd Street south to Central Key Biscayne at 25°45' N (Figure 4). This portion of Biscayne Bay is bound by heavy residential and commercial development, though a few areas of mangrove shoreline remain. Dredge and fill projects have resulted in a number of spoil islands and channels too deep for seagrass growth. Biscayne Bay supports a diversity of biological communities including intertidal wetlands, seagrasses, hard bottom, assemblages, and open water. Unit J is wholly within the Biscayne Bay Aquatic Preserve.

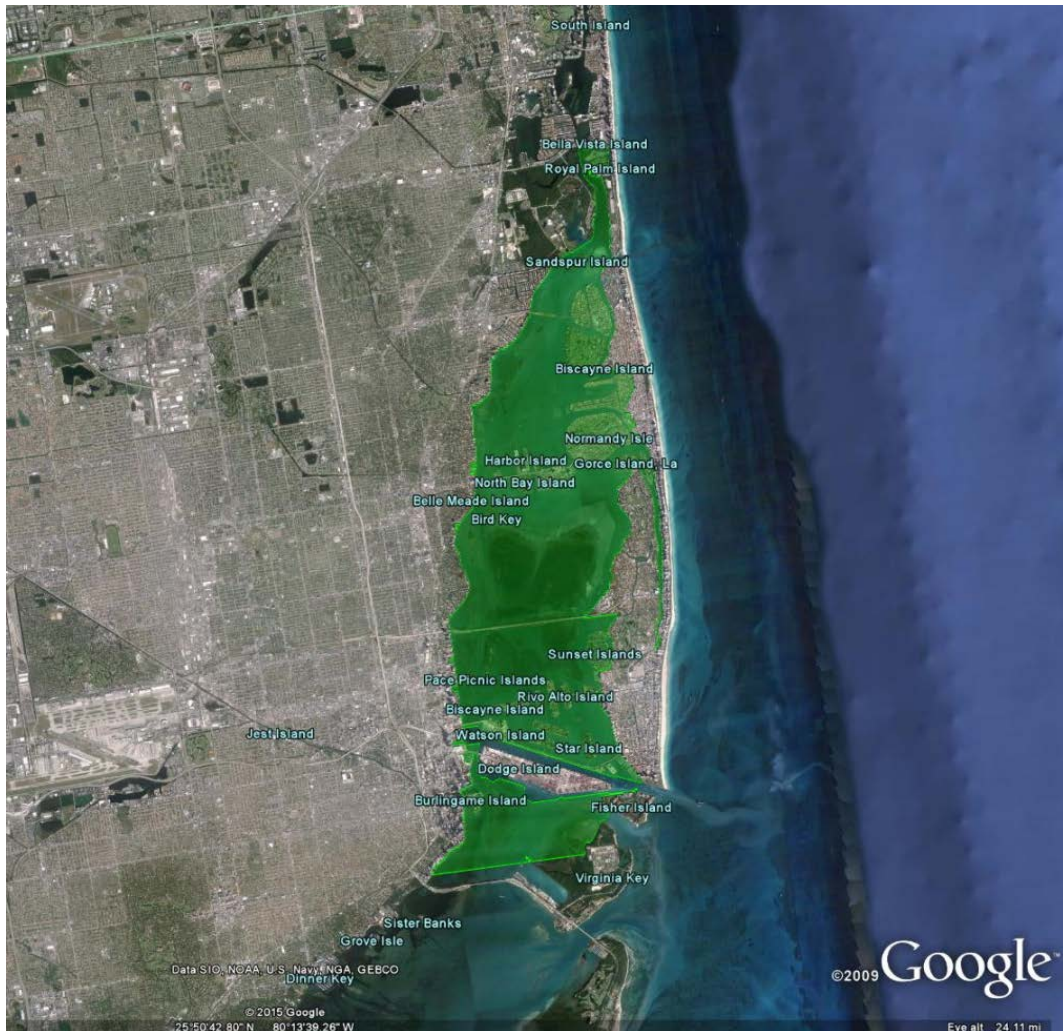


Figure 4. Johnson's seagrass critical habitat Unit J (©2015 Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO)

Status and Threats

A wide range of activities, many funded authorized or carried out by federal agencies, have and will continue to affect the essential habitat requirements of Johnson's seagrass. These are generally the same activities that may affect the species itself, and include: (1) vessel traffic and the resulting propeller dredging; (2) dredge and fill projects; (3) dock, marina, and bridge construction; (4) water pollution; and (5) land use practices (shoreline development, agriculture, and aquaculture).

