EIS
SUB-APPENDIX F

ENDANGERED SPECIES ACT (ESA) CONSULTATION

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Section 7 Consultation Package –

National Marine Fisheries Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
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F/SER31: KL
SER-2012-03723

MAR 07 2014

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Department of the Army
P.O. Box 4970
Jacksonville, Florida 32232

Mr. Chris McArthur
United States Environmental Protection Agency
Region 4
Atlanta Federal Center
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Atlanta, Georgia 30303

Re: Port Everglades Expansion Project, Broward County, Florida

Dear Mr. Summa and Mr. McArthur:

The enclosed document constitutes the National Marine Fisheries Service's (NMFS) Biological Opinion based on our review of the U.S. Army Corps of Engineers' (USACE) planned dredging activities for the expansion of Port Everglades, and the Environmental Protection Agency's (EPA) expansion of the Offshore Dredged Material Disposal Site as an interrelated and interdependent activity. This Opinion is based on project-specific information provided in the consultation packages in addition to NMFS's review of published literature. This Opinion analyzes the project effects on whales, Johnson's seagrass, sea turtles, smalltooth sawfish, staghorn coral and six corals proposed for listing, as well as designated critical habitat for elkhorn and staghorn coral and proposed critical habitat for the NWA DPS of loggerhead sea turtles. We believe that the proposed project is likely to adversely affect, but is not likely to jeopardize, the continued existence of sea turtles, Johnson's seagrass, staghorn coral and proposed corals, and is not likely to destroy or adversely modify designated critical habitat for elkhorn and staghorn corals.

This Opinion includes a conference opinion on 6 species of proposed corals, and the proposed reclassification of staghorn coral from threatened to endangered. As such, if the proposed listings and reclassification are finalized in June 2014, the USACE will need to contact NMFS to determine the mechanism for authorizing the take of corals necessary to implement this action as proposed. Since the USACE has requested conference consultation on the proposed species, at the proper time they must also request that this Conference Opinion be confirmed as NMFS's Biological Opinion.

We look forward to further cooperation with you on other USACE and EPA projects to ensure the conservation and recovery of our threatened and endangered marine species. If you have any

questions regarding this consultation, please contact Kelly Logan by phone at 727-460-9258 or by email at Kel.Logan@noaa.gov.

Sincerely,

Miles M. Croom

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

Enclosure
File: 1514-22.F.4

Endangered Species Act - Section 7 Consultation
Biological Opinion

Agency:	United States Army Corps of Engineers (USACE) and United States Environmental Protection Agency (EPA)
Applicant:	USACE Planning and Civil Works Division
Activity:	Dredging and Expansion of Port Everglades, Broward County, Florida
Consulting Agency:	National Marine Fisheries Service (NMFS) Southeast Regional Office Protected Resources Division
	NMFS Consultation No. SER-2012-03723
Date Issued:	MAR 07 2014
Approved By:	Miles M. Croom for Roy E. Crabtree, Ph.D. Regional Administrator

1 Consultation History 6
2 Description of the Proposed Action 7
3 Action Area 15
4 Status of Listed Species and Critical Habitat 16
5 Environmental Baseline 77
6 Effects of the Action 93
7 Cumulative Effects 109
8 Jeopardy Analysis 110
9 Analysis of Destruction or Adverse Modification of Designated Critical Habitat 126
10 Conclusion 128
11 Incidental Take Statement 129
12 Reasonable and Prudent Measures (RPMs) 131
13 Terms and Conditions 132
14 Conservation Recommendations 134

15 Reinitiation of Consultation 134
16 Literature Cited 135
APPENDIX A 171
APPENDIX B 174
APPENDIX C 175

Glossary of Commonly Used Acronyms

CCA	Crustose Coralline Algae
DPS	Distinct Population Segment
DWH	Deepwater Horizon
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
HCD	Habitat Conservation Division
ITS	Incidental Take Statement
MMPA	Marine Mammal Protection Act of 1972
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ODMDS	Ocean Dredged Material Disposal Site
RBO	Regional Biological Opinion
RPMs	Reasonable and Prudent Measures
SARBO	South Atlantic Regional Biological Opinion
SEFSC	Southeast Fisheries Science Center
SERO	Southeast Regional Office
STSSN	Sea Turtle Stranding and Salvage Network
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

Background

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the 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 those species. When the action of a federal agency may affect a protected species or its critical habitat, that agency is required to consult with either National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the protected species that may be affected.

Consultations on most listed marine species and their designated critical habitat are conducted between the action agency and NMFS. Consultations are concluded after NMFS determines the action is not likely to adversely affect listed species or critical habitat or issues a biological opinion ("opinion") that determines whether a proposed action is likely to jeopardize the continued existence of a federally-listed species, or destroy or adversely modify federally-designated critical habitat. The opinion also states the amount or extent of listed species incidental take that may occur and develops nondiscretionary measures that the action agency must take to reduce the effects of said anticipated/authorized take. The opinion may also recommend discretionary conservation measures. No incidental destruction or adverse modification of critical habitat may be authorized. The issuance of an opinion detailing NMFS's findings concludes ESA Section 7 consultation.

This document represents NMFS's Biological Opinion ("Opinion") based on our review of impacts associated with the USACE's proposed dredging and expansion of Port Everglades ("Port Everglades Expansion project"), and the U.S. Environmental Protection Agency's (EPA) proposed expansion of the Ocean Dredged Material Disposal Site (ODMDS). This Opinion analyzes project effects on Johnson's seagrass, sea turtles, whales, smalltooth sawfish, staghorn coral, and designated critical habitat for elkhorn and staghorn corals in accordance with Section 7 of the ESA. NMFS based this Opinion on project information provided by the USACE as well as published literature and the best available scientific and commercial information. It is NMFS's Biological Opinion that the action, as proposed, is not likely to jeopardize the continued existence of Johnson's seagrass, sea turtles or staghorn coral, and is not likely to destroy or adversely modify the designated critical habitat for elkhorn and staghorn corals.

NMFS has also proposed to list 6 additional coral species, which may be found within the action area. The 6 species are: *Orbicella annularis, Orbicella faveolata, Orbicella franksi, Mycetophyllia ferox, Dichocoenia stokesii,* and *Agaricia lamarcki.* In addition, NMFS has proposed to reclassify *Acropora cervicornis* and *Acropora palmata* from threatened to endangered (77 FR 73220, December 7, 2012). The USACE has requested a formal Conference Opinion for these proposed corals. A conference consultation on the potential effects of the action on proposed critical habitat for the Northwest Atlantic DPS of loggerhead sea turtles is also included. Conference is a process of early interagency cooperation involving informal or formal discussions between the action agency and NMFS pursuant to Section 7(a)(4) of the ESA regarding the likely impact of an action on proposed species or proposed critical habitat. Conferences are: (1) required for proposed federal actions likely to jeopardize proposed species, or destroy or adversely modify proposed critical habitat; (2) designed to help federal agencies

identify and resolve potential conflicts between an action and species conservation early in a project's planning; and (3) designed to develop recommendations to minimize or avoid adverse effects to proposed species or proposed critical habitat. [50 CFR §402.02, 50CFR §402.10]. This document will incorporate NMFS's Conference Opinion for the 6 proposed coral species and proposed loggerhead critical habitat based on our review of impacts associated with the Port Everglades Expansion project and expansion of the ODMDS. It is NMFS's Opinion that the proposed action will not jeopardize the continued existence of any of these proposed species or destroy or adversely modify the proposed critical habitat for the loggerhead Northwest Atlantic DPS.

BIOLOGICAL OPINION

1 Consultation History

On March 25, 2002, the USACE submitted a biological assessment for the Port Everglades Expansion project. Due to changes in the project design, listing of new species and designation of new critical habitat, ongoing information requests, and workload, consultation could only be completed recently. The following is a list of important consultation dates and activities:

- 2003 – Changes in ship simulations resulted in potential changes to project impacts; the USACE requested the consultation be suspended.
- September 17, 2004 – USACE submitted a revised biological assessment.
- May 9, 2005 – NMFS proposed to list elkhorn and staghorn corals.
- Late May 2005 – NMFS and USACE discussed the survey information previously provided to NMFS and determined that no additional surveys would be completed at that time.
- June 23, 2005 – USACE determined that the Port Everglades Expansion project may affect, but is not likely to adversely affect, elkhorn and staghorn coral.
- March 29, 2006 – USACE provided additional details and graphics regarding the disposal areas.
- May 9, 2006 – NMFS listed elkhorn and staghorn corals as threatened under the ESA.
- May 2006 – USACE conducted a reef survey to provide additional details on species composition at the end of the entrance channel.
- June 21, 2006 – USACE and NMFS biologists met to discuss project status and transfer information.
- June 23, 2006 – USACE sent draft of Port Everglades Reef Report.
- July 25, 2006 – USACE and NMFS met to discuss results of Port Everglades Reef Report.
- August 11, 2006 – NMFS provided comments on Reef Report to USACE. NMFS recommended that USACE complete a survey designed specifically to identify the presence and abundance of elkhorn and staghorn corals.
- August 18, 2006 – NMFS sent letter to USACE stating our belief that the coral reef survey study design was flawed.
- August-September, 2006 – USACE and NMFS coordinated by emails and agreed to a revised project area and updated seagrass reports.
- October 18, 2006 – USACE provided a letter responding to NMFS's determination that the original coral resource survey design was flawed.
- March 26, 2008 – NMFS sent a letter to USACE stating our concern that *Acropora cervicornis* may occur closer than the stated 3,500 feet (ft) from the entrance channel.
- April 28, 2008 – USACE and NMFS met to discuss project timeline and coral survey methodology. NMFS and USACE agreed to develop alternative survey methods for navigational channels in order to provide for human safety.
- December 2009 – Dial Cordy, Inc. finalized the Benthic and Fish Community Assessment Report.
- Summer 2010 – USACE conducted a new *Acropora* survey using the new alternative methods.

- October 2010 – USACE submitted the *Acropora* Survey Final Report to NMFS.
- October 12, 2010 – NMFS and USACE reviewed video and results of *Acropora* survey.
- August 2, 2011 – NMFS received information on a new *Acropora* survey conducted by the U.S. Navy. The survey found colonies of *Acropora* on the outer reef near the Port Everglades entrance channel. NMFS requested a hold on consultation until completion of the Navy report.
- December 2011 – NMFS received a copy of the final report from the Navy.
- February 13, 2012 – NMFS provided a copy of the final report from the Navy to the USACE.
- May 1, 2012 – NMFS and USACE met to discuss ongoing projects and timelines. During the meeting, NMFS requested that the USACE submit a complete consultation package for the Port Everglades Expansion project.
- September 5, 2012 – USACE submitted the final consultation package to NMFS.
- September 27, 2012 – USACE and NMFS met in St. Petersburg to discuss project status, possible alternatives, and ongoing NMFS concerns.
- October 16, 2012 – NMFS and USACE met in West Palm Beach with Dial Cordy, Inc. to discuss the towed video *Acropora* survey footage.
- December 7, 2012 – NMFS proposed to list 7 additional corals in the greater Caribbean region, 6 of which are documented in the project area.
- January 2, 2013 – USACE requested initiation of a formal conference opinion on the 6 proposed corals within the project area.
- January-May 2013 – NMFS worked on development of alternative coral reef mitigation options.
- May-October 2013 – NMFS and USACE developed "blended mitigation alternatives" to address impacts to coral reef resources.
- November 19-20, 2013 – NMFS and USACE met to resolve differences and composed a framework for a blended mitigation approach.

During the meeting held in St. Petersburg, Florida on November 19 and 20, 2013, NMFS and USACE resolved many of the remaining differences and completed the framework for a blended mitigation plan. USACE provided NMFS with a revised project description via email dated November 22, 2013 and we initiated formal consultation on that date.

2 Description of the Proposed Action

This consultation addresses the expansion of Port Everglades located within Hollywood, Broward County, Florida (see Figure 1). The total time frame for dredging is approximately 5 years. The propagation and outplanting of corals, a mitigation component of the proposed action, is expected to take 7 years with monitoring continued for an additional 3 years. The proposed project components are as follows (see Figure 2):

1. Deepen, widen, and extend the Outer Entrance Channel from an existing 45-ft project depth over a 500-ft channel width to 57 ft deep by 800 ft wide and extend it 2,200 ft seaward

2. Deepen the Inner Entrance Channel from 42 ft to 50 ft
3. Deepen the Main Turning Basin from 42 ft to 50 ft
4. Widen the rectangular shoal region to the southeast of the Main Turning Basin (Widener) by approximately 300 ft and deepen to 50 ft
5. Widen the Southport Access Channel in the proximity of Berths 23-26, referred to as "The Knuckle," by about 250 ft and relocate the U.S. Coast Guard (USCG) facility farther east on USCG property
6. Shift the existing 400-foot-wide Southport Access Channel about 65 ft to the east from approximately Berth 26 to the south end of Berth 29 to provide a transition back to the existing federal channel limits
7. Deepen the Southport Access Channel from about Berth 23 to the south end of Berth 32 from 42 ft to 50 ft
8. Deepen the Turning Notch, including the expanded portion, from 42 ft to 50 ft with an additional 100-foot north-south widening parallel to the Southport Access Channel on the eastern edge over a length of about 1,845 ft, and widen the western edge of the channel approximately 130 ft to provide access to the Turning Notch from the existing federal channel
9. Pre-treat rock substrates as necessary, including blasting
10. Dispose of dredged material not used for mitigation construction at the ODMDS, located east of the Port
11. Create approximately 5 acres of boulder reef
12. Relocate approximately 11,500 corals from within the impact area to the artificial boulder reef
13. Propagate and outplant corals, including between 35,000 and 50,000 *Acropora cervicornis* colonies
14. Temporarily relocate existing Aids to Navigation (ATONs) adjacent to the channel

All dredge depths may include up to 2 ft overdredge, meaning that the contractor(s) will be able to dredge to 2 ft below all depths identified above. Exact dredging methods will be determined later and will be dependent upon to whom the USACE awards the contract. Hopper dredges may be used prior to beginning the expansion to remove accumulated shoal material from the existing channel. Sand, silt, clay, soft rock, rock fragments, and loose rock will be removed via clamshell or suction dredge. Where contractors encounter hard rock, the USACE anticipates that explosives, and/or large cutterhead equipment will be used to remove the rock. Approximately 5.47 million cubic yards of material will be removed from all dredging activities to complete the expansion.

The use of explosives will be limited to areas inshore of the outer reef. The USACE estimates that up to 50% of the area to be dredged may require pre-treatment of hard substrate, and that there may be up to 900 days on which blasting takes place over the course of the 5-year construction period. The USACE will require the contractor(s) to use the following conservation measures to protect marine mammals and sea turtles:

1. A danger zone will be determined based on the explosive weight used and its effects during an open water detonation. This will give a conservative danger zone because the USACE will only use confined blasting techniques.

2. A combination of aerial observers, on water observers, and observers on the drill vessel will monitor the danger zone.

3. Any marine mammal or sea turtle within the danger zone shall not be forced to move out of these zones. Detonation shall not occur until the animal has moved out of the danger zone of its own volition.

4. In the event a protected species is injured or killed during the use of explosives, the USACE will immediately notify NMFS and engage in additional consultation prior to further use of explosives.

5. If explosives are used, the USACE will place the explosives in strategically oriented pre-drilled holes. These holes will be stemmed with angled gravel to direct the explosive energy into the rock.

6. The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock.

7. Drill patterns are restricted to a minimum of 8-foot separation from a loaded hole.

8. Hours of blasting are restricted from 2 hours after sunrise to 1 hour before sunset to allow for adequate observation of the project area for protected species.

9. Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.

10. Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.

11. The blast design will match the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.

12. Delay timing adjustments to a minimum of 8 milliseconds (ms) between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water.

13. Due to the likelihood of a large number of manatees in the area during the winter months, USACE has agreed as part of the ESA consultation with USFWS not to blast between November 15 and March 15. This will also help protect whales which migrate through this area in the early spring and late fall.

14. Test blasts will be performed prior to the actual project blasting. Observers will also be stationed to observe for endangered species prior to test and project blasts.

Safety radii are as follows:

1. The Danger Zone (NMFS refers to this as the Caution Zone): The radius in feet from the detonation beyond which no expected mortality or injury from an open water explosion is likely to occur (NMFS 2005c). The danger zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

2. The Safety Zone is the approximate distance in feet beyond which injury (Level A harassment as defined in the MMPA) is unlikely to occur from an open water explosion (NMFS 2005c). The safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

3. The Watch Zone is 3 times the radius of the Danger Zone to ensure that animals entering or near the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

4. The Exclusion Zone extends to 500 ft outside the Danger Zone radius. Detonation will not occur if a marine mammal or sea turtle may be within that zone (based on observational data).

Monitoring/watch plan. A watch plan will be formulated based on the required monitoring radii and optimal observation locations. The watch plan will be consistent with the program that was utilized successfully at Miami Harbor in 2005 and will consist of at least 5 observers including at least 1 aerial observer, 2 boat-based observers, and 2 observers stationed on the drill barge. A 6th observer will be placed in the most optimal observation location (boat, barge, fixed structure, shore, or aircraft) on a day-by-day basis depending on the location of the blast and the placement of dredging equipment, as determined by the blaster in charge and the chief protected species observer. This process will ensure complete coverage of the 3 zones as well as any critical areas. The watch will begin at least 1 hour prior to each blast and continue for one-half hour after each blast (Jordan et al. 2007).

Studies have shown that stemmed blasts have up to a 60% to 90% decrease in the strength of the pressure wave released, compared to open-water blasts of the same charge weight (Hempen et al. 2007; Hempen et al. 2005; Nedwell and Thandavamoorthy 1992). However, unlike open-water blasts, very little documentation exists on the effects that confined blasting can have on marine animals near the blast (Keevin et al. 1999). The blast mitigation procedures detailed above, in particular the rigorous observer program, have been successfully used in several USACE projects (i.e., San Juan Harbor, Puerto Rico, in 1994; Miami Harbor in 2005; and Wilmington Harbor in 2012).

The USACE will require the contractor(s) to follow the Terms and Conditions in NMFS's 1997 Regional Biological Opinion (RBO) on Hopper Dredging along the South Atlantic Coast. The

1997 RBO incorporates (by reference) NMFS's 1995 Biological Opinion on hopper dredging of channels and beach nourishment activities in the southeastern United States from North Carolina through Florida East Coast. The contractor(s) will be required to follow the Terms and Conditions in the 1997 and 1995 Biological Opinions mentioned above, with the exception of the conditions related to the southeast United States' North Atlantic Right Whale calving area, because the proposed project is not located in or near the calving area. The USACE will also require the contractor(s) to follow the enclosed NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006 (Appendix B).

Based on info from the DEIS (USACE 2013), current impact estimates show expanding the Port's Outer Entrance Channel will directly affect (via dredging) less than 8 acres of seagrasses, including 4.67 acres of Johnson's seagrass, 1.2 acres of mangroves, and 21.66 acres of coral reef habitat. The USACE will use mitigation credits at Westlake Park for losses of seagrass and mangroves. Further, approximately 98 to 118 acres of coral reef habitat may be impacted by sedimentation and anchoring of dredging vessels, depending on the methods ultimately used. The USACE anticipates that the methods used will likely result in the lower end of these effects; thus, the Port Everglades Expansion project includes mitigation actions to compensate for impacts to approximately 120 acres containing corals and coral reef. NMFS and the USACE worked together to create a "blended" mititgation plan, consisting of artificial reef creation and enhancement, and propogation and transplantion of sponges and corals, including listed staghorn corals, to natural reefs. The draft Habitat Equivalency Analysis, draft mitigation plan, and final meeting notes from collaborative meetings held in November 2013 (all of which can be found within the consultation documents for this project) were used to develop the following agreed-upon elements of mitigation:

1. *Creation of approximately 5 acres of artificial boulder reefs.*
   USACE proposes to deploy piles of limestone that have either been quarried and transported to the mitigation area, or dredged from the channel construction areas. The exact layout and artificial reef sites will be determined as part of the final mitigation plan.

2. *Relocation of approximately 11,500 corals from the impact area to artificial boulder reefs.*
   Approximatley 11,500 corals are proposed to be relocated from the impact area to the created artificial boulder reefs. Corals are removed from their natural substrate using hand tools, such as chisels and hammers. Depending on the distance to the outplanting site, the dislocated corals are transported either underwater by the diver or in seawater-filled containers at the surface. The corals are then attached to the artificial boulder reef using technologically proven standards. The density of the outplants will approximate the density in which they occurred in their natural state.

3. *Propagation and outplantation of corals and sponges, including between 35,000 and 50,000 staghorn coral colonies*
   The USACE proposes to enhance partially degraded reef sites near to, but not directly in or adjacent to, the area impacted by the Port Everglades Expansion project. This proposed reef mitigation project would enhance degraded reefs through the placement (outplanting) of regionally appropriate corals and sponges at appropriate density and

numbers as determined by NMFS. The organisms for outplanting would be sourced from corals and sponges of opportunity or propagated within in situ or ex situ coral nurseries. The exact numbers and proportions of the various coral species outplanted will be determined as part of the final mitigation plan. The USACE anticipates that between 35,000 and 50,000 colonies of staghorn coral will be part of the suite of outplanted organisms. The USACE anticipates that this portion of the mitigation (setting up or augmenting nurseries, growing corals and outplanting enough to meet the mitigation goals) will take up to 7 years to meet their mitigation requirements,with monitoring continuing for up to an additional 3 years.

Coral nurseries currently exist within Broward County and could be the source of the outplanted corals. However, it is possible that the volume of corals needed for the Port Everglades mitigation actions will exceed the capacity of existing nurseries; thus, new nurseries may be established. Scientifically vetted best practices for nursery propagation, outplanting, and monitoring have been developed and used by nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson et al. 2011). Typical coral nursery establishment includes collection of small fragments less than 5 centimeters in diameter from the reef and holding the fragments in an underwater or tank-based nursery environment through their juvenile life stage. Corals of opportunity (i.e., fragments or colonies found already broken or dislodged from reef substrates) are the preferred source of fragment stock for the nursery; however, sometimes wild colonies must be sampled to obtain nursery stock. Small branch clippings from wild donor colonies can be collected using a variety of cutting tools, including stainless steel surgical bonecutters, diagonal electrical wire cutters, needle-nose pliers, etc. For colonies with thicker branches, PVC cutters have also proven effective. Branches are cut cleanly and evenly to ensure optimal survival of the fragment as well as rapid healing and recovery of the donor colony (Johnson et al. 2011). Offshore nurseries are sited to balance a number of factors including, among others, appropriate habitat and water quality conditions, potential for future impacts, and permitting. The physical and genetic origin of each coral is tracked from fragment collection to ensure that both nursery and outplanting operations are done in a scientifically responsible way. Regular maintenance is performed on nursery structures and the corals themselves to ensure all are free of coral competitors and predators. Once coral fragments have grown to a size where the probability of survival on natural reefs has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted to the natural reef.