Vessel traffic has the potential to affect Johnson's seagrass critical habitat by reducing water transparency. Operation of vessels in shallow water environments often leads to the suspension of sediments due to the spinning of propellers on or close to the bottom. Suspended sediments reduce water transparency and the depth to which sunlight penetrates the water column. Populations of Johnson's seagrass that inhabit shallow water and water close to inlets where vessel traffic is concentrated are likely to be most affected. This effect is expected to worsen with increases in boating activity.

The dredging of bottom sediments to maintain, or in some cases create, inlets, canals, and navigation channels can directly affect essential features of Johnson's seagrass critical habitat. Dredging results in turbidity through the suspension of sediments. As discussed previously, the suspension of sediments reduces water transparency and the depth to which sunlight can penetrate the water column. The suspension of sediments from dredging can also re-suspend nutrients, which could result in over-enrichment and/or reduce dissolved oxygen levels. Further, dredging can destabilize sediments and alter both the shape and depth of the bottom within the dredged footprint. This may affect the ability of the critical habitat to function through the removal or modification of essential features.

Dock, marina, and bridge construction leads to loss of habitat via construction impacts (e.g., pile installation) and shading. Similar to dredging, installation of piles for docks or bridges can result in increased turbidity that can negatively impact water transparency over short durations. Additionally, installed piles also replace the stable, unconsolidated bottom sediments essential for the species. Completed structures can have long-term effects on critical habitat in the surrounding area because of the shade they produce. While shading does not affect water transparency directly, it does affect the amount and/or duration of sunlight that can reach the bottom. The threat posed by dock, marina, and bridge construction is especially apparent in coastal areas where Johnson's seagrass is found.

Other threats include inputs from adjacent land use. Johnson's seagrass critical habitat located in proximity to rivers, canal mouths, or other discharge structures is affected by land use within the watershed. Waters with low salinity that are highly colored and often polluted are discharged to the estuarine environment. This can impact salinity, water quality, and water transparency, all essential features of Johnson's seagrass critical habitat. Frequent pulses of freshwater discharge to an estuarine area may decrease salinity of the habitat and provoke physiological stress to the species. Nutrient over-enrichment, caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural land run-off, stimulates increased algal growth, decreased water transparency, and diminished oxygen content within the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities. Discharges can also contain colored waters stained by upland vegetation or pollutants. Colored waters released into these areas reduce the amount of sunlight available for photosynthesis by rapidly reducing the amount of shorter wavelength light that reaches the bottom. In general, threats from adjacent land use will be ongoing, randomly occurring events that follow storm events.

4 ENVIRONMENTAL BASELINE

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and the ecosystem, within the action area. It does not include the effects of the action under review in this consultation.

By regulation, environmental baselines for Biological Opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area, other than the action under review. We identify the anticipated impacts of all proposed federal projects in the specific action area of the consultation at issue, that have already undergone

formal or early Section 7 consultation as well as the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Focusing on the impacts of the activities in the action area specifically, allows us to assess the prior experience and state (or condition) of the endangered and threatened individuals, and areas of designated critical habitat that occur in an action area, and that will be exposed to effects from the actions under consultation. This is important because, in some phenotypic states or life history stages, listed individuals will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other states, stages, or areas within their distributions. The same is true for localized populations of endangered and threatened species: the consequences of changes in the fitness or performance of individuals on a population's status depends on the prior state of the population. Designated critical habitat is not different: under some ecological conditions, the physical and biotic features of critical habitat will exhibit responses that they would not exhibit in other conditions.

4.1 Status of Johnson's seagrass critical habitat within the Action Area

As discussed above, this consultation focuses on activities occurring in Unit J, which encompasses the northern portion of Biscayne Bay from NE 163rd Street south to Central Key Biscayne at 25° 45' N (Figure 4). This portion of Biscayne Bay is bounded by heavy residential and commercial development, though a few areas of mangrove shoreline remain. The average depth of Biscayne Bay within the action area ranges from 0 ft to approximately -19.63 ft Mean Lowest Low Water (MLLW), referenced to the local tidal datum at the time of the hydrographic survey that measured it, with a mean of -3.79 ft MLLW (NOS 1998). The deepest water, more than -9 ft MLLW, is within the Meloy Channel, which comprises approximately 25% of the horizontal extent of the action area, but is excluded from the critical habitat unit. Seagrass beds occupy approximately 50% of the benthos within the action area. The distribution of Johnson's seagrass in this area is not known, but the essential features of Johnson's seagrass critical habitat appear to be present throughout the area.

4.2 Factors Affecting Johnson's seagrass critical habitat within the Action Area

4.2.1 Federal Actions

A wide range of activities funded, authorized, or carried out by federal agencies may affect the essential features of critical habitat for Johnson's seagrass. These include actions permitted or implemented by the USACE such as dredging; dock/marina construction; bridge/highway construction; residential construction; shoreline stabilization; breakwaters; and the installation of subaqueous lines or pipelines. Other federal activities that may affect Johnson's seagrass critical habitat include actions by the Environmental Protection Agency and the USACE to manage freshwater discharges into waterways; management of National Parks; regulation of vessel traffic to minimize propeller dredging and turbidity; and other activities by the U.S. Coast Guard and U.S. Navy. Although these actions have probably affected Johnson's seagrass critical habitat, none of these past actions have destroyed or adversely modified Johnson's seagrass critical habitat. Although some of these actions may have the potential to indirectly affect nutrient load, salinity, or water transparency in the action area, the continued growth of seagrasses in the action area indicates that any effect they may have had on the essential features of Johnson's seagrass critical habitat have been insignificant.

According to NMFS's Public Consultation Tracking System database, there have been no ESA Section 7 consultations completed on activities with the potential to affect Johnson's seagrass critical habitat within the action area.

4.2.2 State or Private Actions

4.2.2.1 Development and Urbanization

The action area is located in a highly developed coastal area with an extensive canal system. Freshwater discharges and nutrient over-enrichment due to coastal runoff and discharge into Biscayne Bay may be increased by upland development. Freshwater discharge may reduce salinity to inadequate levels for survival of Johnson's seagrass, thus affecting the second essential feature of the designated critical habitat, adequate water quality. Similarly, nutrient over-enrichment can lead to planktonic algae blooms, decreasing water transparency, the third essential feature of the designated critical habitat. Death and decomposition of the algal bloom typically decrease dissolved oxygen content in the water, thus affecting the first essential feature of the designated critical habitat, adequate water quality, defined as being free from nutrient over-enrichment by inorganic and organic nitrogen and phosphorous or other inputs that create low oxygen conditions. These processes affect all of the waters of Biscayne Bay to varying degrees due to large-scale mixing of waters, diffusion, and currents. Thus activities outside of the action area may affect the essential features of Johnson's seagrass critical habitat within the action area.

4.2.2.2 Recreational Vessel Traffic

Marina and dock construction increases recreational vessel traffic within areas of Johnson's seagrass critical habitat, which increases suspended sediments from propellers. As mentioned above, suspended sediments are known to adversely affect Johnson's seagrass critical habitat by reducing water transparency, which is one of the essential features. Increases in vessel traffic may also result in an increase in propeller dredging and vessel grounding incidents. Propeller dredging and grounding incidents in soft bottom disturb the sediment, and, thus may adversely affect another essential feature of Johnson's seagrass critical habitat: stable, unconsolidated sediments that are free from physical disturbance.

4.2.3 Conservation and Recovery Actions Shaping the Environmental Baseline

State and federal conservation measures exist to protect Johnson's seagrass and its habitat under an umbrella of management and conservation programs that address seagrasses in general (Kenworthy et al. 2006). Johnson's seagrass habitat is also included in the designation of critical habitat for the Florida manatee and is therefore subject to ESA Section 7 consultation by the USFWS, which has ESA jurisdiction over that species. These conservation measures must be continually monitored and assessed to determine if they will ensure the long-term protection of the species and the maintenance of environmental conditions suitable for its continued existence throughout its geographic distribution.

5 EFFECTS OF THE ACTION ON JOHNSON'S SEAGRASS CRITICAL HABITAT

Effects of the action include direct and indirect effects of the action under consultation. Indirect effects are those that result from the proposed action, occur later in time (i.e., after the proposed action is complete), but are still reasonably certain to occur.

Effects of the proposed action also include effects of other activities that are interrelated or interdependent with the proposed action. Interrelated actions are those that are part of a larger action and depend on that larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Thus these actions are also described and their effects on listed species and critical habitat are evaluated as effects of the proposed action. We have identified no interrelated or interdependent actions relative to the proposed action.