Similar to nursery siting, outplanting sites are selected balancing several factors to maximize success. During outplanting, care is taken to ensure external stresses are minimized and that a population with an acceptable level of genetic diversity and environmental tolerance is developed. Algae and predators are periodically removed from the outplanted corals until they are firmly established on the reef. A stock population is maintained within the nursery to provide new colonies for outplanting. Corals can be attached directly to the reef or using attachment platforms like masonry nails or cement pucks. Outplanted corals can be wedged into holes or crevices, or secured using epoxy, cement, wire, or plastic ties.

In addition to the above activities for Port expansion, NMFS received a request for consultation dated August 26, 2013, from EPA to expand the ODMDS located offshore of Fort Lauderdale, Broward County, Florida (see Figure 3). NMFS has determined that this project is interrelated to and interdependent with the Port Evergaldes Expansion project, therefore it will be included in this Biological Opinion. The proposed project includes expanding the ODMDS from the existing 0.9 square nautical miles (nm^2) to an area of 3.21 nm^2, which will have a north-south oriented release zone. The Port Everglades Expansion project includes disposal of up to 5.47 million cubic yards (mcy) of dredged material within the ODMDS. The western edge of the site is located 3.3 nm offshore and the center of the site is located approximately 4 nm offshore. Water depths range from 604 to 735 ft. Previously collected sidescan sonar data (EPA 2004) and data collected from the OSV (Ocean Survey Vessel) Bold's site designation survey in May 2011 (ANAMAR 2012) indicate the bottom within the expansion area is primarily a homogenous mix of sand, silt, and clay with scattered rubble. There are approximately 12.85 acres of hardbottom within the expansion area; however, it is located below the 30-meter depth contour and is not considered critical habitat for any listed coral species, nor does it function as refuge habitat for sea turtles.

Figure 1. Location of Port Everglades Expansion project. Known colonies of *Acropora* corals are indicated in green.

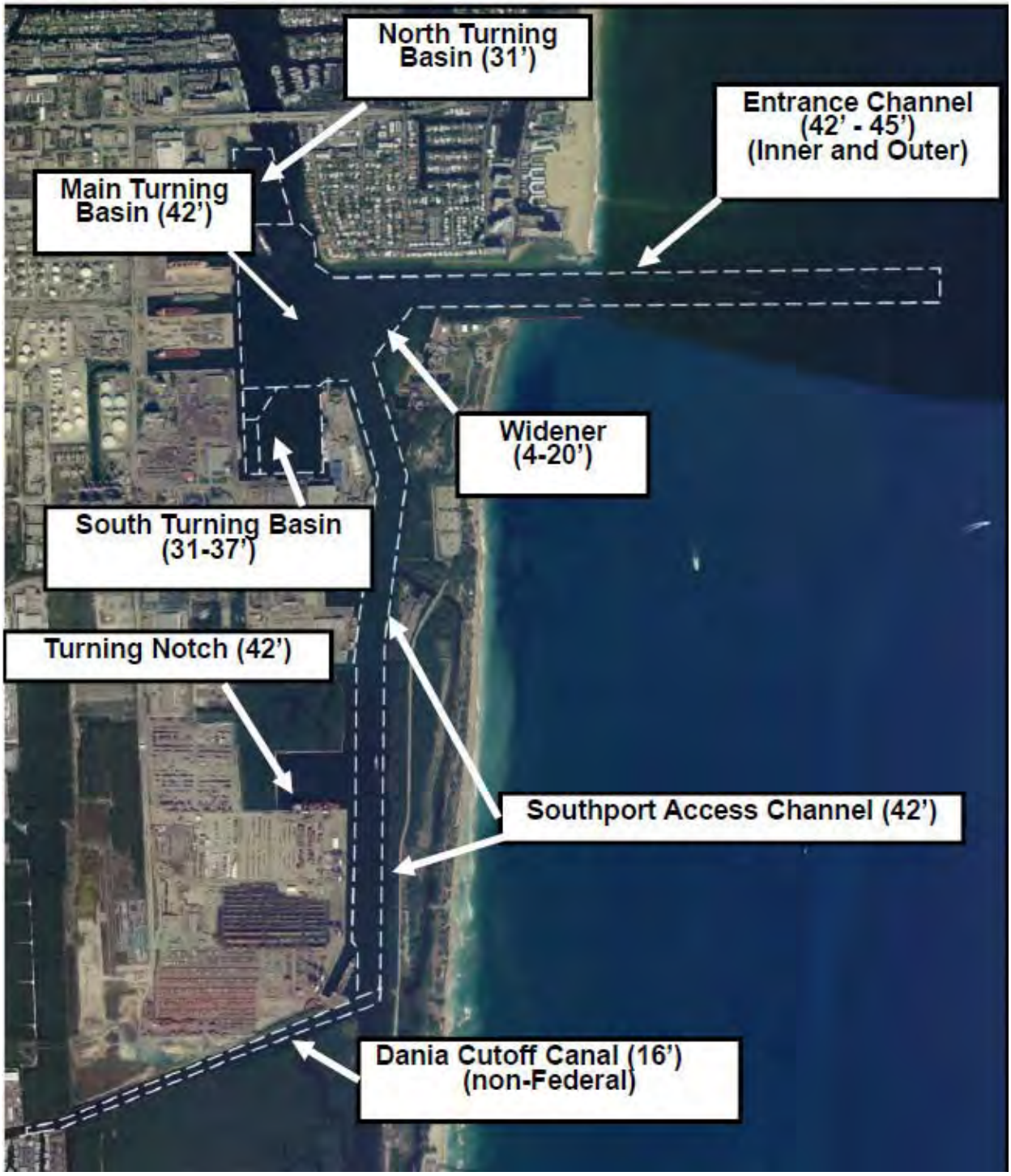

Figure 2. Port Everglades Expansion project components showing current depths. The Dania Cutoff Canal and the North Turning Basin are no longer part of the project (figure courtesy of USACE).

Figure 3. Location of EPA's ODMDS expansion project

3 Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The

action area for this project includes the Port Everglades Harbor, which is located in Hollywood, Broward County, Florida. Port Everglades includes several areas within the Intracoastal Waterway and the access channel, which extends into the Atlantic Ocean. The action area also includes a 150-ft buffer zone surrounding the access channel, in which effects of dredging will likely occur. The action area also includes the spoil disposal sites, which consist of a site in the nearshore Atlantic Ocean off Broward County where the boulder mitigation reef will be created, the ODMDS in the Atlantic Ocean off Broward County, and the routes of vessel travel to and from the disposal sites. Last, the action area includes the coral nursery and outplanting sites within the Florida Reef Tract offshore.

4 Status of Listed Species and Critical Habitat

The following endangered (E), threatened (T), and proposed species (P), and designated critical habitat under the jurisdiction of NMFS may occur in or near the action area**.**

Table 1. Listed and Proposed Species and Critical Habitat Likely to Occur in or Near the Project Area

Common Name	**Listed Species** Scientific Name	Status
Turtles		
Green sea turtle	*Chelonia mydas*[1]	E/T
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Loggerhead sea turtle	*Caretta caretta*[2]	T
Hawksbill sea turtle	*Eretmochelys imbricata*	E
Fish		
Smalltooth sawfish	*Pristis pectinata*[3]	E
Invertebrates and Marine Plants		
Staghorn coral	*Acropora cervicornis*	T; P-E[4]
Johnson's seagrass	*Halophila johnsonii*	T
Marine Mammals		
Humpback whale	*Megaptera novaeangliae*	E
Sperm whale	*Physeter macrocephalus*	E
Designated Critical Habitat		
Elkhorn/staghorn coral		
Common Name	**Proposed Species** Scientific Name	Status
Invertebrates		
Elliptical star coral	*Dichocoenia stokesii*	P-T[5]
Lamarck's sheet coral	*Agaricia lamarcki*	P-T
Rough cactus coral	*Mycetophyllia ferox*	P-E
Lobed star coral	*Orbicella annularis*	P-E
Mountainous star coral	*Orbicella faveolata*	P-E

[1] Green turtles are listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are listed as endangered.
[2] Northwest Atlantic Ocean (NWA) DPS.
[3] The U.S. DPS.
[4] *Acropora cervicornis* is currently listed as threatened and proposed for reclassification to endangered on December 7, 2012.
[5] All proposed corals were listed in the Federal Register on December 7, 2012.

Knobby star coral	*Orbicella franksi*	P-E
Proposed Critical Habitat		
Loggerhead sea turtle	Migratory and Breeding Habitat	Within Critical Habitat Unit Logg-N-19

4.1 Species and Critical Habitat Not Likely to be Adversely Affected

NMFS has analyzed the routes of potential project effects in the marine environment on 5 species of sea turtles (loggerhead, Kemp's ridley, leatherback, hawksbill, and green), smalltooth sawfish, humpback whales, and sperm whales from the proposed action. We have determined the potential routes of effects to sea turtles and smalltooth sawfish include (1) injury or death from potential interactions with and operation of dredges and blasting, and (2) avoidance of the area during construction operations due to disturbance caused by blasting, dredging, and placement of dredged materials in the various disposal sites (ODMDS, and the artificial reef mitigation site). Loss of foraging habitat within the dredge footprint could also affect sea turtles. The potential routes of effects to whales include injury or death from potential interactions with hopper dredges during dredging and disposal of dredged material in the ODMDS, injury or death from potential blasting, and temporary avoidance of areas during construction. Of these, only interactions with hopper dredges have the potential for adverse effects, and only for certain turtle species, as discussed below and in the Effects of the Action section.

Smalltooth Sawfish

Smalltooth sawfish are unlikely to be found within the existing channel area but may be found in the mangrove areas located at the western edge of John U. Lloyd State Park, although no sawfish have been reported. In the unlikely event a sawfish is present in the project area, sawfish should not be injured or killed by the dredging or construction activities because the dredges advance relatively slowly (the cutterhead dredges and mechanical-type dredges that are feasible to use in these areas are very slow, almost stationary) and are noisy, giving mobile sawfish the opportunity to get out of the way. Due to the sawfish's mobility, ability to detect the approaching draghead, and apparent avoidance behavior, the risk of injury will be discountable. While sea turtles are regularly taken by hopper dredges, apparently failing to react in time to avoid the overtaking draghead, possibly because they have limited hearing abilities at lower frequencies, no sawfish take by a dredge [of any type] has ever been reported to NMFS. The implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* may provide an additional measure of protection.

Sawfish may also be affected by blasting. Underwater explosions produce a pressure waveform with rapid oscillations from positive pressure to negative pressure that results in rapid volume changes in gas-containing organs. In fish, the swimbladder, a gas-containing organ, is the most frequently damaged organ (Christian 1973; Faulk and Lawrence 1973; Kearns and Boyd 1965; Linton et al. 1985a; Yelverton et al. 1975). It is subject to rapid contraction and overextension in response to the explosive shock waveform (Wiley et al. 1981). Species lacking swimbladders (like smalltooth sawfish) or with small swimbladders are highly resistant to explosive pressures (Aplin 1947; Fitch and Young 1948; Goertner 1994). For example, Wiley et al. (1981) and Goertner et al. (1994) noted that hogchokers (*Trinectes maculatus*), which lack swimbladders, were extremely tolerant of underwater explosions, and greatly exceeded the tolerance of any species with swimbladders that they had tested. The USACE will require the contractor to adhere to the above safety conditions related to blasting. Based on these measures and the

sawfish's likely absence from the main channel areas, NMFS believes that the effects on sawfish from blasting will be discountable.

As previously noted, no sawfish have been reported and they are unlikely to be found within the existing channel area, but may be found in the mangrove areas located at the western edge of John U. Lloyd State Park. The dredging will remove approximately 1.2 acres of fringe mangroves along the east side of the existing channel. Even so, dredging near the mangrove area will only be for a portion of the overall project time. Dredging will occur a section at a time; time spent on each section depends on the amount of pre-treatment necessary and the amount of rock to be removed from each area. There is additional mangrove habitat (that will not be impacted) available directly adjacent to the project site and within the park. Smalltooth sawfish may be affected by being temporarily unable to use discreet sections affected by construction due to potential avoidance of construction activities, blasting, and related noise; however, disturbance from dredging activities and related noise in areas most likely to be used by sawfish will be intermittent, localized, and only for part of the construction period.

Like many elasmobranchs, juvenile smalltooth sawfish exhibit site fidelity to the areas in which they are pupped for the first several years of their lives, typically remaining in very shallow nearshore waters where they can avoid predation by coastal shark species. In South Florida, sawfish have established distinct nursery areas where they utilize shallow, euryhaline habitat and red mangroves for foraging and refuge; these areas have been designated as critical habitat for the species (discussed below), though NMFS expects that areas outside of the designated critical habitat are used by some sawfish for pupping and nursery habitat, where there is appropriate juvenile habitat. As noted, dredging will remove approximately 1.2 acres of fringe mangroves along the east side of the existing channel. Additional mangrove habitat exists directly adjacent to the impact area, along the west side of John U. Lloyd State Park (see Figure 4), which will be preserved. USACE will also install breaks in the riprap area to allow better access to these mangroves. NMFS believes that if juvenile sawfish are using the mangroves they are likely to be using the more suitable habitat inside the park; the 1.2 acres of fringe mangroves are in deeper waters directly adjacent to the shipping channel and as such are subject to constant traffic and pollutants. The continual vessel traffic and deeper water means these fringe mangroves are not the preferred habitat for juvenile sawfish, which prefer shallow (0-3 ft depth), undisturbed habitats. Therefore, we believe that habitat related effects on sawfish will be insignificant.

Figure 4. Mangrove impacts along the Southern Access Channel

Sea Turtles

Hydraulic and Mechanical Dredges

Large, hydraulic suction cutterhead dredges will be used to complete the deepening and widening of the channel. Smaller, mechanical clamshell-type ("bucket") dredges may also be used on portions of the project. NMFS believes the chance of injury or death from interactions with clamshell and/or hydraulic dredging equipment is discountable as these dredge types advance very slowly and sea turtles are highly mobile and are likely to avoid the areas during construction. NMFS has received very few reports of sea turtle takes associated with these dredging methods in the South Atlantic region: only 1 (live) sea turtle has been taken by a clamshell dredge over the past 33 years. The take occurred at Cape Canaveral, Florida, which routinely has very high local sea turtle abundance. Cold-stunned turtles have also been taken by cutterhead dredging, but this also rarely happens and has been generally limited to shallow, confined waters (e.g., Laguna Madre, Texas) or bays where turtles get trapped and stunned when the rapid passage of a cold front causes the temperature of the shallow water body to drop abruptly. Due to the infrequency of interactions with these gear types and the project location and channel depths, NMFS believes that the likelihood of cold stunning occurring is discountable

and also that the possibility of a sea turtle being taken by a hydraulic cutterhead or a clamshell dredge is discountable.

Disposal Vessels
NMFS believes that the possibility that disposal vessel(s) will collide with and injure or kill sea turtles during disposal operations is discountable, given the vessels' slow speed (the fastest disposal scows travel at speeds of 12 knots or less (pers. comm. Terri Jordan-Sellers, USACE to Kelly Logan, NMFS, February 19, 2014), the ability of these species to move out of the way, and anticipated avoidance behavior by sea turtles at the sea surface or in the water column. Furthermore, NMFS believes the proposed dredged material (approximately 4.57 mcy) disposal activities over the life of the project are not likely to adversely affect sea turtles. Sea turtles may be attracted to ODMDS sites, to forage on the bycatch that may be occasionally found in the dredged material being dumped. As such, turtles could be potentially impacted by the sediments being discharged overhead. However, NMFS has never received a report of an injury to a sea turtle resulting from burial in, or impacts from, dredge disposal sediments, from inshore or offshore disposal sites, anywhere the USACE conducts dredged material disposal operations. Sea turtles are highly mobile and apparently are able to avoid descending dredged material discharged at the surface. NMFS believes the possibility of injury, or burial of normal, healthy sea turtles by dredged material disposal, is discountable.

Habitat Loss
Habitat effects to sea turtles include the loss of less than 8 acres of seagrass (4.67 of which is Johnson's seagrass) and some coral reef habitat. There is no nearshore hardbottom within the action area to attract foraging juvenile green turtles. However, there are some deeper reef areas within the expansion of the outer entrance channel that may contain sponges and crabs (foraged by hawksbill and loggerhead turtles, respectively). NMFS believes that foraging habitat for sea turtles is not likely a limiting factor in the action area, and thus the loss of potential seagrass and coral reef foraging habitat within the action area will have insignificant effects on sea turtles.

Blasting
Underwater explosions may affect marine life by causing death, injury, temporary threshold shifts (TTS or recoverable hearing loss), or behavioral reactions, depending on the distance an animal is located from a blast. An underwater explosion is composed of an initial shock wave, followed by a succession of oscillating bubble pulses. A shock wave is a compression wave that expands radially out from the detonation point of an explosion. At a distance from a detonation, the propagation of the shock wave may be affected by several components including the direct shock wave, the surface-reflected wave, the bottom-reflected wave, and the bottom-transmitted wave. The direct shock wave results in the peak shock pressure (compression) and the reflected wave at the air-water surface produces negative pressure (expansion). For an explosion with the same energy and at the same distance, an underwater blast is much more dangerous to animals than an air blast. The shock wave in air dissipates more rapidly and tends to be reflected at the body surface; in water the blast wave travels through the body and may cause internal injury to gas-filled organs due to impedance differences at the gas-liquid interface.

Explosions are known to injure and kill sea turtles (Duronslet et al. 1986, Gitschlag 1990, Gitschlag and Herczeg 1994, Klima et al. 1988, O'Keefe and Young 1984). NMFS studied the

effects of offshore oil and gas structure removals using 23 kg (50 lb) of nitromethane (Klima et al. 1988). Caged loggerhead and Kemp's ridley sea turtles were placed at distances of 700 ft (213.4 m), 1,200 ft (365.8 m), 1,800 ft (548.6 m), and 3,000 ft (914.4 m) from the platform to be removed with explosives. The charges were placed inside platform pilings at a depth of 5 m below the mudline. Post-detonation, 4 sea turtles within1,000 ft of the explosion were unconscious, as well as an individual at 3,000 ft. Sea turtles were expected to have drowned if not recovered from the water following the detonation. All turtles exposed to the blast exhibited everted cloacas and vasodilation lasting 2-3 weeks.

The sea turtle ear appears to be adapted to both aerial and aquatic environments. Sea turtles have a primitive reptilian ear and are considered to be hearing generalists, having limited hearing abilities at lower frequencies. Although there is some variation in sea turtle hearing measurements between species and size classes (Ketten and Bartol 2006), the available data suggest that species of sea turtles are likely sensitive to frequencies from approximately 100 Hertz (Hz) to 2,000 Hz (Lenhardt 1994, Lenhardt et al. 1996, McCauley et al. 2000a and 2000b, Moein et al. 1994, O'Hara and Wilcox 1990), with greatest underwater hearing sensitivities below 1,000 Hz (Ketten and Bartol 2006). Confined underwater blasts generally produce pulses of sound at low frequencies of several Hz to a few kHz (Hall 2010). Therefore, confined blasting will likely be heard by sea turtles and may result in behavioral reactions. Behavioral reactions to the sound produced from explosions may be important if they occur in biologically important areas such as foraging areas, near nesting beaches during nesting season, or in developmental juvenile habitats. The action area is not located near any nesting beaches or known juvenile development habitats, therefore we believe that behavioral effects due to sounds produced by confined blasting will be insignificant.

For all turtle species, potential routes of effects from the use of blasting are not likely to result in adverse effects for the following reasons:

1. Blasting mitigative procedures as proposed by the USACE are detailed in Section 2. Test blasts will be performed prior to the actual project blasting. Observers will also be stationed to observe for endangered species prior to test and project blasts. Test blasts are expected to cause sea turtles to leave the project area with, at most, insignificant behavioral modifications.

2. Studies have shown that stemmed blasts have up to a 60% to 90% decrease in the strength of the pressure wave released, compared to open-water blasts of the same charge weight (Hempen et al. 2007; Hempen et al. 2005; Nedwell and Thandavamoorthy 1992). However, unlike open-water blasts, very little documentation exists on the effects that confined blasting can have on marine animals near the blast (Keevin et al. 1999). The blast mitigation procedures detailed above, in particular the rigorous observer program, have been successfully used in several recent USACE projects (i.e., San Juan Harbor, Puerto Rico, in 1994, Miami Harbor in 2005, and Wilmington Harbor in 2012).

Since these procedures have been successfully used in several recent projects without incident, it is our continued judgment that they provide sufficient protections to sea turtles, and thus the effects from blasting are discountable.

Hopper Dredge Vessel Collisions
NMFS believes that the possibility that the hopper dredge vessel(s) will collide with and injure or kill sea turtles during dredging and/or sand pumpout operations is discountable, given the vessel's slow speed, the ability of these species to move out of the way, and anticipated avoidance behavior by sea turtles at the sea surface or in the water column.

Hopper Dredge Entrainment Effects
Leatherback Sea Turtles
NMFS believes the potential use of a hopper dredge may affect, but is not likely to adversely affect, leatherback sea turtles. Leatherback sea turtles tend to be open ocean, pelagic foragers and are uncommon in shallow nearshore waters, except during nesting season or during times when they may come in towards shore to feed on aggregations of jellyfish. The project area is not located near any nesting beaches. There has never been a reported take of a leatherback by a hopper dredge. The typical leatherback would be as large as or larger than the large, industry-standard California-type hopper dredge trailing-suction draghead, making leatherbacks unlikely to be entrained. Additionally, the California-type draghead design and level position during dredging (as opposed to more upright positioning of other dredge types), makes it less likely to entrain larger sea turtles (Studt 1987). Lastly, in over 32 years of observer-monitored hopper dredging projects in Jacksonville District, only 1 leatherback was ever been reported as lethally taken or observed, and that was in a relocation trawl. Relocation trawling is not proposed for this project. Based on the above, we believe that the risk of hopper dredging effects on leatherback sea turtles will be discountable. Leatherback sea turtles will not be discussed further in this opinion.

Hawksbill Sea Turtles
Hawksbill sea turtle nesting occurs in Puerto Rico, the U.S. Virgin Islands, and along the southeast coast of Florida. Outside of the nesting areas, hawksbills have been seen off the U.S. Gulf of Mexico states and along the Eastern Seaboard as far north as Massachusetts, although sightings north of Florida are rare (NMFS and USFWS 1993). They are closely associated with coral reefs and other hardbottom habitats, but they are also found in other habitats including inlets, bays, and coastal lagoons (NMFS and USFWS 1993). The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan 1999). During the past 20 years of NMFS consultations with the USACE on hopper dredging projects carried out in the Palm Beach Harbor, Port Everglades, Port of Miami, and Key West areas there has never been a documented take of a hawksbill sea turtle by a hopper dredge.[6] Due to hawksbill sea turtles' preferred habitat and diet, it is not expected that interactions would occur in the action area; therefore, NMFS believes the possibility that they would be adversely affected by hopper dredge is discountable. Hawksbill sea turtles will not be considered further in this opinion.