All four essential features of Johnson's seagrass critical habitat are present within the proposed action area. The proposed action will not affect the essential features of adequate water quality or adequate salinity within the action area. The construction of the new seawall will result in the loss of approximately 9,210 ft² (3,070 ft × 3 ft) of stable, unconsolidated sediments that are free from physical disturbance. The construction of an overhanging T-wall and cap will affect water transparency by reducing transmission of sunlight necessary for photosynthesis in an area of 4,800 ft² (3,200 ft × 1.5 ft). A permanent loss of any one of these essential features renders the area incapable of supporting Johnson's seagrass and constitutes a total loss of the conservation function of the critical habitat in the area of the loss. Therefore, this project will result in the loss of 14,010 ft² (~0.322 ac) of Johnson's seagrass critical habitat (9,210 ft² sediments replaced + 4,800 ft² shaded).

6 CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, or local private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed actions are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

No categories of effects beyond those already described are expected in the action areas. Dock and marina construction will likely continue at current rates, with concomitant loss and degradation of seagrass habitat, including Johnson's seagrass. However, these activities are subject to USACE permitting and thus the ESA Section 7 consultation requirement. Furthermore, NMFS and the USACE have developed protocols to encourage the use of light-transmitting materials in future construction of docks within the range of Johnson's seagrass. However, even if all new docks are constructed in full compliance with the NMFS and USACE's *Construction Guidelines for Minor Piling-Supported Structures in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat*, there will still be shading impacts to Johnson's seagrass from new docks (but shading impacts would be reduced if guidelines are followed). As previously stated, Landry et al. (2008) found that Johnson's seagrass persisted under docks constructed of grated decking versus non-grated decking. Although it was reduced in frequency under grated docks, Johnson's seagrass was observed in higher densities under grated versus non-grated docks. In summary, NMFS acknowledges that shading impacts to Johnson's seagrass

will continue via dock construction. As NMFS and the USACE continue to encourage permit applicants to design and construct new docks in full compliance with the NMFS and USACE's *Construction Guidelines for Minor Piling-Supported Structures in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat*, the NMFS and USACE's *Key for Construction Conditions for Docks or Other Minor Structures Constructed in or Over Johnson's seagrass (Halophila johnsonii)*, and the recommendations in Landry et al. (2008) and Shafer et al. (2008), NMFS believes that shading impacts to Johnson's seagrass will be reduced in the short- and long-term.

Upland development and associated runoff will continue to degrade water quality and decrease water clarity necessary for growth of seagrasses. Flood control and imprudent water management practices will continue to result in freshwater inputs into estuarine systems, thereby degrading water quality and altering salinity. Long-term, large-scale reduction in salinity has been identified as a potentially significant threat to the persistence and recovery of Johnson's seagrass.

7 CRITICAL HABITAT DESTRUCTION/ADVERSE MODIFICATION ANALYSIS

NMFS's regulations define destruction or adverse modification to mean a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR § 402.02). Other alterations that may destroy or adversely modify critical habitat may include impacts to the area itself, such as those that would impede access to or use of the essential features. We intend the phrase "significant delay" in development of essential features to encompass a delay that interrupts the likely natural trajectory of the development of physical and biological features in the designated critical habitat to support the species' recovery. NMFS will generally conclude that a federal action is likely to "destroy or adversely modify" designated critical habitat if the action results in an alteration of the quantity or quality of the essential physical or biological features of designated critical habitat, or that precludes or significantly delays the capacity of that habitat to develop those features over time, and if the effect of the alteration is to appreciably diminish the value of critical habitat for the conservation of the species. This analysis takes into account the geographic and temporal scope of the proposed action, recognizing that "functionality" of critical habitat necessarily means that it must now and must continue in the future to support the conservation of the species and progress toward recovery. Destruction or adverse modification does not depend strictly on the size or proportion of the area adversely affected, but rather on the role the action area serves with regard to the function of the overall designation, and how that role is affected by the action.

Recovery for Johnson's seagrass as set forth in the final recovery plan (NMFS 2002), will be achieved when the following recovery objectives are met: (1) the species' present geographic range remains stable for at least 10 years, or increases; (2) self-sustaining populations are present throughout the range at distances less than or equal to the maximum dispersal distance to allow for stable vegetative recruitment and genetic diversity; and (3) populations and supporting habitat in its geographic range have long-term protection (through regulatory action or purchase acquisition). We evaluated the projects' expected impacts on critical habitat to determine

whether it will be able to continue to provide its intended functions in achieving these recovery objectives and supporting the conservation of the species.