Kemp's Ridley Sea Turtles

[6] http://el.erdc.usace.army.mil/seaturtles/index.cfm

NMFS believes the routes of effects from the potential use of a hopper dredge may affect, but are not likely to adversely affect, Kemp's ridley sea turtles because they have not been encountered during the past 20 years of hopper dredging activities in Palm Beach Harbor, Port Everglades, Port of Miami, or Key West. This species has a very restricted range relative to other sea turtle species with most adults occurring in the Gulf of Mexico in shallow near shore waters, although adult-sized individuals sometimes are found on the eastern seaboard of the United States as well. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in the Mexican state of Tamaulipas, although few nests have also been recorded in Florida and the Carolinas (Meylan et al. 1995). Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Henwood and Ogren 1987, Lutcavage and Musick 1985, Ogren 1989). Upon leaving Chesapeake Bay in autumn, juvenile ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Epperly et al. 1995c, Epperly et al. 1995b, Musick and Limpus 1997). Adult Kemp's ridleys primarily occupy neritic habitats, typically containing muddy or sandy bottoms where prey can be found. In the post-pelagic stages, Kemp's ridley sea turtles are largely cancrivorous (crab eating), with a preference for portunid (swimming) crabs (Bjorndal 1997). Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be scavenged discards from the shrimping industry (Shaver 1991). Kemp's ridley sea turtles will not be considered further in this opinion based on the improbability of their presence in the action area and a low likelihood of an encounter with a hopper dredge.

Humpback Whales

Humpback whales may be found in or near the action area. These species are generally found seaward of the continental shelf, and would only be in the action area during migrations to and from breeding grounds (during the spring and fall months). NMFS has analyzed the routes of potential effects on humpback whales from the proposed action and, based on our analysis, determined that potential effects are limited to the following: injury from potential interactions with construction equipment (e.g., a dredge vessel striking a whale), injury from use of explosives, and temporary avoidance of the area during construction operations. The USACE will require the contractor to follow the aforementioned blasting safety conditions. Blasting would result in temporary impacts and would not be a daily occurrence of the project. In addition, whales do not use this area throughout the year and would most likely be migrating, the USACE would not be blasting during a large portion of the year (November through March), as per the requirements to avoid harm to manatees listed above. Therefore, NMFS concludes that the project's blasting effects are discountable.

In addition, the dredge crew and contractors will be required to abide by NMFS's *Vessel Strike Avoidance and Reporting Guidelines* (Appendix A) and all dredges will be required to have NMFS-approved endangered species observers aboard. NMFS believes that the possibility that the disposal vessel(s) will collide with and injure or kill whales during disposal operations is discountable, given the vessel's slow speed (the fastest disposal scows travel at speeds of 12

knots or less (pers. comm. Terri Jordan-Sellers, USACE to Kelly Logan, NMFS, February 19, 2014), and the whales' limited, seasonal presence in the action area. With implementation of these conservation measures, NMFS believes that the likelihood of a dredge or disposal vessel striking a humpback whale is discountable.

Sperm Whales

Sperm whales are predominantly found seaward of the continental shelf and are not expected to be found within the shallow waters inshore of the outer reef nor at the ODMDS. Therefore, we believe the risk to sperm whales from blasting or dredging impacts, including potential collision with a dredge vessel en route to or from the ODMDS, is discountable.

Proposed Critical Habitat for Loggerhead Sea Turtles

While a portion of the project occurs in proposed critical habitat for loggerheads, specifically unit Logg-N-19, which includes concentrated breeding habitat and constricted migratory corridor habitat, the project is not expected to impact the primary constituent elements (PCEs) and thus the habitat itself. The PCEs that support breeding habitat are (1) high concentrations of reproductive male and female loggerheads; (2) proximity to primary Florida migratory corridor; and (3) proximity to Florida nesting grounds. The PCEs for constricted migratory habitat are (1) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (2) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. Dredging and port expansion will not alter the PCEs for breeding habitat as it will not impact the high concentration of reproductive individuals in the area nor the proximity to the nesting grounds or migratory corridor. The PCEs for the constricted migratory corridor will not be impacted as the project will not alter the passage conditions of the corridor. Therefore, effects to loggerhead critical habitat as it is currently proposed are discountable.

4.2 Species and Critical Habitat Likely to be Adversely Affected

NMFS believes that the proposed project may affect green and loggerhead sea turtles, Johnson's seagrass, staghorn coral, 6 coral species proposed to be listed, and elkhorn and staghorn coral-designated critical habitat.

4.2.1 Sea Turtles

The following subsections are synopses of the best available information on the status of the sea turtle species that are likely to be adversely affected by 1 or more components of the proposed action, including information on the distribution, population structure, life history, abundance, and population trends of each species and threats to each species. The biology and ecology of these species as well as their status and trends inform the effects analysis for this opinion. Additional background information on the status of sea turtle species can be found in a number of published documents, including: recovery plans for the Atlantic green sea turtle (NMFS and USFWS 1991), and loggerhead sea turtle (NMFS and USFWS 2008a); Pacific sea turtle recovery plans (NMFS and USFWS 1998a; NMFS and USFWS 1998b; NMFS and USFWS 1998c; NMFS and USFWS 1998b); and sea turtle status reviews, stock assessments, and biological reports (Conant et al. 2009; NMFS-SEFSC 2001; NMFS-SEFSC 2009a; NMFS and USFWS 1995b; NMFS and USFWS 2007a; NMFS and USFWS 2007b; NMFS and USFWS 2007c;

NMFS and USFWS 2007d; NMFS and USFWS 2007e; TEWG 1998; TEWG 2000a; TEWG 2007; TEWG 2009).

4.2.1.1 General Threats Faced by All Sea Turtle Species

Sea turtles face numerous natural and anthropogenic threats that shape their status and affect their ability to recover. As many of the threats are the same or similar in nature for all listed sea turtle species, those identified in this section are discussed in a general sense for all listed sea turtles. Threat information specific to a particular species is then discussed in the corresponding status section where appropriate.

Fisheries

Incidental bycatch in commercial fisheries is identified as a major contributor to past declines, and threat to future recovery, for all of the sea turtle species (NMFS and USFWS 1991, 1992, 1993, 2008, 2011). Domestic fisheries often capture, injure, and kill sea turtles at various life stages. Sea turtles in the pelagic environment are exposed to U.S. Atlantic pelagic longline fisheries. Sea turtles in the benthic environment in waters off the coastal United States are exposed to a suite of other fisheries in federal and state waters. These fishing methods include trawls, gillnets, purse seines, hook-and-line gear [including bottom longlines and vertical lines (e.g., bandit gear, handlines, and rod-reel)], pound nets, and trap fisheries. (Refer to the Environmental Baseline section of this opinion for more specific information regarding federal and state managed fisheries affecting sea turtles within the action area). The Southeast shrimp fisheries have historically been the largest fishery threat to benthic sea turtles in the southeastern United States, and continue to interact with and kill large numbers of sea turtles each year.

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further impeding the ability of sea turtles to survive and recover on a global scale. For example, pelagic stage sea turtles, especially loggerheads and leatherbacks, circumnavigating the Atlantic are susceptible to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al. 1995; Bolten et al. 1994; Crouse 1999). Bottom longline and gillnet fishing are known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. Shrimp trawl fisheries are also operating off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. Many unreported takes or incomplete records by foreign fleets make it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to sea turtle survival and recovery throughout their respective ranges.

Non-Fishery In-Water Activities

There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the United States, the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS 1997a). Sea turtles entering coastal or inshore areas have also been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include

harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, in-water construction activities, and scientific research activities.

Coastal Development and Erosion Control
Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997). These factors may decrease the amount of nesting area available to females and change the natural behaviors of both adults and hatchlings, directly or indirectly, through loss of beach habitat or changing thermal profiles and increasing erosion, respectively. (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchlings as they approach and leave the surf zone or head out to sea by creating physical blockage, concentrating predators, creating longshore currents, and disrupting of wave patterns.

Environmental Contamination
Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g., DDT, PCBs, and PFCs), and others that may cause adverse health effects to sea turtles (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area. In 2010, there was a massive oil spill in the Gulf of Mexico at BP's Macondo well. Official estimates are that millions of barrels of oil were released into the Gulf of Mexico. Additionally, approximately 1.8 million gallons of chemical dispersant were applied on the seawater surface and at the wellhead to attempt to break down the oil. At this time the assessment of total direct impact to sea turtles has not been determined. Additionally, we do not know the long-term impacts to sea turtles because of habitat impacts, prey loss, and subsurface oil particles and oil components broken down through physical, chemical, and biological processes.

Marine debris is a continuing problem for sea turtles. Sea turtles living in the pelagic environment commonly eat or become entangled in marine debris (e.g., tar balls, plastic bags/pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the pelagic environment (i.e., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Climate Change
There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see http://www.climate.gov).

Climate change impacts on sea turtles currently cannot be predicted with any degree of certainty; however, significant impacts to the hatchling sex ratios of sea turtles may result (NMFS and USFWS 2007c). In sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007c).

The effects from increased temperatures may be intensified on developed nesting beaches where shoreline armoring and construction have denuded vegetation. Erosion control structures could potentially result in the permanent loss of nesting beach habitat or deter nesting females (NRC 1990). These impacts will be exacerbated by sea level rise. If females nest on the seaward side of the erosion control structures, nests may be exposed to repeated tidal overwash (NMFS and USFWS 2007c). Sea level rise from global climate change is also a potential problem for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Baker et al. 2006; Daniels et al. 1993; Fish et al. 2005). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Other changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, etc.) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.) which could ultimately affect the primary foraging areas of sea turtles.

Other Threats
Predation by various land predators is a threat to developing nests and emerging hatchlings. The major natural predators of sea turtle nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Emergent hatchlings in the United States are preyed upon by these mammals as well as ghost crabs, laughing gulls, and the exotic South American fire ant (*Solenopsis invicta*). In addition to natural predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS and USFWS 2008a).

Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

Actions Taken to Reduce Threats
Actions have been taken to reduce anthropogenic impacts to sea turtles from various sources, particularly since the early 1990s. These include lighting ordinances, predation control, and nest relocations to help increase hatchling survival, as well as measures to reduce the mortality of pelagic immatures, benthic immatures, and sexually mature age classes from various fisheries and other marine activities. Some actions have resulted in significant steps towards reducing the recurring sources of mortality of sea turtles in the environmental baseline and improving the status of all sea turtle populations in the Atlantic and Gulf of Mexico. For example, the TED regulation published on February 21, 2003 (68 FR 8456), represent a significant improvement in the baseline effects of trawl fisheries on sea turtles, though shrimp trawling is still considered to be one of the largest source of anthropogenic mortality for most of our sea turtle species (NMFS-SEFSC 2009a).

4.2.1.2 Loggerhead Sea Turtle – Northwest Atlantic DPS
The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS subsequently published a final rule listing 9 DPSs of loggerhead sea turtles (76 FR 58868, September 22, 2011, effective October 24, 2011). The DPSs established by this rule include (1) Northwest Atlantic Ocean (threatened), (2) Northeast Atlantic Ocean (endangered), (3) South Atlantic Ocean (threatened), (4) Mediterranean Sea (endangered), (5) North Pacific Ocean (endangered), (6) South Pacific Ocean (endangered), (7) North Indian Ocean (endangered), (8) Southeast Indo-Pacific Ocean (endangered), and (9) Southwest Indian Ocean (threatened). The Northwest Atlantic Ocean (NWA) DPS is the only 1 that occurs within the action area and therefore is the only one considered in this Opinion. NMFS has proposed to designate critical habitat for the NWA DPS of loggerhead sea turtles. Specific areas proposed for designation include 36 occupied marine areas within the range of the NWA DPS. These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. The rule is scheduled to be finalized in July 2014.

Species Description and Distribution
Loggerheads are large sea turtles with the mean straight carapace length (SCL) of adults in the southeast United States being approximately 3 ft (92 cm). The corresponding mass is approximately 255 lb (116 kg) (Ehrhart and Yoder 1978). Adult and subadult loggerhead sea turtles typically have a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, 5 pairs of costals, 5 vertebrals, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes (Dodd 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). Habitat uses within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Subadult and adult

loggerheads are primarily found in coastal waters and prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC 1990). In the western North Atlantic, loggerhead nesting is concentrated along the coasts of the United States from southern Virginia to Alabama. Additional nesting beaches are found along the northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), off the southwestern coast of Cuba (Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Non-nesting, adult female loggerheads are reported throughout the United States and Caribbean Sea. Little is known about the distribution of adult males, which are seasonally abundant near nesting beaches. However, aerial surveys suggest that the general species distribution of loggerheads in U.S. waters is as follows: 54% in the Atlantic off the southeast United States, Atlantic, 29% in the Atlantic off the northeast United States, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Within the NWA, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf coast of Florida. NMFS has previously recognized at least 5 Western Atlantic subpopulations based on nesting beach assemblages, divided geographically as follows:

(1) a Northern nesting subpopulation, occurring from North Carolina to Northeast Florida at about 29ºN;

(2) a South Florida nesting subpopulation, occurring from 29°N on the east coast of the state to Sarasota on the west coast;

(3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida;

(4) a Yucatán nesting subpopulation, occurring on the Eastern Yucatán Peninsula, Mexico (Márquez M 1990; TEWG 2000a); and

(5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS-SEFSC 2001).

The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded, based on recent advances in genetic analyses, that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula and that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia), (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through

Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas), and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS and USFWS 2008a). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

Life History Information

The Northwest Atlantic Loggerhead Recovery Team defined the following 8 life stages for the loggerhead life cycle, including the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[7]), (4) juvenile stage (oceanic zone), (5) juvenile stage (neritic zone), (6) adult stage (oceanic zone), (7) adult stage (neritic zone), and (8) nesting female (terrestrial zone) (NMFS and USFWS 2008). Loggerheads are long-lived organisms that reach sexual maturity between 20 and 38 years of age, although this varies widely among populations (Frazer and Ehrhart 1985; NMFS and SEFSC 2001). The annual mating season for loggerhead sea turtles occurs from late March to early June, and eggs are laid throughout the summer months. Female loggerheads deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins 1984) but an individual female only nests every 3.7 years on average (Tucker 2010). Along the southeastern United States, loggerheads lay an average of 100 to 126 eggs per nest (Dodd 1988) which incubate for 42 to 75 days before hatching (NMFS and USFWS 2008b).

As post-hatchlings, loggerheads hatched on U.S. beaches migrate offshore and become associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986), (Witherington 2002). Loggerheads originating from the NWA DPS are believed to lead a pelagic existence in the North Atlantic Gyre for a period as long as 7-12 years (Bolten et al. 1998) before moving to more coastal habitats. Recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Bolten and Witherington 2003; Laurent et al. 1998). These studies suggest some turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or move back and forth between pelagic and coastal habitats interchangeably (Witzell 2002). Stranding records indicate that when immature loggerheads reach 15-24 inches (40-60 cm) SCL, they begin to occur in coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell 2002).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the United States, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads.

[7] Neritic refers to the inshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters.

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads use the relatively enclosed shallow-water estuarine habitats with limited ocean access are less frequently than the juveniles. Juveniles, but not adult loggerheads, regularly use areas such as Pamlico Sound, North Carolina, and the Indian River Lagoon, Florida. In comparison, adult loggerheads tend to use estuarine areas with more open ocean access, such as Chesapeake Bay in the U.S. Mid-Atlantic. Shallow-water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads. Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of Mid-Atlantic shelf waters, especially offshore New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has also been documented (Hawkes et al. 2007a; Georgia Department of Natural Resources, unpublished data; South Carolina Department of Natural Resources, unpublished data). Satellite telemetry has identified the shelf waters along the west Florida coast, The Bahamas, Cuba, and the Yucatán Peninsula as important resident areas for adult female loggerheads that nest in Florida (Foley et al. 2008; M. Lamont, Florida Cooperative Fish and Wildlife Research Unit, personal communication, 2009; M. Nicholas, National Park Service, personal communication, 2009). The southern edge of the Grand Bahama Bank is important habitat for loggerheads nesting on the Cay Sal Bank in The Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands as well as Florida Bay in the United States, and the north coast of Cuba (A. Bolten and K. Bjorndal, University of Florida, unpublished data). Moncada et al. (2009) report the recapture in Cuban waters of 5 adult female loggerheads originally flipper tagged in Quintana Roo, Mexico, indicating that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

Status and Population Dynamics

A number of stock assessments and similar reviews (Conant et al. 2009; Heppell et al. 2003a; NMFS-SEFSC 2009a; NMFS and SEFSC 2001; NMFS and USFWS 2008a; TEWG 1998; TEWG 2000a; TEWG 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Numbers of nests and nesting females can vary widely from year to year. However, nesting beach surveys can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of female loggerhead sea turtles, as long as such studies are sufficiently long and effort and methods are standardized [see, e.g., NMFS and USFWS (2008a)]. NMFS and USFWS (2008a) concluded that the lack of change in two important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population.

<u>Peninsular Florida Recovery Unit</u>

The Peninsular Florida Recovery Unit (PFRU) is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year,

representing approximately 15,735 nesting females per year (NMFS and USFWS 2008a). The statewide estimated total for 2012 was 98,601 nests (FWRI nesting database).

In addition to the total nest count estimates, the Florida Fish and Wildlife Research Institute (FWRI) uses an index nesting beach survey method. The index survey uses standardized data-collection criteria to measure seasonal nesting and allow accurate comparisons between beaches and between years. This provides a better tool for understanding the nesting trends (Figure 5). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989-2012) (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/). Three distinct trends over that time period were identified. From 1989-1998 there was a 23% increase, that was then followed by a sharp decline over the subsequent decade. However, recent large increases in loggerhead nesting occurred since then. FWRI examined the trend from the 1998 nesting high through 2012 and found the decade-long post-1998 decline had reversed and there was no longer a demonstrable trend. Looking at the data from 1989 through 2012 FWRI concluded that there was an overall positive change in the nest counts.

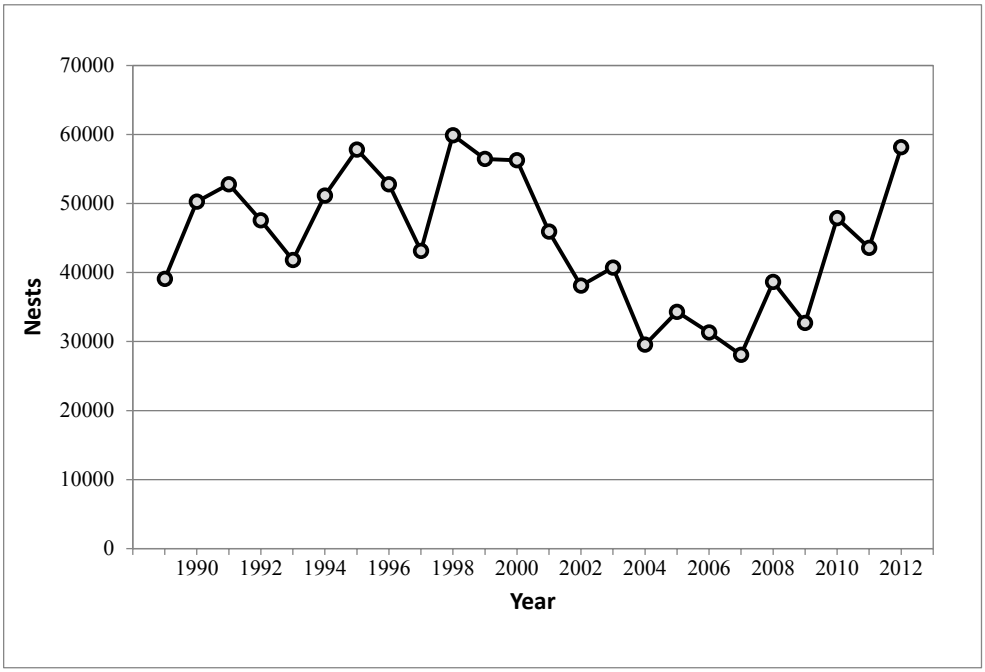

Figure 5. Loggerhead sea turtle nesting at Florida index beaches since 1989

Northern Recovery Unit

Annual nest totals from beaches within the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (Georgia Department of Natural Resources (GDNR) unpublished data, North Carolina Wildlife Resources Commission (NCWRC) unpublished data, South Carolina Department of Natural Resources (SCDNR) unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy and Hopkins 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989-2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9% annual decline in nesting in South

Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the NRU had experienced a long-term decline over that period.

Data since that analysis (Table 2) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting has rebounded to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release, http://www.georgiawildlife.com/node/3139). South Carolina and North Carolina nesting have also begun to show a shift away from the past declining trend.

Table 2. **Total Number of NRU Loggerhead Nests (GADNR, SCDNR, and NCWRC Nesting Datasets)**

Nests Recorded	2008	2009	2010	2011	2012
Georgia	1,649	997	1,761	1,992	2,218
South Carolina	4,500	2,183	3,141	4,015	4,615
North Carolina	841	276	846	948	1,069
Total	6,990	3,456	5,748	6,955	7,902

South Carolina also conducts an index beach nesting survey similar to the one described for Florida. Although the survey only includes a subset of nesting, the standardized effort and locations allow for a better representation of the nesting trend over time. Increases in nesting were seen for the period from 2009-2012, with 2012 showing the highest index nesting total since the start of the program (Figure 6).

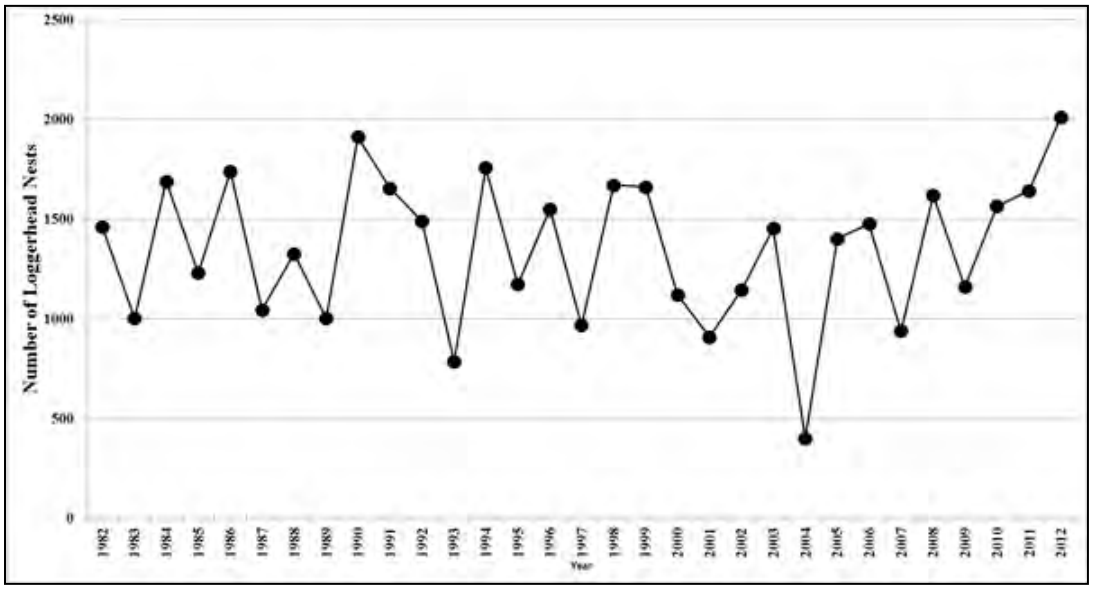

Figure 6. South Carolina index nesting beach counts for loggerhead sea turtles (from the SCDNR website, http://www.dnr.sc.gov/seaturtle/nest.htm)

<u>Other Northwest Atlantic DPS Recovery Units</u>

The remaining 3 recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages but still considered

essential to the continued existence of the species. Nesting surveys for the DTRU are conducted as part of Florida's statewide survey program. Survey effort was relatively stable during the 9-year period from 1995-2004 (although the 2002 year was missed). Nest counts ranged from 168-270, with a mean of 246, but with no detectable trend during this period (NMFS and USFWS 2008a). Nest counts for the NGMRU are focused on index beaches rather than all beaches where nesting occurs. Analysis of the 12-year dataset (1997-2008) of index nesting beaches in the area shows a statistically significant declining trend of 4.7% annually (NMFS and USFWS 2008a). Nesting on the Florida Panhandle index beaches, which represents the majority of NGMRU nesting, had shown a large increase in 2008, but then declined again in 2009 and 2010 before rising back to a level similar to the 2003-2007 average in 2011. Nesting survey effort has been inconsistent among the GCRU nesting beaches and no trend can be determined for this subpopulation. Zurita et al. (2003) found a statistically significant increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. However, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008a).