The first recovery criterion for Johnson's seagrass is for its present range to remain stable for 10 years or to increase during that time. NMFS's 5-year review (2007) of the status of the species concluded that the first recovery objective had been achieved as of 2007. In fact, the range had increased slightly northward, and we have no information indicating range stability has decreased since then. In Section 5, we determined that this project will result in the loss of approximately 14,010 ft² (0.322 ac) of Johnson's seagrass critical habitat by placement of piles and shading by non-grated, overwater structures and vessels. But the action area is not at a boundary of the species' range; the area that will be impacted is very small; and the loss of the potential areas for colonization will not affect the stability of the species' range now or in the future. Thus, we believe the project will not reduce the ability of the critical habitat to contribute to range stability for Johnson's seagrass.

The second recovery criterion for Johnson's seagrass requires that self-sustaining populations be present throughout the range at distances less than or equal to the maximum dispersal distance for the species. Due to its asexual reproductive mode, self-sustaining populations are present throughout the range of species. As discussed in Section 3.2.1, there are approximately 22,574 ac of Johnson's seagrass critical habitat. The loss of approximately 14,010 ft² (0.322 ac) of designated critical habitat for Johnson's seagrass in Unit J would equate to a loss of approximately 0.0014% of Johnson's seagrass critical habitat ($0.322 \text{ ac} \times 100\% / 22,574 \text{ ac} \approx 0.001426\%$). This loss will not affect the conservation value of available critical habitat to an extent that it would impact Johnson's seagrass self-sustaining populations by adversely affecting the availability of suitable habitat in which the species can spread/flow in the future. Drifting fragments of Johnson's seagrass can remain viable in the water column for 4-8 days (Hall et al. 2006), and can travel several kilometers under the influence of wind, tides, and waves. Because of this, we believe that the removal of approximately 14,010 ft² of critical habitat by this project will not appreciably diminish the conservation value of critical habitat in supporting self-sustaining populations.

The final recovery criterion is for populations and supporting habitat in the geographic range of Johnson's seagrass to have long-term protection (through regulatory action or purchase acquisition). Though the affected portions of the project sites will not be available for the long-term, thousands of acres of designated critical habitat are still available for long-term protection, which include areas surrounding the action areas.

The proposed project will not affect the stability of the geographic range of the species; it will not appreciably diminish the conservation value of the critical habitat in supporting self-sustaining populations; and it will not prevent the long-term protection of the species and its supporting habitat in the remainder of its geographic range. Therefore, we conclude that the adverse effects of the proposed action on Johnson's seagrass critical habitat will not impede achieving the recovery objectives listed above and will, therefore, not appreciably diminish the value of the critical habitat for the conservation and recovery of the species.

8 CONCLUSION

We have analyzed the best available scientific and commercial data, the current status of the species, environmental baseline, effects of the proposed actions, and cumulative effects to determine whether the proposed action is likely to destroy or adversely modify Johnson's seagrass critical habitat. Because the proposed action will not appreciably diminish the value of the critical habitat for the conservation and recovery of Johnson's seagrass, it is our Opinion that the proposed action is likely to adversely affect, but not likely to destroy or adversely modify Johnson's seagrass critical habitat.

8.1 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 endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

NMFS believes the following conservation recommendations are reasonable, necessary, and appropriate to conserve and recover Johnson's seagrass. NMFS strongly recommends that these measures be considered and adopted.

1. NMFS recommends that a report of all current and proposed USACE projects in the range of Johnson's seagrass be prepared and used by the USACE to assess impacts on the species from these projects, to assess cumulative impacts, and to assist in early consultation that will avoid and/or minimize impacts to Johnson's seagrass and its critical habitat. Information in this report should include location and scope of each project and identify the federal lead agency for each project. The information should be made available to NMFS.
2. NMFS recommends that the USACE conduct and support research to assess trends in the distribution and abundance of Johnson's seagrass. Data collected should be contributed to the Florida Fish and Wildlife Conservation Commission's Florida Wildlife Research Institute to support ongoing GIS mapping of Johnson's and other seagrass distribution.
3. NMFS recommends that the USACE, in coordination with seagrass researchers and industry, support ongoing research on light requirements and transplanting techniques to preserve and restore Johnson's seagrass, and on collection of plants for genetics research, tissue culture, and tissue banking.
4. NMFS recommends that the USACE prepare an assessment of the effects of other actions under its purview on Johnson's seagrass for consideration in future consultations.
5. NMFS recommends that the USACE continue promoting the use of the October 2002 *Key for Construction Conditions for Docks or other Minor Structures Constructed in or over Johnson's Seagrass* as the standard construction methodology for proposed docks located in the range of Johnson's seagrass.