In-water Trends

Nesting data are the best current indicator of sea turtle population trends; however, in-water data also provide some insight. Such research suggests the abundance of neritic juvenile loggerheads is steady or increasing. Although Ehrhart et al. (2007) found no significant regression-line trend in a long-term dataset, researchers have observed notable increases in catch per unit effort (CPUE) over the past several years (Ehrhart et al. 2007, Epperly et al. 2007, Arendt et al. 2009). Researchers believe that this increase in CPUE is likely linked to an increase in juvenile abundance, though it is unclear whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence. Bjorndal et al. (2005), (cited in NMFS and USFWS (2008a), caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest oceanic/neritic juveniles (historically referred to as small benthic juveniles), which could indicate a relatively large number of individuals around the same age may mature in the near future (TEWG 2009). However, in-water studies throughout the eastern United States also indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG 2009).

Population Estimate

The NMFS Southeast Fishery Science Center developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS-SEFSC 2009a). The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Resulting trajectories of model runs for each individual recovery unit, as well as the western North Atlantic population as a whole, were found to be very similar. The model run estimates from the 2004-2008 time frame, suggest the adult female population size in the western North Atlantic is approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS-SEFSC 2009a). A less robust

estimate for total benthic females in the western North Atlantic was also obtained, yielding approximately 30,000-300,000 individuals, up to less than 1 million (NMFS-SEFSC 2009a).

Threats

The threats faced by loggerhead sea turtles are well-summarized in the general discussion of threats in Section 4.2.1.1. However, the impact of fishery interactions is a point of further emphasis for this species. The Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009). Significant mortality occurs in longline fisheries, bottom and mid-water trawl fisheries, dredge fisheries, gillnet fisheries, and pot/trap fisheries. Although total mortality from all fisheries has not been estimated, the combined mortalities are likely significant.

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants as they were observed in a study by Storelli et al. (2008), to have the highest organochlorine concentrations in sampled tissues (Storelli et al. 2008). Storelli et al. (2008) analyzed tissues from stranded loggerhead sea turtles and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al. 1991). It is thought that dietary preferences were likely to be the main differentiating factor leading to different contaminant concentrations among species.

Specific information regarding potential climate change impacts on loggerheads is also available. Future surface temperature increases of 2°–3°C are expected by 2100 (Hansen et al., 2006). Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina from current ratios of 50%-65%. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring from current ratios of 90%. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most clutches, leading to death (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), as well as short inter-nesting intervals (Hays et al. 2002) and shorter nesting season (Pike et al. 2006).

4.2.1.3 Green Sea Turtle

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered.

Species Description and Distribution

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lb (159 kg) and a straight carapace length of greater than 3.3 ft (1 m). Green sea turtles have a smooth carapace with 4 pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green sea turtles in the Atlantic Ocean has been known to change in

color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux 2001).

With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting (Hays et al. 2001). Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth and USFWS 1997). The two largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef. Differences in mitochondrial DNA properties of green sea turtles from different nesting regions indicate there are genetic subpopulations (Bowen et al. 1992; Fitzsimmons et al. 2006). Despite the genetic differences, sea turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. However, such mixing occurs at extremely low levels in Hawaiian foraging areas, perhaps making this central Pacific population the most isolated of all green sea turtle populations occurring worldwide (Dutton et al. 2008).

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed in inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957; Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatan Peninsula.

The complete nesting range of green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as the USVI and Puerto Rico (Dow et al. 2007; NMFS and USFWS 1991). However, the vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard through Broward counties. For more information on green sea turtle nesting in other ocean basins, refer to the 1991 Recovery Plan for the Atlantic Green Turtle (NMFS and USFWS 1991) or the 2007 Green Sea Turtle 5-Year Status Review (NMFS and USFWS 2007a).

*Life History Informati*on

Green sea turtles reproduce sexually, and mating occurs in the waters off nesting beaches. Mature females return to their natal beaches (i.e., the same beaches where they were born) to lay eggs (Balazs 1982; Frazer and Ehrhart 1985) every 2-4 years while males are known to reproduce every year (Balazs 1983). In the southeastern United States, females generally nest

between June and September, and peak nesting occurs in June and July (Witherington and Ehrhart 1989). During the nesting season, females nest at approximately 2-week intervals, laying an average of 3-4 clutches (Johnson and Ehrhart 1996). Clutch size often varies among subpopulations, but mean clutch size is around 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart 1989). Eggs incubate for approximately 2 months before hatching. Survivorship at any particular nesting site is greatly influenced by the level of anthropogenic stressors, with the more pristine and less disturbed nesting sites (e.g., along the Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed [e.g., Nicaragua (Campbell and Lagueux 2005; Chaloupka and Limpus 2005)].
After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS and USFWS 2007b). Green sea turtles exhibit particularly slow growth rates of about 1-5 cm per year (Green 1993; McDonald-Dutton and Dutton 1998), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately 20-25 cm carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Growth studies using skeletochronology indicate that green sea turtles in the western Atlantic shift from the oceanic phase to nearshore developmental habitats after approximately 5-6 years (Bresette et al. 2006; Zug and Glor 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel and Ingle 1974). However, some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). Green sea turtles reach sexual maturity at 20-50 years of age (Chaloupka and Musick 1997; Hirth and USFWS 1997), which is considered one of the longest ages to maturity of any sea turtle species.

While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds, and it is clear they are capable of "homing in" on these sites if displaced (McMichael et al. 2003). Reproductive migrations of Florida green sea turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green sea turtles are believed to reside in nearshore foraging areas throughout the Florida Keys and in the waters southwest of Cape Sable, with some post-nesting turtles also residing in Bahamian waters as well (NMFS and USFWS 2007b).

Status and Population Dynamics
Population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. However, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends is provided in the most recent 5-year status review for the species (NMFS and USFWS 2007b) organized by ocean region (i.e., Western Atlantic Ocean, Central Atlantic Ocean, Eastern Atlantic Ocean, Mediterranean Sea, Western Indian Ocean, Northern Indian Ocean, Eastern Indian Ocean, Southeast Asia, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). Trends at 23 of the 46 nesting beach sites reviewed in the 5-year status review found that nesting at 10 of the sites appeared to be increasing, nesting at 9 appeared to be stable, and

nesting at 4 appeared to be decreasing. With respect to regional trends, the Pacific, the Western Atlantic, and the Central Atlantic regions appeared to show more positive trends (i.e., more nesting sites increasing than decreasing) while the Southeast Asia, Eastern Indian Ocean, and possibly the Mediterranean Sea regions appeared to show more negative trends (i.e., more nesting sites decreasing than increasing). These regional determinations should be viewed with caution since trend data was only available for about half of the total nesting concentration sites examined in the review and site-specific data availability appeared to vary across all regions.

The Western Atlantic region (i.e., the focus of this Opinion) was one of the best performing in terms of abundance in the entire review as there were no sites that appeared to be decreasing. The 5-year status review for the species identified 8 geographic areas considered to be primary sites for green sea turtle nesting in the Atlantic/Caribbean and reviewed the trend in nest count data for each (NMFS and USFWS 2007a). These sites include (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau. Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precluded a meaningful trend assessment for either (NMFS and USFWS 2007a). Seminoff (2004) likewise reviewed green sea turtle nesting data for 8 sites in the western, eastern, and central Atlantic, including all of the above with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, where nesting is stable, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic; however, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a). More information about site-specific trends for the other major ocean regions can be found in the most recent 5-year status review for the species (see NMFS and USFWS (2007a)).

By far, the largest known nesting assemblage in the Western Atlantic region occurs at Tortuguero, Costa Rica. According to monitoring data on nest counts, as well as documented emergences (both nesting and non-nesting events [i.e., false crawls]), there appears to be an increasing trend in this nesting assemblage since monitoring began in the early 1970s. For instance, from 1971-1975 there were approximately 41,250 average annual emergences documented and this number increased to an average of 72,200 emergences from 1992-1996 (Bjorndal et al. 1999). Troëng and Rankin (Troëng and Rankin 2005) collected nest counts from 1999-2003 and also reported increasing trends in the population consistent with the earlier studies, with nest count data suggesting 17,402-37,290 nesting females per year (NMFS and USFWS 2007a). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica, population of nesting females growing at 4.9% annually.

In the continental United States, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf coast of Florida (Meylan et al. 1995). More recently, green sea turtle

nesting has occurred in North Carolina on Bald Head Island, just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, 6 nests in South Carolina, and 6 nests in Georgia (nesting databases maintained on www.seaturtle.org).

In Florida, FWRI has established index beaches to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the ten years of regular monitoring (Figure 7). According to data collected from Florida's index nesting beach surveys from 1989-2012, green sea turtle nest counts across Florida have increased approximately 10-fold from a low of 267 in the early 1990s to a high of 10,701 in 2011. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in both 2010 and 2011 followed by another decrease in 2012 (Figure 7). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

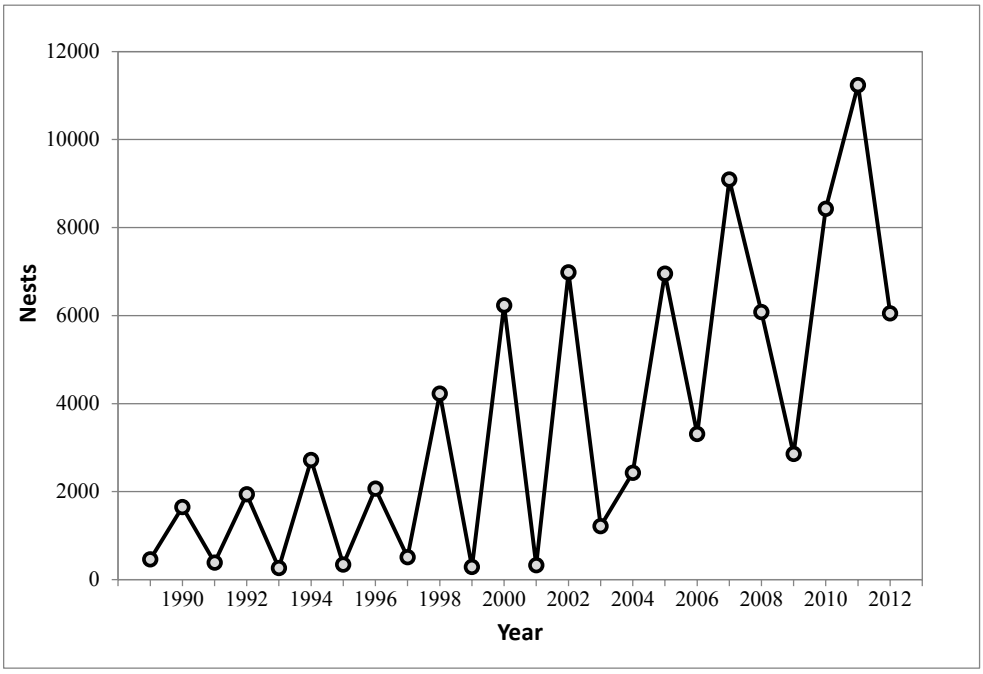

Figure 7. Green sea turtle nesting at Florida index beaches since 1989

Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Green sea turtles also face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (e.g., plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (e.g., nesting beach development, beach nourishment

and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 4.2.1.1.

In addition to general threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). These tumors range in size from 0.1 cm to greater than 30 cm in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, though it is believed to be related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions [e.g., habitat degradation, pollution, low wave energy, and shallow water (Foley et al. 2005)]. Presently, FP is cosmopolitan, but has been found to affect large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991).

Cold-stunning is another natural threat to green sea turtles. Although it is not considered a major source of mortality in most cases, as temperatures fall below 8°-10°C turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and Ehrhart 1989). During January 2010, an unusually large cold-stunning event in the southeastern United States resulted in around 4,600 sea turtles, mostly greens, found cold-stunned, with hundreds found dead or dying. A large cold-stunning event occurred in the western Gulf of Mexico in February 2011, resulting in approximately 1,650 green sea turtles being found cold-stunned in Texas. Of these, approximately 620 were found dead or died after stranding, and approximately 1,030 were rehabilitated and released. Additionally, during this same time frame, approximately 340 green sea turtles were found cold-stunned in Mexico, though approximately 300 of those were subsequently rehabilitated and released.

4.2.2 Corals: Staghorn, Mountainous Star, Knobby Star, Lobed Star, Elliptical Star, Lamarck's Sheet, and Rough Cactus

Elkhorn and staghorn corals were listed as threatened under the ESA in May 2006 (71 FR 26852). In December 2012, NMFS proposed changing their status from threatened to endangered (77 FR 73219); a final determination on the status change is still pending. Elkhorn coral does not occur within the project area.

Additionally, in December 2012, NMFS proposed to list 7 coral species (lobed star, mountainous star, knobby star, pillar, rough cactus, Lamarck's sheet, and elliptical star coral) in the western Atlantic, Gulf of Mexico, and/or Caribbean basins under the ESA. Five of those species are proposed as endangered, and 2 species are proposed as threatened (77 FR 73219; December 7, 2012). Pillar coral does not occur within the project area.

General information about corals that pertains to all the listed and proposed coral species is presented at the beginning of each of the subsections. Species-specific information is then

presented for each of the listed and proposed coral species. However, lobed star, mountainous star, and knobby star corals are presented as a group since information is often only available for the species complex rather than the individual species.

Species Description

Corals are marine invertebrates in the phylum Cnidaria, which include true stony corals, the blue corals, and fire corals. All of the currently-listed and proposed corals in the NMFS Southeast Region (North Carolina through Texas and the U.S. Caribbean) are stony corals. Stony corals are characterized by polyps with multiples of 6 tentacles around the mouth for feeding and capturing prey items in the water column (Brainard et al. 2011a). Most stony corals form complex colonies made up of a tissue layer of polyps growing on top of a calcium carbonate skeleton, which the polyps produce through the process of calcification.

All of the listed and proposed-for-listing coral species are reef building species, which are capable of rapid calcification rates because of their symbiotic relationship with single-celled dinoflagellate algae, zooxanthellae, which occur in great numbers within the host coral tissues. Zooxanthellae photosynthesize during the daytime, producing an abundant source of energy for the host coral that enables rapid growth. At night, polyps extend their tentacles to filter-feed on microscopic particles in the water column, such as zooplankton, providing additional nutrients for the host coral. In this way, reef-building corals obtain nutrients autotrophically (i.e., via photosynthesis) during the day, and heterotrophically (i.e., via predation) at night (Brainard et al. 2011b).

Staghorn Coral

Staghorn coral (*Acropora cervicornis*; threatened, proposed endangered) coral (*Acropora palmata*; threatened, proposed endangered) are branching species that occur throughout the wider Caribbean. Staghorn corals have straight or slightly curved, cylindrical branches that look like deer antlers. The species range in color from golden yellow to brown, and the growing tips tend to be lighter or lack color. Individual staghorn coral colonies can reach up to 5 ft (1.5 m) across but may form thickets composed of multiple colonies that are difficult to tell apart. Staghorn corals are reef-building species that provide important habitat for other reef organisms, and other reef-building corals cannot fill the unique structural and ecological role of this coral species (Bruckner 2002a).

Lobed Star, Mountainous Star, and Knobby Star Corals

Lobed star coral (*Orbicella annularis*; proposed endangered), mountainous star coral (*Orbicella faveolata*; proposed endangered), and knobby star coral (*Orbicella franksi*; proposed endangered) are the 3 species in the *Orbicella annularis* complex. These 3 species were formerly in the genus *Montastraea*; however, recent work has reclassified the 3 species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). The species complex was historically one of the primary reef framework builders throughout the wider Caribbean. The complex was considered a highly plastic, single species – *Montastraea annularis* – with growth forms ranging from columnar, to massive, to platy (formed of plates). In the early 1990s, Weil and Knowlton (1994) suggested the partitioning of these growth forms into separate species, resurrecting the previously described taxa, *Montastraea* (now *Orbicella*) *faveolata* and *Montastraea* (now *Orbicella*) *franksi.* These 3 sibling species were differentiated on the basis of

morphology, depth range, ecology, and behavior (Weil and Knowton 1994). Subsequent reproductive and genetic studies have generally supported the partitioning of the *annularis* complex into three species. *Orbicella faveolata* is the most genetically distinct while *Orbicella annularis* and *Orbicella franksi* are less so (Budd et al. 2012; Fukami et al. 2004; Lopez et al. 1999).

Some studies report on the species complex rather than individual species since visual distinction can be difficult where colony morphology cannot be discerned (e.g. small colonies or photographic methods). Information from these studies is reported for the species complex. Where species-specific information is available, it is reported. However, information about *O. annularis* published prior to 1994 will be attributed to the species complex since it is dated prior to the split of *O. annularis* into 3 separate species.

Lobed star coral colonies grow in columns that exhibit rapid and regular upward growth. Live colony surfaces usually lack ridges or bumps. Colonies can grow to several meters in height and diameter and are commonly grey, green, and brownish in color (Szmant et al. 1997).

Mountainous star corals grow in heads or sheets, the surface of which may be smooth or have keels or bumps. Colonies can reach up to 33 ft (10 m) in diameter with a height of 13-16 ft (4-5 m) and are commonly grey, green, and brownish in color (Szmant et al. 1997).

Knobby star corals are distinguished by large, unevenly arranged polyps that give the colony its characteristic irregular surface. Colony form is variable. Colonies can reach up to 16 ft (5 m) in diameter with a height of up to 6.5 ft (2 m) and are green, grey, and brown in color (Szmant et al. 1997).

Rough Cactus Coral
Rough cactus coral (*Mycetophyllia ferox*; proposed endangered) colonies are encrusting, flat plates. Colonies are thin, weakly attached plates with interconnecting, slightly sinuous, narrow valleys. Colonies are most commonly greys and browns in color with valleys and walls of contrasting colors, and their maximum size is 20 inches (50 cm) in diameter (Veron 2000).

Lamarck's Sheet Coral
Lamarck's sheet coral (*Agaricia lamarcki*; proposed threatened) forms flat or encrusting platy colonies that are commonly arranged in whorls. Colonies are brown in color, usually with pale margins. Polyp mouths are characteristically white and star-shaped. Maximum colony diameter is approximately 3 ft (1 m) (Veron 2000).

Elliptical Star Coral
Elliptical star coral (*Dichocoenia stokesii*; proposed threatened) colonies are either massive and spherical, or form thick, sub-massive plates. Although sometimes green, they are usually orange-brown with white margins between polyps (Veron 2000).

Distribution
In general, the corals in the Southeast Region are widely distributed throughout the western Atlantic, Caribbean, and Gulf of Mexico. Corals need hard substrate on which to settle and

form; however, only a narrow range of suitable environmental conditions allows coral to grow and exceed loss from physical, chemical, and biological erosion. Reef-building corals do not thrive outside a narrow temperature range of 25°C-30°C, but they are able to tolerate temperatures outside this range for brief periods of time, depending on how long and severe the exposure to extremes, as well as other biological and environmental factors. Two other important factors influencing suitability of habitat are light and water quality. Reef-building corals require light for photosynthesis of their symbiotic algae, and poor water quality can negatively affect both coral growth and recruitment. Availability of light generally limits how deep corals are found. Hydrodynamic condition (e.g., high wave action) is another important habitat feature, as it influences the growth, mortality, and reproductive rate of each species adapted to a specific hydrodynamic zone.

Staghorn Coral

Staghorn coral commonly grows in water ranging from 15 to 65 ft (5-20 m) in depth and rarely in waters to 196 ft (60 m) (Davis 1982; Jaap 1984; Jaap et al. 1989; Wells 1933). Staghorn coral is widely distributed throughout the western Atlantic and Caribbean. Areas occupied by this coral within U.S. jurisdiction are limited to 4 counties in the state of Florida, Puerto Rico, U.S. Virgin Islands, and Navassa Island. There is currently no evidence of range constriction for this species, though populations throughout the range have decreased substantially since the 1970s.

In Florida, staghorn coral has been documented along the east coast as far north as Palm Beach County. It occurs in deeper water (50-100 ft/16-30 m) at its northernmost range (Goldberg 1973; E. Tichenor, Palm Beach County Reef Rescue, pers. comm. to Jennifer Moore, NMFS 2008) and is distributed across its depth range (15-100 ft/5-30 m) off Broward and Miami-Dade Counties, the Florida Keys, and the Dry Tortugas (Jaap 1984). Off the shore of Broward County, staghorn corals form extensive thickets, which are the largest known remaining populations within U.S. jurisdiction. In Puerto Rico, coral reefs with varying densities of staghorn corals are off all coasts of the main island and around some of its smaller islands. Dense, tall thickets of staghorn coral are present in only a few reefs along the southwest, north, and west shore of the main island and isolated offshore locations (Schärer et al. 2009; Weil et al. 2002). In the U.S. Virgin Islands staghorn corals occur off St. Croix, St. Thomas, and St. John (Brainard et al. 2011a).

Lobed Star, Mountainous Star, and Knobby Star Corals

The 3 species in the *Orbicella annularis* complex (composed of lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and knobby star coral (*Orbicella franksi*) is distributed throughout the Caribbean, Bahamas, and Flower Garden Banks (IUCN 2010; Veron 2000). The complex occurs commonly throughout U.S. waters of the western Atlantic and Caribbean, including Florida (Martin though Monroe counties) and the Gulf of Mexico. The species occupy most reef environments, occurring in both protected and wave exposed habitats (Goreau and Wells 1967; Van Duyl 1985). Lobed star coral occurs shallower than its siblings, in depths ranging from 1.5-66 ft (0.5-20 m) (Szmant et al. 1997). Mountainous and knobby star corals can be found in depths up to 230 ft (70 m [Brainard et al. 2011a]).

Rough Cactus Coral

Rough cactus coral occurs throughout the U.S. waters of the western Atlantic, Caribbean, and Gulf of Mexico (Veron 2000), but has not been reported from Flower Garden Banks (Hickerson

et al. 2008). It has also been observed in the Bahamas, but it is absent in the waters of Bermuda. The species occurs in shallow reef environments in depths ranging from 16-98 ft (5 to 30 m [Brainard et al. 2011a]).