6. NMFS recommends that the USACE review and implement the recommendations in the July 2008 report, *The Effects of Docks on Seagrasses, With Particular Emphasis on the Threatened Seagrass, Halophila johnsonii* (Landry et al. 2008).
7. NMFS recommends that the USACE review and implement the Conclusions and Recommendations in the October 2008 report, *Evaluation of Regulatory Guidelines to Minimize Impacts to Seagrasses from Single-family Residential Dock Structures in Florida and Puerto Rico* (Shafer et al. 2008).

8.2 REINITIATION OF CONSULTATION

As provided in 50 CFR 402.16, 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 proposed action is exceeded, (2) new information reveals effects of the action that may affect 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 listed species or critical habitat that was not considered in the Biological Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

9 LITERATURE CITED

- FWRI. 2011. Seagrass Florida. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, Florida, USA. FWC Open Data GIS & Mapping Data, OpenData Portal, http://geodata.myfwc.com/datasets/4d1b4e758e704def90773bd49806dd4c_6, accessed on February 17, 2017.
- FWRI. 2013. Coral and Hard Bottom Habitats in Florida. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, Florida, USA. FWC Open Data GIS & Mapping Data, OpenData Portal, http://geodata.myfwc.com/datasets/1ab76f29338b441ab0d0f9e28aecdcdc_7, accessed March 15, 2017.
- FWRI. 2014. Mangroves Florida. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, Florida. FWC Open Data GIS & Mapping Data, OpenData Portal, http://geodata.myfwc.com/datasets/a78a27e02f9d4a71a3c3357aefc35baf_4, accessed February 17, 2017.
- FWRI. 2017. The Unified Florida Coral Reef Tract Map. ESRI, Redlands, California. <https://www.arcgis.com/home/item.html?id=6837a60d7b294016b6250b7bdea4dd43>, accessed April 14, 2017.
- FWRI, and DMFM. 2017. Artificial Reefs in Florida. D. o. M. F. M. a. F. F. a. W. C. C. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, editor. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, Florida. FWC Open Data GIS & Mapping Data, OpenData Portal, http://geodata.myfwc.com/datasets/eb2bfd225149405bba23604f20159f56_1, accessed March 15, 2017.
- Hall, L. M., M. D. Hanisak, and R. W. Virnstein. 2006. Fragments of the seagrasses *Halodule wrightii* and *Halophila johnsonii* as potential recruits in Indian River Lagoon, Florida. Marine Ecology Progress Series 310:109-117.
- Kenworthy, W. J., S. Wyllie-Echeverria, R. G. Coles, G. Pergent, and C. Pergent-Martini. 2006. Seagrass conservation biology: an interdisciplinary science for protection of the seagrass biome. Pages 595-623 in A. W. D. Larkum, R. J. Orth, and C. M. Duarte, editors. Seagrasses: Biology, Ecology and Conservation. Springer Netherlands.
- Landry, J. B., W. J. Kenworthy, and G. D. Carlo. 2008. The effects of docks on seagrasses, with particular emphasis on the threatened seagrass, *Halophila johnsonii*. Report submitted to NMFS Office of Protected Resources.
- NMFS. 2002. Recovery plan for Johnson's seagrass (*Halophila johnsonii* Eiseman). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland, USA.

- NMFS. 2007. Endangered Species Act 5-Year Review: Johnson's Seagrass (*Halophila johnsonii* Eiseman). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland, USA.
- NMFS. 2014. Biological Opinion on Regional General Permit SAJ-82 (SAJ-2007-1590), Florida Keys, Monroe County, Florida. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeastern Regional Office, Saint Petersburg, Florida, USA.
- NOS. 1998. Biscayne Bay, FL (S200) Bathymetric Digital Elevation Model (30 meter resolution) Derived From Source Hydrographic Survey Soundings Collected by NOAA. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects, Silver Spring, Maryland, USA. Accessed on February 16, 2017, http://estuarinebathymetry.noaa.gov/bathy_htmls/S200.html.
- Shafer, D. J., J. Karazsia, L. Carrubba, and C. Martin. 2008. Evaluation of regulatory guidelines to minimize impacts to seagrasses from single-family residential dock structures in Florida and Puerto Rico. U.S. Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory Report ERDC/EL TR-08-41, Vicksburg, Mississippi, USA.