Lamarck's Sheet Coral
Lamarck's sheet coral is distributed in the western Atlantic and throughout the Caribbean but is not known to occur in Bermuda (IUCN 2010). In U.S. waters, the species occurs in Florida (Goldberg 1973), Puerto Rico (Acevedo et al. 1989; Garcia-Sais 2010; Morelock et al. 2001), the Virgin Islands (Rogers et al. 1984; Smith et al. 2010), and Flower Garden Banks (Caldow et al. 2009). The species occurs in water depths ranging from 10-249 ft (3-76 m [Carpenter et al. 2008; Ghiold and Smith 1990; Humann 1993]). Although the species can rarely inhabit shaded areas in shallow waters, it primarily occurs at deeper depths. It also inhabits reef slopes and walls and can be one of the most abundant corals on deep reefs (Humann 1993).

Elliptical Star Coral
Elliptical star coral is distributed in the western Atlantic and throughout the Caribbean, the Gulf of Mexico, Florida (including the Florida Middle Grounds), the Bahamas, and Bermuda (Aronson et al. 2008). It is found in most reef environments within its range (Veron 2000), including both back reef and fore reef environments, rocky reefs, lagoons, spur-and-groove formations, channels, and occasionally at the base of reefs (Aronson et al. 2008). The species has been reported in water depths ranging from 6.5-236 ft (2-72 m) (Carpenter et al. 2008).

Life History Information
Corals use a number of diverse reproductive modes (Figure 8). Most coral species reproduce sexually and asexually. Corals reproduce sexually by developing eggs and sperm within the polyps. Some coral species have separate sexes (gonochoric), while others are both sexes at the same time (hermaphroditic). Strategies for fertilization are by "brooding" or "broadcast spawning" (i.e., internal or external fertilization, respectively). Asexual reproduction occurs through fragmentation when pieces of a colony break off and re-attach to hard substrate to form a new colony. Fragmentation results in multiple genetically-identical colonies. In many species of branching corals, fragmentation is a common and sometimes dominant means of propagation.

Depending on the mode of fertilization, coral larvae (called planulae) undergo development either mostly within the mother colony (brooders) or outside in the ocean (broadcast spawners). In either mode of larval development, planula larvae presumably experience considerable mortality (up to 90% or more) from predation or other factors prior to settlement and metamorphosis. Such mortality cannot be directly observed, but is inferred from the large amount of eggs and sperm spawned versus the much smaller number of recruits observed later. Coral larvae are relatively poor swimmers; therefore, their dispersal distances largely depend on how long they remain in the water column and the speed and direction of water currents transporting the larvae. The documented maximum larval life span is 244 days (*Montastraea magnistellata* [Graham et al. 2008]), which suggests that the potential for long-term dispersal of coral larvae, at least for some species, may be substantially greater than previously thought and may partially explain the large geographic ranges of many species.

Biological and physical factors that have been shown to affect spatial and temporal patterns of coral recruitment include:

- substratum availability and community structure (Birkeland 1977)
- grazing pressure (Rogers et al. 1984; Sammarco 1985)
- fecundity, mode, and timing of reproduction (Harriott 1985; Richmond and Hunter 1990)
- behavior of larvae (Goreau et al. 1981; Lewis 1974)
- hurricane disturbance (Hughes and Jackson 1985)
- physical oceanography (Baggett and Bright 1985; Fisk and Harriott 1990)
- the structure of established coral assemblages (Harriott 1985; Lewis 1974)
- chemical cues (Morse et al. 1988)

In general, upon proper stimulation coral larvae settle on appropriate substrates. Some evidence indicates that chemical cues from crustose coralline algae (CCA), microbial films, and/or other reef organisms (Gleason et al. 2009; Morse et al. 1996; Morse et al. 1994; Negri et al. 2001) or acoustic cues from fish and crustaceans in reef environments (Vermeij et al. 2010) stimulate settlement behaviors. Once a settlement site is chosen, the larvae attach to the surface and lay down a calcium carbonate skeleton. Successful recruitment of larvae is the only way new genetic individuals enter a population, thereby maintaining or increasing genotypic diversity (i.e., number of individuals if a population of clonal organisms). The larval stage is also important, as it is the only phase in the life cycle of corals where dispersal occurs over long distances. This helps genetically link populations and provides the potential to re-populate depleted areas. Because newly settled corals barely protrude above the substrate, juveniles need to reach a certain size to limit damage or mortality from threats such as grazing, sediment burial, and algal overgrowth (Bak and Elgershuizen 1976; Birkeland 1977; Sammarco 1985). Once recruits reach about 1-2 years post-settlement, growth and mortality rates appear similar across species. In some species, it appears that there is virtually no limit to colony size beyond structural integrity of the colony skeleton, as polyps apparently can bud indefinitely.

Stony corals require hard substrate for settlement of their larvae, and presence of other benthic organisms (e.g., macroalgae) can preclude settlement. Encrusting sponges and soft corals, zoanthids, and macroalgae are major coral competitors because of their ability to blanket large areas of the sea floor. The presence of macroalgae inhibits coral settlement both by competing for space and by trapping sediment that can abrade and smother small recruits. Juvenile corals are the most susceptible to overgrowth and mortality from these competitors, and corals are generally better able to compete as they grow larger (Bak and Elgershuizen 1976; Birkeland 1977).

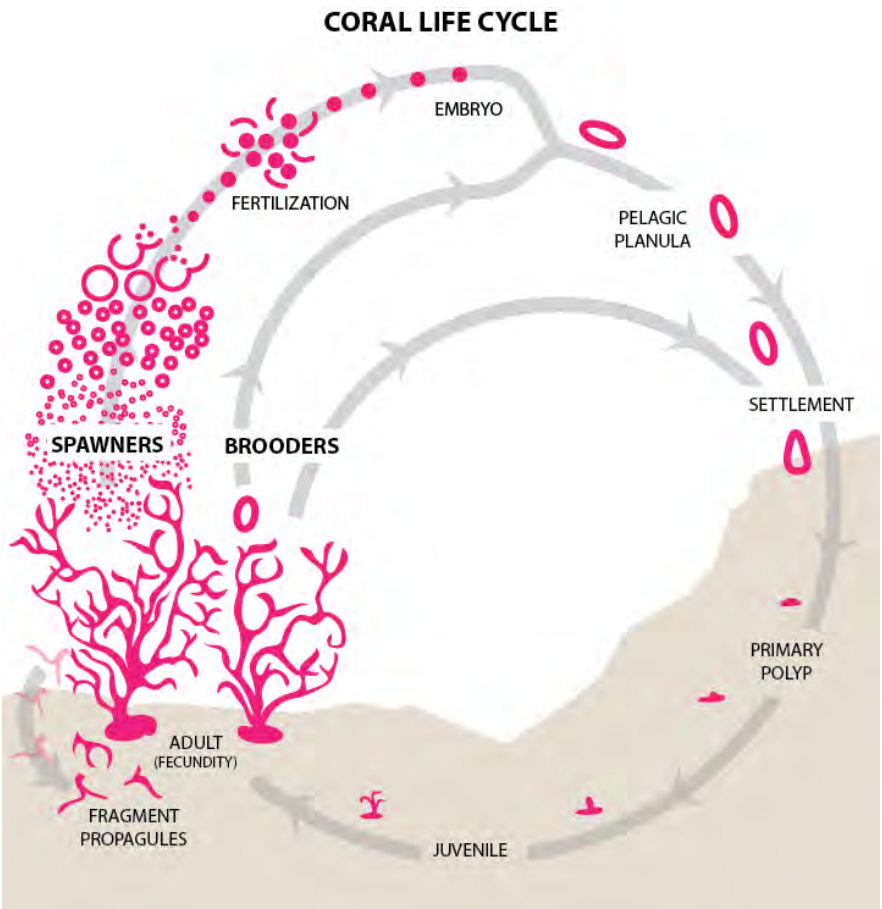

Figure 8. Coral life cycle showing different life history stages for broadcast spawners versus brooders, as well as asexual fragmentation (Reproduced from Brainard et al. 2011. Diagram prepared by Amanda Toperoff, NOAA PIFSC)

Staghorn Coral

Staghorn corals reproduce both sexually and asexually. Staghorn corals are hermaphroditic and are broadcast spawners (Szmant 1986). However, the species cannot self-fertilize, and 2 genetically distinct parents are required to produce viable larvae (Baums et al. 2005). Staghorn corals release gametes a few nights after the full moon during July, August, or September; however, some populations may have spawning events during 2 months. Staghorn colonies reach sexual maturity at 6.5 inches (17 cm) in branch length, but reproductive colonies 3.5 inches (9 cm) in branch length have been observed (Soong and Lang 1992). Skeletal growth rates are fast relative to other Caribbean coral species. Linear extension rates range from 1-4.5 inches (3-11.5 cm) per year for staghorn coral (Becker and Mueller 2001; Gladfelter et al. 1978; Jaap 1974; Shinn 1966; Shinn 1976; Vaughan 1915). New recruits and juveniles typically grow at slower rates. Larger colonies have higher fertility rates and produce proportionally more gametes than small colonies since basal and branch tip tissue are not fertile (Soong and Lang 1992). Fertilized eggs develop into planula larvae over several days in the water column. When larvae are ready to settle, they swim down to the bottom where they crawl along the surface searching for an appropriate settlement site. Certain species of CCA help settlement and post-settlement survival in staghorn coral (Ritson-Williams et al. 2009).

Lobed Star, Mountainous Star, and Knobby Star Corals
All 3 species of the *Orbicella annularis* complex are hermaphroditic broadcast spawners, with spawning concentrated on nights 6-8 following the full moon in late summer (Levitan et al. 2004). Fertilization success measured in the field was generally below 15 % for all 3 species but was highly linked to the number of colonies observed spawning at the same time (Levitan et al. 2004). Minimum size for reproduction of the *O. annularis* species complex was found to be 13 in^2 (83 cm^2) in Puerto Rico and was estimated to correspond to 4-5 years of age (Szmant-Froelich 1985). The *Orbicella annularis* species complex typically exhibits a linear growth of ~0.4 inches (1 cm) per year (Gladfelter et al. 1978), but increased appreciation for the slow rate of growth of post-settlement stages suggest this age for minimum reproductive size may be an underestimate (M.W. Miller, Southeast Fisheries Science Center, Miami, FL. pers. obs., October 2010). Growth rates of the *O. annularis* species complex are also negatively correlated with depth and water clarity (Hubbard and Scaturo 1985). The slow post-settlement growth rates of *O. faveolata* (Szmant and Miller 2005) and small eggs (Szmant et al. 1997) and larvae of all 3 species are factors that may contribute to extremely low post-settlement survivorship, even lower than other Caribbean broadcasters, such as elkhorn coral (Szmant and Miller 2005). Spatial distribution may also affect fecundity on the reef, with deeper colonies of *O. faveolata* being less fecund due to polyp spacing (Villinski 2003).

Successful recruitment by *Orbicella annularis* complex species has seemingly always been rare. (Hughes and Tanner 2000) reported the occurrence of only a single recruit of *Orbicella* over 18 years of intensive observation of 129 ft^2 (12 m^2) of reef in Discovery Bay, Jamaica, while many other recruitment studies throughout the Caribbean also report the species complex to be negligible to absent (Bak and Engel 1979; Rogers et al. 1984). *Orbicella* spp. juveniles also have higher mortality rates than larger colonies (Smith and Aronson 2006). Despite their generally boulder-like form, at least the lobed star coral is capable of some degree of fragmentation/fission and clonal reproduction (Foster et al. 2007).

Rough Cactus Coral
Rough cactus coral is a hermaphroditic brooder and polyps produce 96 eggs per cycle on average (Szmant 1986). It does not reproduce via fragmentation. Their larvae contain zooxanthellae (i.e., symbiotic algae) that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al. 2009). Colony size at first reproduction is greater than 15.5 in^2 (100 cm^2 [Szmant 1986]). Recruitment of this species appears to be very low; even studies from the 1970s reported zero settlement (Dustan 1977).

Lamarck's Sheet Coral
The specific reproductive strategy of Lamarck's sheet coral is presently unknown, but its congeners are primarily gonochoric brooders (i.e., separate sex individuals who partially rear larvae prior to release) (Delvoye 1988; Van Moorsel 1983). The larvae have been reported to primarily settle in relatively deep water (85-121 ft [26-37 m]), although the species has been found in shallow water (Bak and Engel 1979). Larvae of species within the genus are known to use chemical cues from CCA to indicate appropriate settlement substrate (Morse et al. 1988). The species has low recruitment rates. As an example, only one of 1,074 *Agaricia* recruits in a survey at the Flower Garden Banks may have been Lamarck's sheet coral (Shearer and Coffroth 2006). Net sexual recruitment over a decade can be negligible, with reproduction primarily via

fragmentation (Hughes and Jackson 1985). Maximum size for Lamarck's sheet coral is up to ~6.5 ft (2 m) in diameter (Humann 1993), with radial growth rates in Jamaica ranging from 0-0.5 inches (0-1.4 cm) per year, but growing a bit more slowly in depths greater than 65 ft (20 m [Hughes and Jackson 1985]). Rogers et al. (1984) and Bak and Luckhurst (1980) have described the overall life history characteristics of Lamarck's sheet coral as roughly parallel to *Orbicella annularis*, that is, low overall recruitment rates, high survival, and high partial mortality. However, in Jamaica, Lamarck's sheet coral had faster growth, higher recruitment, and lower mortality rates than lobed star coral at the same site and depth (Hughes and Jackson 1985).

Elliptical Star Coral

Reproductive characteristics of elliptical star coral have been described from a histological study of populations in southeast Florida (Hoke 2007). This species is predominantly a gonochoric spawner with an overall sex ratio of 2:1 (male:female), but a small portion of hermaphroditic colonies (~18 %) were also observed in this southeast Florida population. Due to its morphology, elliptical star coral does not reproduce via fragmentation. Minimum colony size at reproduction was 25 in^2 (160 cm^2) in this population, and 2 potential spawning events per year were inferred: one in late August/early September and a second in October. Juvenile density has been reported as very low (Bak and Engel 1979) to relatively common in certain habitats (Chiappone 2010). The annual growth rate has been reported as 0.08-0.3 inches (2-7 mm) per year in diameter and 0.08-0.2 inches (2-5.2 mm) per year in height (Vaughn 1915).

Population Dynamics and Status

Documenting population dynamics for corals is confounded by several unique life history characteristics. Particularly, clonality and asexual reproduction makes it particularly difficult to census a species to determine population abundance estimates. This can only truly be done by tracking genotypically individual colonies within a set area over time to determine if a new colonies in the population are new sexual recruits or colonies formed by asexual reproduction or partial mortality (Williams et al. 2006). This is why coral abundance estimates are usually reported in percent cover rather than number of individuals.

Asexual reproduction can play a major role in maintaining local populations, but in the absence of sexual recruitment, it can also lead to decreased resilience to stressors due to decreased genetic diversity. Since corals cannot move and are dependent upon external fertilization to produce larvae, fertilization success declines greatly as adult density declines. In populations where fragmentation happens often, the number of genetically distinct adults is even lower than colony density. Likewise, when there are fewer adult colonies, there are also fewer sources of fragments to provide for asexual recruitment. These conditions imply that once a population declines to or below a certain level (i.e., the number of adults in an area is too low for sexual reproduction to be effective), the chances for recovery are low. Thus, local (reef-scale) reductions in colony numbers and size may prevent recovery for decades.

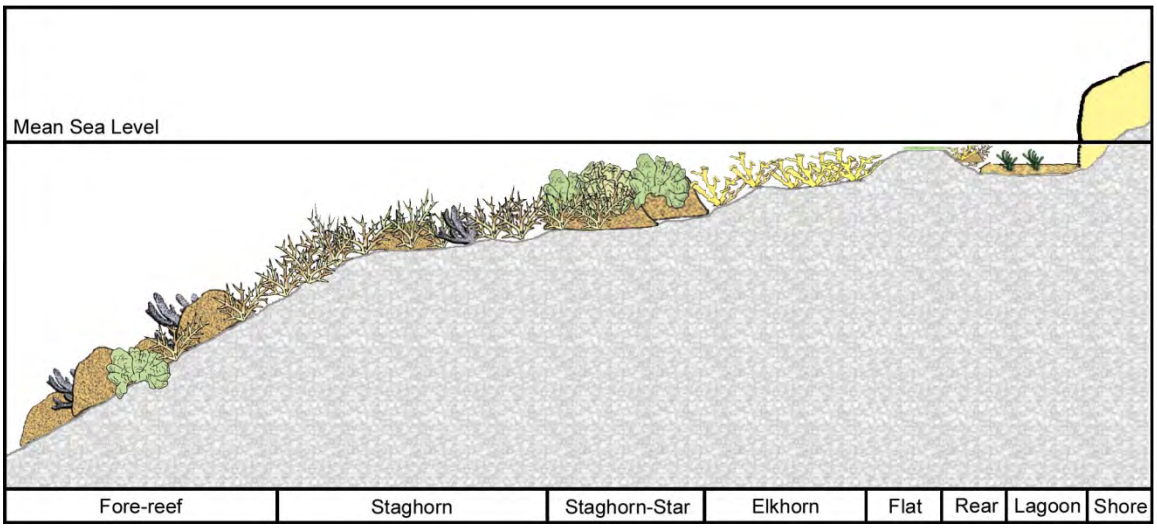

Figure 9. Generalized reef zone schematic (Acropora Biological Review Team 2005)

Staghorn Coral

Historically, staghorn coral was one of the dominant coral species and principle contributors to reef creation in the Atlantic and Caribbean. It commonly formed vast thickets, lending its names to a distinct zone in classical descriptions of Caribbean reef morphology (Figure 9). In the decades of the 1960s and 1970s, many Caribbean reefs were described as having an elkhorn (*A. palmata*) zone based upon high coverage, colony density, and in some cases, near exclusiveness of these species at particular depths (Goreau 1959).

Few historical estimates for staghorn coral population sizes are available because of its historically abundant status, its ability to produce clones through fragmentation, and its tendency to grow together to form complex thickets where individual colonies are difficult to tell apart. Although quantitative data on former distribution and abundance are scarce, in the few locations where quantitative data are available (e.g., Florida Keys, Dry Tortugas, Belize, Jamaica, and the U.S. Virgin Islands), declines in abundance (coverage and colony numbers) are estimated at greater than 97% (*Acropora* Biological Review Team 2005). Staghorn coral underwent precipitous declines throughout its range in the early 1980s due to mortality events associated with white band disease outbreaks and subsequent hurricane damage (Kramer 2002; Rogers et al. 2002). However, there are some small pockets of remnant robust populations such as in southeast Florida (Vargas-Angel et al. 2003), Honduras (Keck et al. 2005; Riegl et al. 2009), and the Dominican Republic (Lirman et al. 2010).

Miller et al. (2013) extrapolated population abundance of staghorn coral in the Florida Keys and Dry Tortugas from stratified random samples across habitat types. Population estimates of staghorn coral in the Florida Keys were 10.2 ± 4.6 (SE) million colonies in 2005, 6.9 ± 2.4 (SE) million colonies in 2007, and 10.0 ± 3.1 (SE) million colonies in 2012. In the Dry Tortugas, population estimates were 0.4 ± 0.4 (SE) million colonies in 2006 and 3.5 ± 2.9 (SE) million colonies in 2008, though the authors note their sampling scheme in the Dry Tortugas was not optimized for staghorn coral. In both the Florida Keys and Dry Tortugas, most of the population was dominated by small colonies less than 30 cm diameter. In the Florida Keys, partial mortality

was highest in 2005, with up to 80% mortality observed, and lowest in 2007 with a maximum of 30%. In 2012, partial mortality ranged from 20%-50% across most size classes.

The recent trends in abundance for staghorn coral seem to conform to a pattern of stability punctuated by episodic, catastrophic declines. After the initial declines in the 1980s due to hurricanes and disease, a major El Niño/La Niña Southern Oscillation cycle in 1997-1998 resulted in a large bleaching event and a loss of coral in the Caribbean and the Atlantic (Wilkinson and Souter 2008).

There have been several reports of local trends in abundance. Lidz and Zawada (2013) observed 400 colonies of staghorn coral along 70.2 km of transects near Pulaski Shoal in the Dry Tortugas where the species had not been seen since the cold water die-off of the 1970s, but no thickets were observed. Cover of staghorn coral increased on a Jamaican reef from 0.6% in 1995 to 10.5% in 2004 (Idjadi et al.) and 44% by 2005, but then collapsed after the 2005 bleaching event and subsequent predation to less than 0.5% in 2006 (Quinn and Kojis 2008). Walker et al. (2012b) report increasing size of 2 thickets (expansion of up to 7.5 times the original size of 1 of the thickets) monitored off southeast Florida, but also noted that cover within monitored plots concurrently decreased by about 50%, highlighting the dynamic nature of staghorn coral as it moves around via fragmentation and re-attachment.

Riegl et al. (2009) monitored staghorn coral in photo plots on the fringing reef near Roatan, Honduras from 1996 to 2005. Staghorn coral cover was 0.42% in 1996, declined to 0.14% in 1999 after the Caribbean bleaching event in 1998 and mortality from runoff associated with a Category 5 hurricane, and decreased further to 0.09 % in 2005. Staghorn coral colony frequency decreased 71% between 1997 and 1999. In sharp contrast, offshore banks near Roatan had dense thickets of staghorn coral with 31% cover in photo-quadrats in 2005 and appeared to survive the 1998 bleaching event and hurricane, most likely due to bathymetric separation from land and greater flushing. Modeling showed that under undisturbed conditions, retention of the dense staghorn coral stands on the banks off Roatan is likely with a possible increased shift towards dominance by other coral species. (Riegl et al. 2009).

A report on the status and trends of Caribbean corals over the last century indicates that after the large mortality events of the 1970s and 1980s, cover of staghorn coral has remained relatively stable (though much reduced) throughout the region as has the frequency of reefs at which staghorn coral was described as the dominant coral (IUCN 2013). However, the report also indicates that the number of reefs with staghorn coral present declined during the 1980s, remained relatively stable (though lower) in the 1990s, and then continued to decrease through 2011.

Fragmentation is the most common way of forming new colonies in staghorn corals (Bak and Criens 1982; Davis 1977; Gilmore and Hall 1976; Hughes 1985; Tunnicliffe 1981). However, staghorn coral retains moderate to high levels of genotypic diversity (i.e., the ratio of genetically distinct individuals to all colonies in a population) in many geographic areas (Baums et al. 2010; Baums et al. 2006; Vollmer and Palumbi 2007), though areas with low levels of genotypic diversity also exist. Baums et al. (2010) report staghorn coral at other Florida sites showed higher levels of diversity, indicating a more even reliance on sexual and asexual reproduction.

Studies have found that genetic exchange is restricted between populations separated by greater than 300 miles (500 km), emphasizing the importance of locally diverse populations for the recovery of this species (Baums et al. 2010; Baums et al. 2006; Vollmer and Palumbi 2007).

Settlement of staghorn larvae is rarely detected in coral recruitment studies (Bak and Engel 1979; Rylaarsdam 1983; Sammarco 1980). Studies from across the wider Caribbean, however, confirm 2 overall patterns of sexual recruitment of staghorn corals: (1) low juvenile densities relative to other coral species; and (2) low juvenile densities relative to the commonness of adults (Porter 1987). This pattern suggests that the composition of the adult population is dependent upon variable recruitment and likely reflects the dominance of asexual reproduction by fragmentation for these species (i.e., surviving fragments are usually large and never undergo a "juvenile" stage). Fragmentation can provide a mechanism for locally maintaining and expanding staghorn coral populations. In many locations, populations of staghorn coral have been reduced to such an extent that the potential for recovery through re-growth of fragments is limited. Similarly, as the density of staghorn coral colonies has declined, gametes become diluted, and successful sexual reproduction is less likely and results in reduced potential for exchange of genetic material between populations that are spatially farther apart (Bruckner 2002b). Contributing to density concerns for staghorn coral are observations that spawning does not occur at the same time. Observations at sites in the Florida Keys where distinct genotypes do co-occur in close proximity indicate that they often spawn on different nights preventing effective larval production (Miller et al. unpublished data). Thus, there is evidence to suggest that sexual recruitment of staghorn coral is currently compromised and limiting the potential for recovery.

Lobed Star, Mountainous Star, and Knobby Star Corals

As described above, the 3 species in the *Orbicella annularis* complex were not suggested for formal separation until the mid-1990s and further supported by genetic studies through 2012 (Budd et al. 2012; Fukami et al. 2004; Lopez et al. 1999; Weil and Knowton 1994). In addition, the three species are potentially difficult to tell apart depending on their growth form (e.g., mounding versus platy) and survey method (e.g., video versus in situ). Therefore, many monitoring programs continue to lump the 3 species into the *O. annularis* complex. Future, focused studies may allow for more time to do field identification resulting in high confidence that the reported species is actually the one identified.

The *Orbicella annularis* complex has historically been dominant on Caribbean coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau 1959). There is ample evidence that it has declined dramatically throughout its range, but perhaps at a slower pace than staghorn corals. While the latter began its rapid decline in the early- to mid-1980s, declines in *Orbicella annularis* complex have been much more obvious in the 1990s and 2000s, most often associated with combined disease and bleaching events. In most cases where examined, additional demographic changes accompany these instances of declining abundance (e.g., size structure of colonies, partial mortality).

In Florida, the percent cover data from 4 fixed sites have shown the *Orbicella annularis* complex declined in absolute cover from 5% to 2% in the Lower Keys between 1998 and 2003, and was accompanied by 5% to 40% colony shrinkage and virtually no recruitment (Smith et al. 2008).

Earlier studies from the Florida Keys indicated a 31% decline of *Orbicella annularis* complex absolute cover between 1975 and 1982 at Carysfort Reef (Dustan and Halas 1987) and greater than 75% decline (from over 6% cover to less than 1%) across several sites in Biscayne National Park between the late 1970s and 2000 (Dupont et al. 2008). Further, Ruzicka et al. (2013) documented a Florida Keys-wide decline in all stony coral cover attributable to a decline in the *O. annularis* complex from 1999 to 2009. Most notably, they documented a 25% decline at the deep fore reef sites, where declines are typically not as dramatic. Taken together, these data imply extreme declines in the Florida Keys (80%–95%) between the late 1970s and 2003, and it is clear that further dramatic losses occurred in this region during the cold weather event in January 2010 (Colella et al. 2012).

Similar declines have also been documented for relatively remote Caribbean reefs. At Navassa Island National Wildlife Refuge, percent cover of *Orbicella annularis* complex on randomly sampled patch reefs declined from 26% in 2002 to 3% in 2009, following disease and bleaching events in this uninhabited oceanic island (Miller and Williams 2007). Additionally, 2 offshore islands west of Puerto Rico (Mona and Desecheo) showed reductions in in *O. annularis* complex species (*O. faveolata* and *O. annularis)* live colony counts of 24% and 32% between 1998-2000 and 2008, respectively (Bruckner and Hill 2009). At Desecheo, this demographic decline of one-third of the population corresponded to a decline in *Orbicella annularis* complex cover from over 35% to below 5% across 4 sites.

In the U.S. Virgin Islands, recent data from the U.S. National Park Service's Inventory and Monitoring Program across 6 sites at fixed stations show a decline of *Orbicella annularis* complex from just over 10% cover in 2003 to just over 3% cover in 2009 following mass bleaching and disease impacts in 2005 (Miller et al. 2009). This degree of recent decline was preceded by a decline from over 30% *Orbicella* coverage to approximately 10% between 1988 and 2003, as documented by Edmunds and Elahi (2007). Similarly, percent cover of *Orbicella annularis* complex in a marine protected area in Puerto Rico declined from 49% to 8% between 1997 and 2009 (Hernández-Pacheco et al. 2011). Taken together, these data suggest an 80%-90% decline in *Orbicella annularis* over the past 2 decades in the main U.S. Caribbean territories.

While Bak and Luckhurst (1980) indicated stability in *Orbicella annularis* complex cover across depths in Curaçao during a 5-year study in the mid-1970s, this region has also manifested *Orbicella annularis* complex declines in recent years. Bruckner and Bruckner (2006) documented an 85% increase in the partial mortality of *Orbicella faveolata* and *O. annularis* colonies across 3 reefs in western Curaçao between 1998 and 2005, approximately twice the level for all other stony corals combined. These authors noted that *Orbicella franksi* fared substantially better than the other two complex species in this study. It is likely that *Orbicella annularis* complex populations in Curaçao have fared better than other Caribbean regions, but even those populations are not immune to losses.

Orbicella annularis complex declines in additional locations are noted. For example, at Glovers Reef, Belize, McClanahan and Muthiga (1998) documented a 38%-75% decline in relative cover of *Orbicella annularis* complex across different reef zones between 1975 and 1998, and a further 40% decline in relative cover has occurred since then (Huntington et al. 2011). In contrast, , *O.*

franksi, *O. faveolata*, and *O. annularis* populations have shown stable status at sites in Colombia between 1998 and 2003 (Rodriguez-Ramirez et al. 2010), although demographic changes in *Orbicella annularis* at both degraded and less-degraded reefs imply some degree of population decline in this region (Alvarado-Chacón and Acosta 2009).

Rough Cactus Coral

Rough cactus coral is usually uncommon (Veron 2000) or rare according to published and unpublished records. It constitutes less than 0.1% species contribution (percent of all colonies surveyed) and occurs at densities less than 0.08 colonies per 1 m^2 in Florida (Wagner et al. 2010) and at 0.8 colonies per 100 m transect in Puerto Rico sites sampled by the Atlantic and Gulf Rapid Reef Assessment (Ginsburg and Lang 2003). Recent monitoring data (e.g., since 2000) from Florida (National Park Service permanent monitoring stations), La Parguera, Puerto Rico, and St. Croix (USVI/NOAA Center for Coastal Monitoring and Assessment randomized monitoring stations) show *Mycetophyllia ferox* cover to be consistently less than 1%, with occasional observations up to 2%, and no apparent temporal trend.

Dustan (1977) suggests that *Mycetophyllia ferox* was much more abundant in the upper Florida Keys in the early 1970s than current observations, but that it was highly affected by disease. This data could be interpreted as a substantial decline. Long-term Coral Reef Evaluation and Monitoring Project (CREMP) data in Florida on species presence/absence from fixed stations also show a dramatic decline. For 97 stations in the main Florida Keys, occurrence had declined from 20 stations in 1996 to 4 stations in 2009; in Dry Tortugas occurrence had declined from 8 out of 21 stations in 2004 to 3 stations in 2009 (R. Ruzicka and M. Colella, Florida Marine Research Institute, St. Petersburg, Florida pers. comm. to Jennifer Moore, NMFS, Oct 2010). Recruitment of this species appears to be very low; even studies from the 1970s reported zero settlement (Dustan 1977).

Lamarck's Sheet Coral

Lamarck's sheet coral has been reported to be common (Veron 2000). On reefs at 98-131 ft (30-40 m) depths in the Netherlands Antilles, *Agaricia lamarcki* increased (Bak and Nieuwland 1995) or showed no decline in abundance from 1973 to 1992 (Bak et al. 2005), even though other corals on the same deep reefs decreased. It is not known whether this relative stability at depth holds across the full range of the species. The species has low recruitment rates. As an example, only 1 of 1,074 *Agaricia* recruits in a survey at the Flower Garden Banks may have been *Agaricia lamarcki* (Shearer and Coffroth 2006). Sexual recruitment over a decade has been documented as negligible, with reproduction primarily via fission (Hughes and Jackson 1985). It is a relatively long-lived species (Hughes 1996), with some colonies living more than a century (Hughes and Jackson 1985).

Elliptical Star Coral

Elliptical star coral is usually uncommon (Veron 2000). The overall colony density of *Dichocoenia stokesi* averaged across all habitat types in the south Florida region was ~1.6 colonies per 10 m^2, making it the ninth most abundant coral species in this region (Wagner et al. 2010). Substantial population declines have been reported from a bay in Curaçao (80% decline between 1961 and 1992; Debrot et al. 1998) and the upper Florida Keys (mortality of 75% of colonies across several reef sites after a disease outbreak with no recovery after 7 years;

[Richardson and Voss 2005]). There have been no obvious trends in the abundance of *Dichocoenia stokesi* in monitoring of randomized stations at La Parguera, Puerto Rico or St. John and St. Croix, U.S. Virgin Islands with less than 1.5% cover at most sites. Bak and Engel (1979) reported very low densities of *Dichocoenia* juveniles (approximately 1% of total juvenile colonies). However, reports of juveniles of *Dichocoenia stokesi* have been relatively common compared to most other scleractinian corals in the Florida Keys with mean juvenile densities among 566 sites surveyed during 1999–2009 averaging 0.11 per m^2, but reaching densities as high as one juvenile per m^2 in certain habitats (Chiappone 2010).

Threats

Ocean Warming

Mean seawater temperatures in reef-building coral habitats have increased during the past few decades and are predicted to continue to rise between now and 2100 (IPCC 2013). More importantly, the frequency of warm-season temperature extremes (warming events) in reef-building coral habitat has increased during the past 2 decades and is also predicted to increase between now and 2100 (IPCC 2013). The primary observable coral response to ocean warming is bleaching of coral colonies, wherein corals expel their symbiotic algae (zooxanthellae) in response to stress. Bleaching can affect coral growth, maintenance, reproduction, and survival. An episodic increase of only 1°C-2°C above the normal local seasonal maximum ocean temperature can induce bleaching. Although corals can withstand mild to moderate bleaching, severe, repeated, or prolonged bleaching can lead to colony death and has led to the mass mortality of many coral species during the past 30 years.

In addition to coral bleaching, ocean warming detrimentally affects virtually every life-history stage in reef-building corals. For one Indo-Pacific *Acropora* species, abnormal embryonic development occurs at 32°C, and complete fertilization failure occurs at 34°C (Negri et al. 2007). Further, symbiosis establishment, larval survivorship, and settlement success are impaired in some coral species at temperatures as low as 30°C-32°C (Randall and Szmant 2009; Ross et al. 2013; Schnitzler et al. 2012). Warmer temperatures accelerate the rate of larval development for spawning species, which reduces dispersal distances, the likelihood of successful settlement, and the potential for replenishment of depleted areas (Randall and Szmant 2009).

Multiple threats stress corals simultaneously or sequentially, whether the effects are cumulative, synergistic, or antagonistic. Ocean warming is likely to interact with many other threats, especially considering the long-term consequences of repeated thermal stress, since ocean warming is expected to worsen over this century. Increased seawater temperature interacts with coral diseases to reduce coral health and survivorship. Coral disease outbreaks often have accompanied or immediately followed bleaching events and follow seasonal patterns of high seawater temperatures. The effects of greater ocean warming (i.e., increased bleaching, which kills or weakens colonies) are expected to interact with the effects of higher storm intensity (i.e., increased breakage of dead or weakened colonies) in the Caribbean, resulting in increased rates of coral declines. Likewise, land-based runoff, pollution, or other local stressors may worsen bleaching impacts by increasing coral susceptibility to bleaching and/or increasing the duration of lowered growth after a bleaching event (Carilli et al. 2009; Wooldridge 2009).

Ocean Acidification
Ocean acidification is a result of increased greenhouse gas accumulation, primarily carbon dioxide, in the atmosphere. Ocean acidification is a drop in the pH of seawater that occurs in response to increases in atmospheric carbon dioxide levels that change ocean carbonate chemistry (Caldeira and Wickett 2003). The aragonite saturation state measures the concentration of carbonate ions in the ocean. Corals use carbonate ions to build calcium carbonate skeletons. Thus, decreasing pH and aragonite saturation state are expected to have a major impact on corals and other marine organisms this century by making it more difficult for them to build their skeletons (Fabry 2008). Numerous laboratory and field experiments have shown a relationship between elevated carbon dioxide and decreased calcification rates in particular corals and other calcium carbonate secreting organisms such as CCA (Bates et al. 2009; De Putron et al. 2010; Doney et al. 2009; Langdon et al. 2003). Low-saturation-state water also decreases the rate of biochemical processes that create the cements that infill reefs. A major potential impact from ocean acidification is a reduction in the structural stability of corals and reefs, which results both from increases in bioerosion and decreases in reef cementation. As atmospheric carbon dioxide rises globally, reef-building corals are expected to calcify more slowly and become more fragile.

Laboratory experiments have shown that a declining aragonite saturation state slows the start of and the rate at which newly settled coral larvae create carbonate skeletons (Albright et al. 2008; Cohen et al. 2007; Cohen et al. 2009). Slower growth implies even higher rates of mortality for newly settled corals that are vulnerable to overgrowth competition, sediment smothering, and incidental predation until they reach a refuge at larger colony size. In addition to effects on growth and calcification, recent laboratory experiments have shown that increased carbon dioxide also substantially impairs coral fertilization and settlement success (Albright et al. 2010), suggesting a potential further reduction in recruitment. Community medium-scale studies (Jokiel et al. 2008; Kuffner et al. 2008) showed dramatic declines in the growth rate of CCA and other reef organisms and an increase in the growth of fleshy algae at atmospheric carbon dioxide levels expected later this century. The decrease in CCA growth, coupled with rapid growth of fleshy algae will result in less available habitat for settlement and recruitment of new coral colonies.

Acidification is likely to interact with other threats. Ocean acidification may reduce the temperature threshold at which bleaching occurs (Anthony et al. 2011). Reduced skeletal growth compromises the ability of coral colonies to compete for space against algae, which grows more quickly as nutrient over-enrichment increases. Reduced skeletal density weakens coral skeletons, resulting in greater colony breakage from natural and human-induced physical damage.

Disease
Coral diseases are common and significant threats affecting most coral species. Disease can cause mortality, reduced sexual and asexual reproductive success, and impaired colony growth. A diseased state results from a complex interplay of factors including the cause or agent (e.g., pathogen, environmental toxicant), the host, and the environment. In the case of corals, the host is a complex community of organisms, which includes the coral animal, symbiotic zooxanthellae, and microbial symbionts.

Scientific understanding of individual disease causes in corals remains very poor. Lack of identification of specific pathogens of many coral diseases has hindered the ecological understanding of diseases and the ability to manage them effectively. Several authors have suggested there is a link between increased incidence of coral disease with increased temperature (Bruno et al. 2007; Harvell et al. 1999; Muller et al. 2008; Patterson et al. 2002) that may make corals more prone to infection or make pathogens more potent. An increased prevalence of infectious disease outbreaks has been associated with thermal stress even at temperatures below those required to cause mass bleaching (Bruno et al. 2007). In addition, disease outbreaks have followed bleaching events (Brandt and McManus 2009) and hurricanes (Bruckner and Bruckner 1997; Halley et al. 2001; Miller and Williams 2007; Williams et al. 2008), indicating greater susceptibility to disease when corals are stressed.

Trophic Effects of Fishing

Fishing, particularly overfishing, can have large scale, long-term ecosystem-level effects that can change ecosystem structure from coral-dominated reefs to algal-dominated reefs called a 'phase shift' (Hughes 1994). Phase shifts can result when fishing removes species that are particularly important in structuring coral reef ecosystems (Mumby et al. 2007). Effects of fishing can include reducing population abundance of herbivorous fish species that control algal growth, limiting the size structure of fish populations, reducing species richness of herbivorous fish, and releasing corallivores from predator control. If herbivorous fish populations, particularly large-bodied parrotfish, are heavily fished and a major mortality of coral colonies occurs, then algae can grow rapidly and prevent the recovery of the coral population. The ecosystem may then collapse into an alternative stable state– a persistent phase shift in which algae replace corals as the dominant reef species (Mumby et al. 2007). Although algae can have negative effects on adult coral colonies (i.e., overgrowth, bleaching from toxic compounds), the ecosystem-level effects of algae are primarily from inhibited coral recruitment. Filamentous algae can prevent the recruitment of coral larvae by creating sediment traps that obstruct access to a hard substrate for attachment. Additionally, macroalgae reduces coral recruitment through occupation of the available space, shading, abrasion, chemical poisoning, and infection with bacterial disease (Rasher et al. 2012; Rasher and Hay 2010; Rasher et al. 2011).

The trophic effects of fishing are likely to interact with many other threats. For example, when carnivorous fishes are overfished, corallivorous fish populations may increase, resulting in greater predation on corals (Burkepile and Hay 2007). Further, some corallivores are vectors of disease and can transmit disease from one coral colony to another as they transit and consume from each coral colony (Aeby and Santavy 2006). Increasing corallivore abundance results in transmittal of disease to higher proportions of the corals within the population.

Sedimentation

Human activities in coastal watersheds introduce sediment into the ocean by a variety of mechanisms; including river discharge, surface run-off, groundwater seeps, and atmospheric deposition. Elevated sediment levels are generated by poor land use practices and coastal and nearshore construction, including dredging. Nearshore sediment levels will also likely increase with sea level rise due to erosion at the shoreline and re-suspension of lagoonal sediments.

The most common direct effect of sedimentation is deposition of sediment on coral surfaces as it settles out from the water column. Corals with certain morphologies (e.g., mounding) can passively reject settling sediments or corals can actively displace sediment by ciliary action or mucous production, both of which require energetic expenditures (Bak and Elgershuizen 1976; Dallmeyer et al. 1982; Lasker 1980; Stafford-Smith 1993; Stafford-Smith and Ormond 1992). Corals that are unsuccessful in removing sediment will be smothered and die (Golbuu et al. 2003; Riegl and Branch 1995; Rogers 1983). Sediment can also induce sublethal effects, such as reductions in tissue thickness (Flynn et al. 2006) and excess mucus production (Marszalek 1981). In addition, suspended sediment can reduce the amount of light in the water column, making less energy available for coral photosynthesis and growth (Anthony and Hoegh Guldberg 2003; Bak 1978; Rogers 1979). While some corals may be more tolerant of short-term elevated levels of sedimentation, sediment stress and turbidity can induce bleaching (Philipp and Fabricius 2003; Rogers 1979). Finally, sediment impedes fertilization of spawned gametes (Gilmour 2002; Humphrey et al. 2008) and reduces larval settlement, as well as the survival of recruits and juveniles (Birrell et al. 2005; Fabricius et al. 2003).

Sedimentation is also likely to interact with many other threats. For example, when coral communities that are chronically affected by sedimentation experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by sedimentation.

Nutrients

Nutrients (e.g., nitrogen and phosphorous) are added to coral reefs from both point sources (readily identifiable inputs from a single source such as a pipe or drain) and non-point sources (inputs that occur over a wide area and are associated with particular land uses). Anthropogenic sources of nutrients include sewage, agricultural run-off, river and inlet discharges, and groundwater. Development of coastlines and destruction of mangrove forests compound the problem of anthropogenic nutrient runoff, as mangroves are able to filter massive amounts of nutrients and sediment caused by development. Natural processes bring nutrients to coral reefs as well, such as delivery of nutrient-rich deep water by internal waves and upwelling.

Elevated nutrients affect corals through 2 main mechanisms: direct impacts on coral physiology and indirect effects through nutrient-stimulation of other community components (e.g., macroalgae and filter feeders) that compete with corals for space on the reef. Coral reefs are adapted to low nutrient levels, and overabundance of nutrients can cause an imbalance that affects the entire ecosystem. Nutrient-rich water can enhance benthic algae and phytoplankton growth rates in coastal areas, resulting in overgrowth, competition, and algal blooms. Excess nutrient loads affect coral physiology and the balance between corals and their zooxanthellae (Szmant 2002). Increased nutrients can decrease calcification and reduce skeletal density. Either condition results in corals that are more prone to breakage or erosion. Increased levels of nutrients can also compromise coral health (Hodel and Vargas-Angel 2007). Notably, individual species have varying tolerance to increased nutrients.

Nutrients are likely to interact with many other threats. For example, when coral communities that are chronically affected by nutrients experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in

communities not affected by nutrients. Additionally, experimental studies on diseased coral species indicate that nutrient augmentation adjacent to active disease lesions substantially increases disease severity (Bruno et al. 2003).

Sea Level Rise

Sea level rise may affect various coral life history events, including larval settlement, polyp development, and juvenile growth. It may also contribute to adult mortality and colony fragmentation, mostly due to increased sedimentation and decreased water quality (reduced light availability) caused by coastal inundation. The best available information suggests that sea level will continue to rise due to thermal expansion and the melting of land and sea ice. Many corals that inhabit the relatively narrow zone near the ocean surface have rapid growth rates when healthy, which allowed them to keep up with sea-level rise during the past periods of rapid climate change associated with de-glaciation and warming. However, depending on the rate and amount of sea level rise, rapid rises can lead to reef drowning. Rapid rises in sea level could affect many coral species by both submerging them below their common depth range and, more likely, by degrading water quality through coastal erosion and potentially severe sedimentation or enlargement of lagoons and shelf areas.

Rising sea level is likely to cause mixed responses in coral species depending on their depth preferences, sedimentation tolerances, and growth rates. Further, the nearshore topography can affect the impact sea level rise has on corals. Reductions in growth rate due to local stressors, bleaching, infectious disease, and ocean acidification may prevent the species from keeping up with sea level rise (e.g., from growing at a rate that will allow them to continue to occupy their preferred depth range despite sea-level rise). Additionally, lack of suitable new habitat, limited success in sexual recruitment, coastal runoff, and transition from natural to constructed shorelines will compound some corals' ability to survive rapid sea level rise.

Predation

Predation on some coral genera, including *Acropora and Orbicella*, is a chronic, though occasionally acute, energy drain (Cole et al. 2008; Rotjan and Lewis 2008). Predators of Caribbean corals include snails, polychaete worms, and several species of fishes. The effects of chronic and frequent predation on corals are usually inconsequential but can become significant once the coral population decreases below a threshold. If the living coral cover is substantially reduced by natural or anthropogenic disturbances, the effects of predation become larger even if the rate of predation does not change. The increased focus of predation on the fewer remaining colonies causes the colony to use energy in defense and could result in a reduced rate of healing and/or fecundity or reduced resistance to stressors and/or disease. Additionally, corallivore populations can also increase due to removal of carnivorous predators (i.e., predators of the corallivores) through fishing. Over-predation can lead to significant coral declines when the rate of coral predation is higher than the rate of healing or coral population replenishment.

Predation is likely to interact with other threats. For instance, predation of coral colonies can increase the likelihood of coral disease infection, and likewise diseased colonies may be more likely to be preyed upon. Additionally, nutrient runoff from land stimulates phytoplankton blooms, which provide food for the larvae of invertebrate corallivores and can cause outbreaks of these predators (Birkeland 1982; Fabricius et al. 2010).

Toxins and Contaminants
Toxins and bioactive contaminants may be delivered to coral reefs via either point or non-point sources. The general effects of contaminants on coral communities are reductions in coral growth, coral cover, and coral species richness (Keller et al. 1991; Loya and Rinkevich 1980; Pait et al. 2007), and a shift in community composition to more tolerant species (Rachello-Dolmen and Cleary 2007). Contaminant effects are species specific and may have harmful effects in combination that would not be evident under experimental exposure to an individual substance.

Laboratory experiments have shown chemical contaminants are harmful to corals. However, linking coral decline to specific contaminants in the environment can be difficult. Low concentrations (parts per billion) of organic chemical contaminants including hydrocarbons (Negri and Heyward 2000), antifoulants (Knutson et al. 2012), pesticides (Negri and Heyward 2001), and metals such as copper, zinc, and iron (Bielmyer et al. 2010; Reichelt-Brushett and Harrison 2000; Reichelt-Brushett and Harrison 2005; Vijayavel et al. 2012) can impact physiological function at various life stages. Estrogen compounds at concentrations that occur in urban or sewage-affected coastal waters (i.e., 2 ng L^{-1}) can affect coral growth and fecundity (Tarrant et al. 2004). In lab experiments, various compounds found in common sunscreens caused coral bleaching (Danovaro et al. 2008). Both oil and chemical dispersants are toxic to coral larvae (Epstein et al. 2000; Negri and Heyward 2000; Goodbody-Gringley et al., unpublished data; K. Ritchie, Mote Marine Lab, pers. comm. to A. Moulding, NMFS, Feb., 2012). While toxic and biologically active substances impair corals, their effects are largely "silent," causing chronic and often sublethal stress or contributing to mortality of unapparent cause.

Physical Impacts
Coral reefs must endure physical damage from many different sources and threats acting over a range of spatial and temporal scales. Extreme wave events, such as those generated by severe tropical hurricanes, are naturally occurring processes that are typically viewed as acute disturbances. Direct physical effects from vessel groundings, anchor damage, and coastal construction activities, such as dredging, mining, and drilling, are somewhat analogous to storm damage in that they are relatively discrete events, although they generally occur over much smaller spatial scales than do storms. Other human-induced disturbances, such as those caused by tourism and recreational events, fishing gear, and marine debris, can have pervasive, chronic physical consequences. Chronic stresses reduce the ability of corals to recover from acute events (Connell et al. 1997). The relationships between injury interval and time required for reef recovery are the primary factors in evaluating equilibrium of the system (Connell 1978).

Staghorn Corals
Staghorn corals displayed severe impacts in the 1998 and 2005 bleaching events, and high temperatures and bleaching have been correlated with coral disease. The shallow reef habitat in which staghorn corals grow is especially vulnerable to increasing air and sea temperatures that accompany global climate change.

Laboratory experiments have shown that acidification reduces skeletal deposition and initiation of calcification in newly settled corals (Albright et al. 2008; Cohen et al. 2007; Cohen et al.

2009). Some CCA species provide chemical cues for settlement and enhanced post-settlement survivorship of *Acropora* larvae (Harrington et al. 2004; Ritson-Williams et al. 2010), suggesting a potential further reduction in recruitment as acidification impacts CCA growth.

White band disease is believed to be the main cause of the initial region-wide decline of staghorn corals (Aronson and Precht 2001), and disease continues to be a major threat to the 2 species. A transmissible disease termed rapid tissue loss affects staghorn coral (Williams and Miller 2005). Additionally, staghorn corals are affected by ciliates (a group of protozoans characterized by the presence of hair-like organelles; [Croquer et al. 2006]). .

Predation is a threat to staghorn corals both through direct removal of tissue and through indirect effects. Known predators include snails (*Coralliophila abbreviata*), fireworms (*Hermodice carunculata*), 2 species of damselfishes (*Stegastes planifrons* and *Microspathodon chrysurus*), and the stoplight parrotfish (*Sparisoma viride*). All of these predators are generalists, feeding on a wide range of coral species, and in some cases algae. Predation effects are more pronounced in areas where staghorn coral abundance or colony sizes are reduced, and predation pressure remains constant.

Staghorn corals appear to be particularly sensitive to sediment deposition and shading effects from increased sediment. Because they are highly dependent upon sunlight for nourishment (Lewis 1977; Porter 1976), staghorn corals are very susceptible to increases in water turbidity. Staghorn corals have poor capacity to remove coarser sediments (250-2000 µm) and only slightly more capacity for removing finer sediments (62-250 µm) (Hubbard and Pocock 1972). Water movement (turbulence) and gravity are probably more important in removing sediments from these species than their capabilities of sloughing sediments in still water (Porter 1987). A sedimentation rate of 200 mg cm^{-2} can cause both lethal (Rogers 1983) and sublethal damage resulting in compromised coral health (Hodel and Vargas-Angel 2007) in this species.

Nutrients impact staghorn corals both directly and indirectly. Nutrients from land-based sources of pollution can cause habitat loss through the stimulation of growth of algae that can occupy space on the reef (Lapointe et al. 2005). Increased levels of nutrients also reduce growth rates in staghorn corals (Renegar and Riegl 2005) and compromise their health (Hodel and Vargas-Angel 2007).

Staghorn corals are sensitive to chemical contaminants. Staghorn coral displayed higher susceptibility to copper toxicity than 2 other coral species tested; effects included depressed photosynthesis, decreased growth, tissue accumulation, and other physiological changes at exposures as low as 4 µg L^{-1} (Bielmyer et al. 2010). Staghorn coral treated with various compounds found in common sunscreens experienced rapid and complete bleaching, even at extremely low concentrations (Danovaro et al. 2008). The response of staghorn coral exposed to drilling muds produced during offshore oil and gas exploration included reduced calcification and reduced tissue soluble protein levels (Kendall et al. 1983).

The branching morphology of staghorn corals makes them particularly vulnerable to physical damage. Major storm events are a natural threat to staghorn corals that result in local population declines (Rogers et al. 1982; Woodley et al. 1981). There are observations from diverse geographical locations of coral disease outbreaks following hurricane disturbances including

Puerto Rico, (Bruckner and Bruckner 1997), Navassa, the Florida Keys, (Miller and Williams 2007; Williams et al. 2008), Bonaire, Curaçao, (*Acropora* Biological Review Team 2005), and Honduras (Halley et al. 2001). Historically, tropical storms likely fostered propagation of staghorn coral thickets through fragmentation, but recent observations from periods of frequent hurricane impacts in the Florida Keys document a lack of successful recruitment of fragments and a severe population decline (Williams et al. 2008). Staghorn corals are less able to successfully reproduce asexually due to high mortality of fragments, and reduced colony density and reef rugosity (Alvarez-Filip et al. 2009) that lessen the likelihood of retaining storm-generated fragments in suitable habitat (Williams et al. 2008). Man-made abrasion and breakage impacts to reefs are chronic and cumulative, and occur on an ongoing basis (e.g., derelict fishing gear, vessel grounding and anchoring, fishing, diver interaction).

Orbicella annularis, Orbicella faveolata, and Orbicella franksi

Because *Orbicella annularis* complex species have traditionally been common and are among the main reef builders in the Caribbean, they have been the frequent subject of research, including responses to and impacts of environmental threats. Published reports of individual bleaching surveys have consistently indicated that *O. faveolata*, *O. annularis*, and the *Orbicella annularis* complex are highly-to-moderately susceptible to bleaching (Brandt 2009; Bruckner and Hill 2009; Oxenford et al. 2008; Wagner et al. 2010). Bleaching can prevent gamete production in *O. annularis* (Mendes and Woodley 2002) and *Orbicella annularis* complex colonies (Szmant and Gassman 1990) in the following reproductive season even after they recover normal pigmentation . Bleaching events leave permanent marks in coral growth records (Leder et al. 1991; Mendes and Woodley 2002). Particularly well-documented mortalities in these species following severe mass-bleaching in 2005 highlight the immense impact that thermal stress events and their aftermath can have on *Orbicella annularis* complex populations (Miller et al. 2009). Using demographic data collected in Puerto Rico over 9 years straddling the 2005 bleaching event, Hernández-Pacheco et al. (2011) showed that population growth rates of *O. annularis* were stable in the pre-bleaching period (2001-2005), but declined in the 2 years following the bleaching event. Simulation modeling of different bleaching probabilities predicted extinction of a population with these dynamics within 100 years at a bleaching probability between 10% and 20%; in other words, once every 5-10 years (Hernández-Pacheco et al. 2011). Cervino et al. (2004) also showed that higher temperatures (over experimental treatments from 20°C-31°C) resulted in faster rates of tissue loss and higher mortality in yellow-band affected *Orbicella annularis* complex. Recent work in the Mesoamerican reef system indicated that *Orbicella faveolata* had reduced thermal tolerances in many locations and over time (Carilli et al. 2010) with increasing human populations, implying increasing local threats (Carilli et al. 2009).

The only study conducted regarding the impact of acidification on this genus is a field study that did not find any change in *Orbicella faveolata* calcification in sampled colonies from the Florida Keys up through 1996 (Helmle et al. 2011). Preliminary experiments testing effects of acidification on fertilization and settlement success of *Orbicella annularis* complex (Albright et al., unpublished data) show results that are consistent with the significant impairments demonstrated for *Acropora palmata* (Albright et al. 2010).

Both Bruckner and Hill (2009) and Miller et al. (2009) demonstrated profound declines for *Orbicella annularis* complex from disease impacts, both with and without prior bleaching. Both white-plague and yellow-band diseases can invoke this type of population level decline. Disease outbreaks can persist for years in a population; *Orbicella annularis* colonies suffering from yellow-band in Puerto Rico in 1999 still manifested similar disease signs 4 years later, with a mean tissue loss of 60% (Bruckner and Bruckner 2006).

Orbicella annularis complex does not suffer from catastrophic outbreaks of predators. While *Orbicella annularis* complex can host large populations of corallivorous snails, they rarely display large feeding scars that are apparent on other coral prey, possibly related to differences in tissue characteristics or nutritional value (Baums et al. 2003). However, low-level predation can have interactive effects with other stressors. For example, predation by butterflyfish can serve as a vector to facilitate infection of *Orbicella faveolata* with black-band disease (Aeby and Santavy 2006). Parrotfishes are also known to preferentially target *Orbicella annularis* , *O. franski,* and *O. faveolata* in so-called "spot-biting," which can leave dramatic signs in some local areas (Bruckner et al. 2000; Rotjan and Lewis 2006). Chronic parrotfish biting can impede colony recovery from bleaching in *O. franksi* and *O. faveolata* (Rotjan et al. 2006). Although it is not predation per se, *Orbicella* colonies have often been infested by other pest organisms. Bio-eroding sponges (Ward and Risk 1977) and territorial damselfishes, *Stegastes planifrons*, can cause tissue loss and skeletal damage. Damselfish infestation of *Orbicella annularis* complex appears to have increased in areas where their preferred, branching coral habitat has declined because of loss of Caribbean acroporids (Precht et al. 2010).

Large, massive, long-lived colonies of *Orbicella annularis* complex lend themselves to retrospective studies of coral growth in different environments, so there is a relatively large amount known or inferred regarding relationships between water quality and *Orbicella annularis* complex growth and status. For example, Tomascik (1990) found an increasing average growth (linear extension) rate of *Orbicella annularis* complex with improving environmental conditions on fringing reefs in Barbados. Within the same study, Tomascik also found a general pattern of decreasing growth rates within the past 30 years at each of the 7 fringing reefs and contributed this decrease to the deterioration of water quality along the west coast of Barbados. Torres and Morelock (2002) noted a similar decline in *Orbicella annularis* complex growth at sediment-impacted reefs in Puerto Rico. Density and calcification rate increased from high to low turbidity and sediment load, while extension rate followed an inverse trend (Carricart-Ganivet and Merino 2001). Eakin et al. (1994) demonstrated declines in *Orbicella annularis* linear extension during periods of construction in Aruba. Downs et al. (2005) suggested that localized toxicant exposure may account for a localized mortality event of *Orbicella annularis* complex in Biscayne National Park. *Orbicella faveolata* had somewhat lesser sensitivity to copper exposure in laboratory assays than *Acropora cervicornis* and *Pocillopora damicornis* (Bielmyer et al. 2010). Nutrient-related runoff has also been deleterious to *Orbicella annularis* complex. Elevated nitrogen reduced respiration and calcification in *Orbicella annularis* and stimulated zooxanthellae populations (Marubini and Davies 1996). Elevated nutrients increased the rate of tissue loss in *Orbicella franksi* and *Orbicella faveolata* affected by yellow-band disease (Bruno et al. 2003). Chronic nutrient elevation can produce bleaching and partial mortality in *Orbicella annularis*, whereas anthropogenic dissolved organic carbon kills corals directly (Kuntz et al. 2005).

Rough Cactus Coral
Rough cactus coral is susceptible to acute and subacute white plague. Dustan (1977) reported dramatic impacts from this disease to the population in the upper Florida Keys in the mid-1970s. He also reported that the rate of disease progression was positively correlated with water temperature and measured rates of disease progression up to 3 mm per day.

The susceptibility of rough cactus corals to nutrients is unknown. However, the absence of this species at fringing reef sites impacted by sewage pollution (Tomascik and Sander 1987) suggests it is highly susceptible to nutrient over-enrichment.

No specific research has addressed the effects of acidification on the genus *Mycetophyllia*

Lamarck's Sheet Coral
Lamarck's sheet coral is susceptible to bleaching at elevated temperatures (Ghiold and Smith 1990), via direct loss of zooxanthellae as well as decreased pigment content (Porter et al. 1989). In laboratory studies in Jamaica, Lamarck's sheet coral tolerated temperatures up to 32°C (Fitt and Warner 1995) but virtually complete disruption of photosynthesis occurred at 32°C–34°C (Warner et al. 1996). Cold stress has also produced bleaching (Bak et al. 2005). Although bleaching can often be extensive, it may not induce mortality in Lamarck's sheet coral (Aronson and Precht 2000; Aronson et al. 1998; Porter et al. 1989).

No specific research has addressed the effects of acidification on the genus *Agaricia*.

Lamarck's sheet coral is vulnerable to white plague disease (Garzon-Ferreira et al. 2001; Nugues 2002; Richardson 1998), ciliate infections (Croquer et al. 2006), and tumors (UNEP 2010). The ecological and population impacts of disease have not been established for *Agaricia lamarcki*.

The effects of land-based sources of pollution (LBSP) on the genus *Agaricia* are largely unknown. *Agaricia* sp. typically have small calices (i.e., skeletal structure in which the coral polyp sits) and are not efficient sediment rejecters (Hubbard and Pocock 1972). *Agaricia lamarcki*'s platy morphology could make it sediment-susceptible. Vertical plates of *Agaricia* shed more sediment than horizontally-oriented ones (Bak and Elgershuizen 1976), and fine sediment suspended in hurricanes can cause much higher mortality in platy corals than hemispherical or non-flat morphologies (Bak, unpublished data; Bak et al. 2005).

Elliptical Star Coral
Although elliptical star coral is susceptible to bleaching, it showed the lowest bleaching response of species observed to bleach in the south Florida region (Wagner et al. 2010). In Barbados elliptical star coral ranked 16th of 21 species in bleaching prevalence during the 2005 Caribbean mass-bleaching event (Oxenford et al. 2008). It was also observed to be bleaching-tolerant in the U.S. Virgin Islands during the same event (Clark et al. 2009). Hence, this species is regarded to be at relatively low threat from temperature-induced bleaching. Elliptical star coral hosts clade B zooxanthellae (Correa et al. 2009; LaJeunesse 2002). Zooxanthellae in clade B do not grow well at high temperatures (Kinzie et al. 2001), but in the field, corals with this clade may be relatively bleaching-resistant (McField 1999). Experimental studies suggest clade B is more bleaching-resistant than clade C, but less resistant than clade A (Warner et al. 2006).

No specific research has addressed the effects of acidification on the genus *Dichocoenia*.

Elliptical star coral is highly susceptible to white plague, with infection increasing with temperature (Borger and Steiner 2005). An outbreak event for this disease in the Florida Keys had demonstrable impact at the local population level, yielding mortality of 75% of colonies across several reef sites, substantial shifts in population structure, and essentially no recovery over a 7-year follow-up period (Richardson and Voss 2005). This species is also susceptible to black-band disease (Sutherland et al. 2004), ciliate infection (Croquer et al. 2006), and dark-spot syndrome (Borger and Steiner 2005). Disease susceptibility appears to be variable (Borger and Steiner 2005); for example, *Dichocoenia stokesi* was minimally affected during a 1998 outbreak in St. Lucia that caused widespread mortality in *Orbicella faveolata* and other species (Nugues 2002).

Elliptical star coral is minimally affected by predation. It can be heavily bioeroded, particularly by bivalves (Highsmith 1981), and lose substantial amounts of tissue to sponge overgrowth (Hill 1998).

One laboratory study (Telesnicki and Goldberg 1995b) has shown that elliptical star coral displays physiological stress at turbidity levels that are within allowable levels as regulated by the State of Florida for coastal construction projects. While light levels and photosynthesis were not affected, respiration levels and mucous production were significantly higher at turbidity levels as low as 14–16 Nephelometric Turbidity Units (NTU), and photosynthesis to respiration ratio fell below 1 at 28–30 NTU (Telesnicki and Goldberg 1995a). An earlier laboratory study examining oil/sediment rejection indicated that elliptical star coral was intermediate (of 19 Caribbean coral species examined) in the rate of sediment removal from its tissues (Bak and Elgershuizen 1976).

4.2.3 Elkhorn and Staghorn Coral Designated Critical Habitat

Elkhorn and staghorn corals require hard, consolidated substrate, including attached, dead coral skeleton, for their larvae to settle. Within the geographical area occupied by a listed species, critical habitat consists of specific areas on which those physical or biological features essential to the conservation of the species are found. For elkhorn and staghorn coral, the physical feature of critical habitat essential to the conservation of the species is substrate of suitable quality and availability, in water depths from the mean high water line to 30 m, to support successful larval settlement, recruitment, and reattachment of fragments. Substrate of suitable quality and availability means consolidated hardbottom or dead coral skeletons free from fleshy and turf macroalgae, and sediment cover. A shift in benthic community structure from coral-dominated to algae-dominated that has been documented since the 1980s means that the settlement of larvae or attachment of fragments is often unsuccessful (Hughes and Connell 1999). Sediment accumulation on suitable substrate also impedes sexual and asexual reproductive success by preempting available substrate and smothering coral recruits.

While algae, including crustose coralline algae and fleshy macroalgae, are natural components of healthy reef ecosystems, increases in the dominance of algae since the 1980s impedes coral recruitment. The overexploitation of grazers through fishing has also enabled fleshy macroalgae

to persist in reef and hardbottom areas formerly dominated by corals. Impacts to water quality, in particular nutrient inputs, associated with coastal development are also thought to enhance the growth of fleshy macroalgae by providing them with nutrient sources. Fleshy macroalgae are able to colonize dead coral skeleton and other hard substrate and some are able to overgrow living corals and crustose coralline algae. Because crustose coralline algae is thought to provide chemical cues to coral larvae indicating an area is appropriate for settlement, overgrowth by macroalgae may affect coral recruitment (Steneck 1986). Several studies show that coral recruitment tends to be greater when algal biomass is low (Rogers et al. 1984, Hughes 1985, Connell et al. 1997, Edmunds et al. 2004, Birrell et al. 2005, Vermeij 2006). In addition to preempting space for coral larval settlement, many fleshy macroalgae produce secondary metabolites with generalized toxicity, which also may inhibit settlement of coral larvae (Kuffner and Paul 2004). The rate of sediment input from natural and anthropogenic sources can affect reef distribution, structure, growth, and recruitment. Sediments can accumulate on dead and living corals and exposed hardbottom, thus reducing the available substrate for larval settlement and fragment attachment.

In addition to the amount of sedimentation, the source of sediments can affect coral growth. In a study of 3 sites in Puerto Rico, Torres (2001) found that low-density coral skeleton growth was correlated with increased resuspended sediment rates and greater percentage composition of terrigenous sediment. In sites with higher carbonate percentages and corresponding low percentages of terrigenous sediments, growth rates were higher. This suggests that re-suspension of sediments and sediment production within the reef environment does not necessarily have a negative impact on coral growth while sediments from terrestrial sources increase the probability that coral growth will decrease, possibly because terrigenous sediments do not contain minerals that corals need to grow (Torres 2001).

Long-term monitoring of sites in the U.S.V.I. indicate that coral cover has declined dramatically; coral diseases have become more numerous and prevalent; macroalgal cover has increased; fish of some species are smaller, less numerous, or rare; long-spined black sea urchins are not abundant; and sedimentation rates in nearshore waters have increased from one to 2 orders of magnitude over the past 15 to 25 years (Rogers et al. 2008). Thus, changes that have affected elkhorn and staghorn coral and led to significant decreases in the numbers and cover of these species have also affected the suitability and availability of habitat.

Figure 10**,** below, shows the boundaries of the Florida area of *Acropora* critical habitat. The Florida area contains 3 sub-areas. The shoreward boundary for Florida sub-area A begins at the 6-ft (1.8 m) contour at the south side of Boynton Inlet, Palm Beach County at 26° 32′ 42.5″ N; then runs due east to the point of intersection with the 98-ft (30 m) contour; then follows the 98-ft (30 m) contour to the point of intersection with latitude 25° 45′ 55″ N, Government Cut, Miami-Dade County; then runs due west to the point of intersection with the 6-ft (1.8 m) contour, then follows the 6-ft (1.8 m) contour to the beginning point. The shoreward boundary of Florida sub-area B begins at the MLW line at 25° 45′ 55″ N, Government Cut, Miami-Dade County; then runs due east to the point of intersection with the 98-ft (30 m) contour; then follows the 98-ft (30 m) contour to the point of intersection with longitude 82°W; then runs due north to the point of intersection with the South Atlantic Fishery Management Council (SAFMC) boundary at 24° 31′ 35.75″ N; then follows the SAFMC boundary to a point of intersection with

the MLW line at Key West, Monroe County; then follows the MLW line, the SAFMC boundary (see 50 CFR 600.105(c)), and the COLREGS line (see 33 CFR 80.727. 730, 735, and 740) to the beginning point. The seaward boundary of Florida sub-area C (the Dry Tortugas) begins at the northern intersection of the 98-ft (30 m) contour and longitude 82° 45' W; then follows the 98–ft (30 m) contour west around the Dry Tortugas, to the southern point of intersection with longitude 82° 45' W; then runs due north to the beginning point.

Critical habitat does not include the following particular areas: (1) all areas subject to the 2008 Naval Air Station Key West Integrated Natural Resources Management Plan, (2) all areas containing existing (already constructed) federally authorized or permitted man-made structures such as aids-to-navigation (ATONs), artificial reefs, boat ramps, docks, pilings, maintained channels, or marinas, (3) all waters identified as existing (already constructed) federally authorized channels, and (4) all waters of the Restricted Anchorage Area as described at 33 CFR 334.580, beginning at a point located at 26° 05′ 30'' N, 80 03′ 30'' W.; proceed west to 26° 05′ 30″ N, 80° 06′ 30″ W; thence, southerly to 26° 03′ 00″ N, longitude 80° 06′ 42″ W; thence, east to latitude 26° 03′ 00″ N, 80° 05′ 44″ W.; thence, south to 26° 01′ 36″ N, 80° 05′ 44″ W.; thence, east to 26° 01′ 36″ N, 80° 03′ 30″ W; thence, north to the point of beginning.

The proposed project takes place in sub-area B within the Florida area of critical habitat. The entire Florida area is comprised of 1,329 square miles of designated critical habitat.

Threats

The final critical habitat rule for elkhorn and staghorn coral identifies several sources of threat to the essential feature. Suitable habitat available for larval settlement and recruitment, and asexual fragment reattachment and recruitment of these coral species is particularly susceptible to impacts from human activity because of the shallow water depth range (less than 98 ft/30 m) in which elkhorn and staghorn corals commonly grow and the essential feature occurs. The proximity of this habitat to coastal areas subject this feature to impacts from multiple activities, including, but not limited to dredging and disposal activities, stormwater run-off, coastal and maritime construction, land development, wastewater and sewage outflow discharges, point and non-point source pollutant discharges, fishing, placement of large vessel anchorages, and installation of submerged pipelines or cables. The impacts from these activities, combined with those from natural factors (e.g., major storm events), significantly affect the quality and quantity of available substrate for these threatened species to successfully sexually and asexually reproduce.

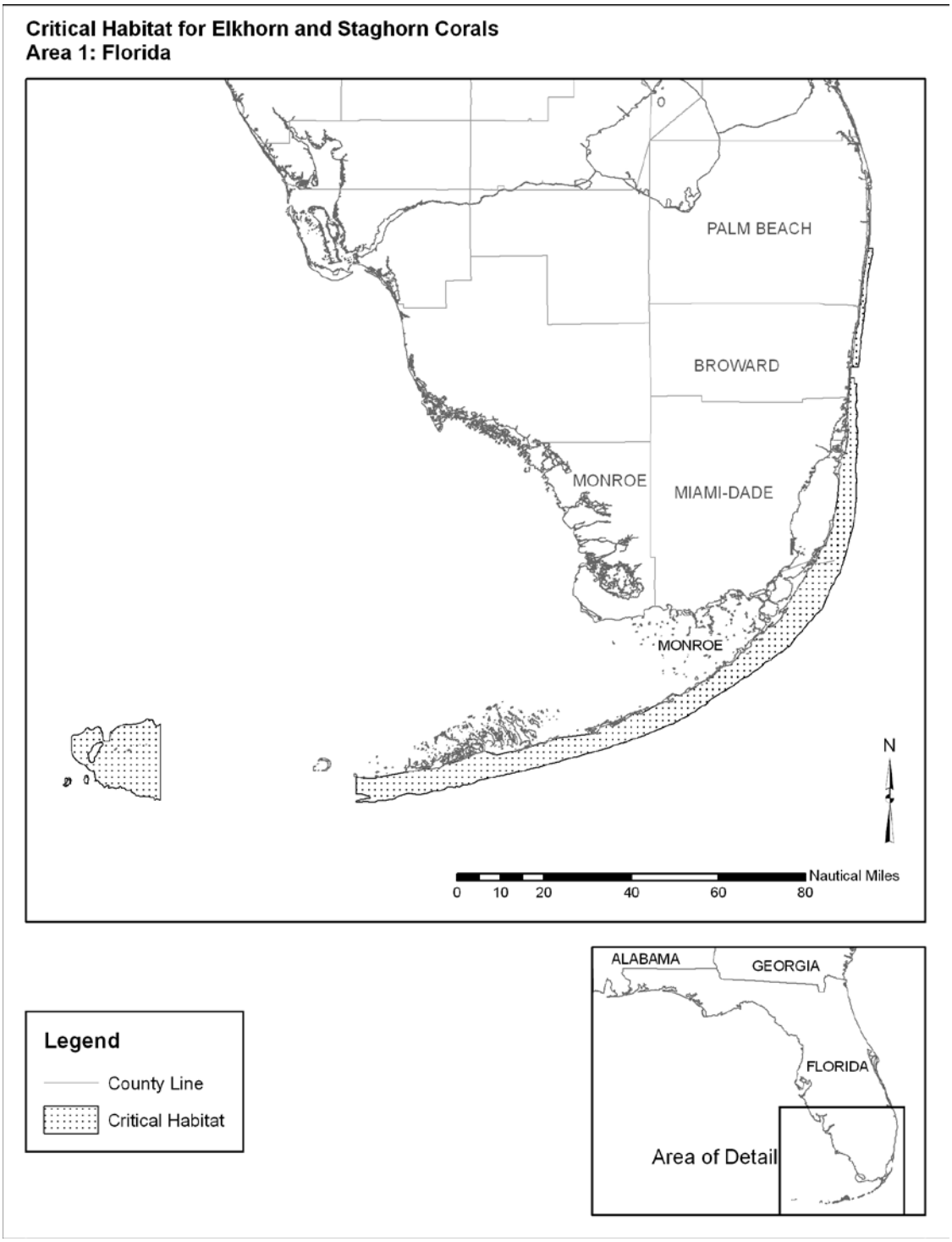

Figure 10. Florida unit designated critical habitat for *Acropora cervicornis* and *Acropora palmata* (50 CFR Parts 223 and 226 Endangered and Threatened Species; Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule)

4.2.4 Johnson's Seagrass

Johnson's seagrass is the first marine plant ever listed under the ESA. It was listed as "threatened" on September 14, 1998, based on the results of fieldwork and a status review

initiated in 1990. Kenworthy (1993, 1997, 1999) and NMFS (2007) discuss the field study results and summarize an extensive literature review on the status of Johnson's seagrass. In addition to the published literature, the Johnson's Seagrass Recovery Implementation Team (Recovery Team) is currently updating the 2002 Recovery Plan for Johnson's Seagrass. The updated Recovery Plan is in review, but much of the information contained in this opinion that updates our knowledge of the status of and threats to the species, life history information, and cumulative impacts, comes from talks with Dr. W. Judson Kenworthy (Team Leader) and other NMFS members of the Recovery Team, and from their review of sections of the updated Recovery Plan. That information is attributed throughout this opinion to the Recovery Team. The following discussion summarizes those findings relevant to our evaluation of the proposed action.

Life History and Population Biology

Based on the current knowledge of the species, Johnson's seagrass reproduction is believed to be entirely asexual, and dispersal is by vegetative fragmentation. Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found, although dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds either in the field or under laboratory conditions (Jewett-Smith et al. 1997, Hammerstrom and Kenworthy 2002, NMFS 2007). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting either that the species does not reproduce sexually or that the male flowers are difficult to observe or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean.

Throughout its range, Johnson's seagrass occurs in dynamic and disjunctive patches. It spreads rapidly, growing horizontally from dense apical meristems with leaf pairs having short life spans (Kenworthy 1997). Kenworthy suggested that the observed horizontal spreading, rapid growth patterns, and high biomass turnover could explain the dynamic patches observed in distribution studies of this species. While patches may colonize quickly, they may also disappear rapidly. Sometimes they will disappear for several years and then re-establish, a process referred to as "pulsating patches" (Heidelbaugh et al. 2000, Virnstein and Morris 2007, Virnstein et al. 2009). Mortality, or the disappearance of patches, can be caused by a number of processes, including burial from bioturbation and sediment deposition (Heidelbaugh et al. 2000), erosion, herbivory, desiccation, and turbidity. In the absence of sexual reproduction, one possible explanation for the pulsating patches is dispersal and reestablishment of vegetative fragments, a process that commonly occurs in aquatic plants and has been demonstrated in other seagrasses (Philbrick and Les 1996, DiCarlo et al. 2005), and was also recently confirmed by experimental mesocosm studies with Johnson's seagrass (Hall et al. 2006).

Johnson's seagrass is a shallow-rooted species and vulnerable to uprooting by wind, waves, storm events, tidal currents, bioturbation, and motor vessels. It is also vulnerable to burial by sand movement and siltation (Heidelbaugh et al. 2000). Having a canopy of only 2-5 cm, it may be easily covered by sediments transported during storms or redistributed by macrofaunal bioturbation during the feeding activities of benthic organisms. Mesocosm experiments indicate that clonal fragments can only survive burial for up to a period of 12 days (W.J. Kenworthy, CCFHR, NOAA, Beaufort, North Carolina, unpublished). Mechanisms capable of disturbing

patches may create clonal fragments that become dispersed. Hall et al. (2006) showed that drifting fragments of Johnson's seagrass can remain viable for 4 to 8 days, during which time they can settle, root, and grow. The process of asexual fragmentation can occur year-round. Fragments could drift several kilometers under the influence of wind and tidally- driven circulation, providing potential recruits for dispersal and new patch formation. In the absence of sexual reproduction, these are likely to be the most common forms of dispersal and patch maintenance.

Population Status and Distribution

Johnson's seagrass occurs in a variety of habitat types, including on intertidal wave-washed sandy shoals, on flood deltas near inlets, in deep water, in soft mud, and near the mouths of canals and rivers, where presumably water quality is sometimes poor and where salinity fluctuates widely. It is an opportunistic plant that occurs in a patchy, disjunctive distribution from the intertidal zone to depths of approximately 2-3 meters in a wide range of sediment types, salinities, and in variable water quality conditions (NMFS 2007).

Johnson's seagrass exhibits a narrow geographical range of distribution and has only been found growing along approximately 200 kilometers (km) of coastline in southeastern Florida north of Sebastian Inlet, Indian River County, south to Virginia Key in northern Biscayne Bay, Miami-Dade County. This apparent endemism suggests that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world. Kenworthy (1997, 1999) confirmed its limited geographic distribution in patchy and vertically disjunctive areas throughout its range. Since the last status review (NMFS 2007), there have not been any reported reductions in the geographic range of the species. In fact, the St. Johns River Water Management District (SJRWMD) observed Johnson's seagrass approximately 21 km north of the Sebastian Inlet mouth on the western shore of the Indian River Lagoon – a discovery that slightly extends the species' known northern range (Virnstein and Hall 2009).

Two survey programs regularly monitor the presence and abundance of Johnson's seagrass within this range. One program, conducted by the SJRWMD since 1994, covers the northern section of the species' geographic range between Sebastian Inlet and Jupiter Inlet (Virnstein and Morris 2007, Virnstein et al. 2009). The second recently initiated survey (2006) is of the southern range of the species between Jupiter Inlet and Virginia Key in Biscayne Bay (Kunzelman 2007). Johnson's seagrass is a perennial species (meaning it lasts for greater than 2 growing seasons), showing no consistent seasonal or year-to-year pattern based on the northern transect surveys, but has exhibited some winter decline (NMFS 2007). However, during exceptionally mild winters, Johnson's seagrass can maintain or even increase in abundance from summer to winter. In the surveys conducted between 1994 and 2007, it occurred in 7.1% of the 1-m^2 quadrats in the northern range. Depth of occurrence within these surveys ranged from 0.03 to 2.5 m. Where it does occur, its distribution is patchy, both spatially and temporally. It frequently disappeared from transects only to reappear several months or several years later (NMFS 2007).

Based on the results of the southern transect sampling, it appears there is a relatively continuous, although patchy, distribution of the species from Jupiter Inlet to Virginia Key (NMFS 2007). The largest reported contiguous patch of Johnson's seagrass in the southern range was observed

in Lake Worth Lagoon and was estimated to be 30 acres (Kenworthy 1997). Eiseman and McMillan (1980) documented Johnson's seagrass in the vicinity of Virginia Key (latitude 25.75° N); this location is considered to be the southern limit of the species' range. There have been no reports of this species farther south of the currently known southern distribution. The presence of Johnson's seagrass in northern Biscayne Bay (north of Virginia Key) is well documented. In addition to localized surveys, the presence of Johnson's seagrass has been documented by various field experiences and observations of the area by federal, state, and county entities. Johnson's seagrass has been documented in various USACE and USCG permit applications reviewed by NMFS. Findings from the southern transect sampling (summer 2006 and winter 2007) show little difference in the species' frequency or abundance between the summer and winter sampling period. The lower frequencies of Johnson's seagrass occurred at those sites where larger-bodied seagrasses (e.g., *Thalassia testudinum* [turtle grass] and *Syringodium filiforme* [manatee grass]) were more abundant (NMFS 2007). The southern range transect data support some of the conclusions drawn from previous studies and other surveys. This is a rare species; however, it can be found in relatively high abundance where it does occur. Based on the results of the southern transect sampling, it appears that, although it is disjunctively distributed and patchy, there is some continuity in the southern distribution, at least during periods of relatively good environmental conditions and no significant large-scale disturbances (NMFS 2007).

Information on the species' distribution and results of limited experimental work suggest that Johnson's seagrass has a wider tolerance range for salinity, temperature, and optical water quality conditions than other species such as paddle grass, *Halophila decipiens* (Dawes et al. 1989, Kenworthy and Haunert 1991, Gallegos and Kenworthy 1996, Kenworthy and Fonseca 1996, Durako et al. 2003, Kunzelman et al. 2005, Torquemada et al. 2005). Johnson's seagrass has been observed near the mouths of freshwater discharge canals (Gallegos and Kenworthy 1996), in deeper turbid waters of the interior portion of the Indian River Lagoon (Kenworthy 2000, Virnstein and Morris 2007), and in clear water associated with the high energy environments and flood deltas inside ocean inlets (Kenworthy 1993, 1997; Virnstein et al. 1997; Heidelbaugh et al. 2000; Virnstein and Morris 2007). It can colonize and persist in high- tidal-energy environments and has been observed where tidal velocities approach the threshold of motion for unconsolidated sediments (35-40 cm s^{-1}). The persistent presence of high-density, elevated patches of Johnson's seagrass on flood tidal deltas near inlets suggests that it is capable of sediment stabilization. Intertidal populations of Johnson's seagrass may be completely exposed at low tides, suggesting high tolerance to desiccation and wide temperature tolerance.

In Virnstein's study areas within the Indian River Lagoon, Johnson's seagrass was found associated with other seagrass species or growing alone in the intertidal, and, more commonly, at the deep edge of some transects in water depths down to 180 cm. In areas in which long-term poor water and sediment quality have existed until recently, Johnson's seagrass appears to occur in relatively higher abundance, perhaps due to the inability of the larger species to thrive. Johnson's seagrass appears to be out-competed in seagrass habitats where environmental conditions permit the larger seagrass species to thrive (Virnstein et al. 1997, Kenworthy 1997). When the larger, canopy-forming species are absent, Johnson's seagrass can grow throughout the full seagrass depth range of the Indian River Lagoon (NMFS 2007, Virnstein et al. 2009).

Observations by researchers have suggested that Johnson's seagrass exploits unstable environments or newly-created un-vegetated patches by exhibiting fast-growth and support for all local ramets in order to exploit areas in which it could not otherwise compete. It may quickly recruit to locally uninhabited patches through prolific lateral branching and fast horizontal growth. While these attributes may allow it to compete effectively in periodically disturbed areas, if the distribution of this species becomes limited to stable areas it may eventually be out-competed by more stable-selected plants represented by the larger-bodied seagrasses (Durako et al. 2003). In addition, the physiological attributes of Johnson's seagrass may limit growth (i.e., spreading) over large areas of substrate if the substrate is somehow altered (e.g., dredged to a depth that would preclude future recruitment of Johnson's seagrass); therefore, its ability to recover from widespread habitat loss may be limited. The clonal and reproductive growth characteristics of Johnson's seagrass result in its distribution being patchy, noncontiguous, and temporally fluctuating. These attributes suggest that colonization between broadly disjunctive areas is likely difficult and that the species' risk of extinction may be increased if it is removed from large areas within its range by natural or anthropogenic means.

Threats

The emerging consensus among seagrass experts on the Recovery Team is that the possibility of mortality due to reduced salinity over long periods of time is the most clearly identified threat to the species' long-term persistence. Some studies have shown that Johnson's seagrass has a wide tolerance for salinity. However, short-term experiments have shown reduced photosynthesis and increased mortality at low salinities (<10 psu [practical salinity units=parts per thousand]). Longer duration mesocosm experiments have resulted in 100% mortality of Johnson's seagrass after 10 days at salinities <10 psu (Kahn and Durako 2008). The Recovery Team has recently determined that the most significant threat to the species is the present or threatened destruction, modification or curtailment of its habitat or range through water management practices and stochastic environmental factors which can alter the salinity of its habitat. Given that it is not uncommon for salinities to decline below 15-20 psu in its range (Steward et al. 2006), and that a number of natural and human-related factors can affect salinity throughout its range, the Recovery Team identified reduced salinity as a potentially significant threat to the species because the potential for long-term mortality over a large scale could counteract the life history strategy the species uses to persist in the face of numerous, ongoing environmental impacts. In previous reviews, including the critical habitat listing rule and the 2002 Recovery Plan, several additional factors were considered threats, including: (1) dredging and filling, (2) construction and shading from in- and over-water structures, (3) propeller scarring and anchor mooring, (4) trampling, (5) storms, and (6) siltation. In reviewing all information available since the original listing, the Recovery Team conducted assessments of each of these factors and has been unable to confirm that any of these poses a significant threat to the persistence and recovery of the species. A brief discussion of these factors follows.

Routine maintenance dredging associated with the constant movement of sediments in and around inlets may affect seagrasses by direct removal, light limitation due to turbidity, and burial from sedimentation. The disturbance of sediments can also destabilize the benthic community. Altering benthic topography or burying the plants may remove them from the photic zone. Permitted dredging of channels, basins, and other in- and on-water construction projects cause loss of Johnson's seagrass and its habitat through direct removal of the plants, fragmentation of

habitat, shading, turbidity, and sedimentation. Although dredge and fill activities can and do adversely affect Johnson's seagrass and its designated critical habitat, federal, state, and local permitting programs closely scrutinize these activities and the construction of in- and over-water structures. The USACE, under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, has federal authority over the issuance of dredge-and-fill permits. This permitting process includes language to protect and conserve seagrasses through field evaluations, consultations, and recommendations to avoid, minimize, and mitigate for impacts to seagrasses.

Height, width, and orientation have been identified as the 3 most important factors affecting seagrass growth and abundance under and around over-water structures (Burdick and Short 1999, Beal and Schmit 2000). Landry et al. (2008) stated there is a compelling argument supporting prior studies that indicate that docks can have negative impacts on seagrasses by reducing their abundance and in some cases, preventing seagrass from growing. Their study found evidence that all species of seagrass were impacted by docks. However, they found that although it is reduced in frequency under grated docks, Johnson's seagrass was observed in higher densities under the grated docks compared to non-grated docks. Furthermore, their results suggest that Johnson's seagrass does benefit from the light-transmitting characteristics of grated decking. Landry et al. (2008) found that grated docks were more similar to the adjacent and the reference transects (for seagrass) than non-grated docks. This suggests that while both grated and non-grated docks can have detrimental effects on seagrass beds, grated docks are relatively less detrimental to seagrass beds than non-grated docks. Given the supporting experimental evidence that fiberglass grating does improve the incident solar radiation penetrating under structures (Shafer and Robinson 2001), continuing to require grated decking will benefit most seagrasses. Landry et al. (2008) recommend that grated decking should be used for any dock construction to take place over seagrasses, most importantly Johnson's seagrass.

In the results from their study evaluating the regulatory construction guidelines to minimize impacts to seagrasses from single-family residential dock structures in Florida and Puerto Rico, Shafer et al. (2008) emphasized avoidance of seagrasses as a first priority. Avoidance may be achieved by relocating or realigning the structure. It is important to note that Shafer et al. (2008) observed that in the majority of cases, permit applicants and regulatory agencies are, when practicable, generally succeeding in avoiding seagrass impacts by extending the length of the access walkway so that the terminal platform is constructed in deep water that is not conducive to seagrass growth. If avoidance is not possible, Shafer et al. (2008) recommend revising the USACE-NMFS dock construction guidelines to prioritize dock orientation (in a north-south direction) and height (minimum of 5 ft above mean high water) as the most important specifications for the survivorship of seagrasses under docks.

Most dock construction is subject to the construction guidelines (i.e., the USACE and NMFS jointly developed *Key for Construction Conditions for Docks or Other Minor Structures Constructed in or over Johnson's Seagrass* ("Johnsons seagrass key"), dated October 2002 and the associated publication, *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation, Marsh, or Mangrove Habitat* ("dock construction guidelines"), dated August 2001. Some docks meeting certain provisions, are exempt from state permitting

(http://www.dep.state.fl.us/central/Home/SLERP/Docks/sfdock.pdf) and contribute to loss of Johnson's seagrass through construction impacts and shading.

The USACE's State (Florida) Programmatic General Permit Program (SPGP IV-R1) authorizes permits for in-water construction activities that include: shoreline stabilization projects; construction of boat ramps, boat launch areas and structures associated with such ramps or launch areas; docks, pier associated facilities, and other minor piling-supported structures, and; maintenance dredging of canals and channels. An increasing number of docks in Florida are now permitted through the SPGP. From January 1, 2000-March 31, 2009, the SPGP was utilized 19,927 times of which 52% of this total was for single-family docks. The SPGP does not allow construction in Johnson's seagrass critical habitat. For a dock to be authorized under the SPGP, the applicant must fully comply with the *Johnson's Seagrass Key* and the associated *Dock Construction Guidelines*. Additional project design criteria apply to the SPGP (e.g., docks must be ≤ 1000 sq ft). Similarly, the USACE's SAJ-42 permit allows Miami-Dade County to authorize permits for minor dredging and construction projects within the county. The projects authorized under the SAJ-42 permit must comply with *"Johnson's Seagrass Key"* and the associated *"Dock Construction Guidelines*." No docks were authorized from April 2006 to April 2011 inside of Johnson's seagrass critical habitat outside of Miami-Dade County and only 8 dock/pier projects were authorized in counties within JSG range, but outside of critical habitat (Broward County = 3, Palm Beach County = 3, and 2 in Martin County). Lastly, NMFS recently completed a programmatic consultation on 12 SAJ general permits. The 12 SAJ consultation is for the entire state of Florida, and covered permits issued by the USACE authorize small maintenance dredging, private single-family boat ramps, aerial transmission lines, other minor structures, single-family docks, private multi-family docks, commercial docks, and bulkheads and backfills as long as they meet certain size requirements and limitations on construction methodology.

The Recovery Team has identified weaknesses in the oversight practices of state and federal agencies in the permitting process for some or all of the activities discussed above, due to budget, staffing, and technological limitations. The need for post-construction permit compliance and enforcement for dock structures in Florida and Puerto Rico has been discussed in Shafer et al. (2008). The Recovery Team also identified difficulties in monitoring a rare and patchily-distributed species in single-event surveys associated with permit applications and continues to work with collaborators to improve monitoring methods. The Recovery Team has worked with NMFS's Protected Resources and Habitat Conservation staff to develop and improve guidelines for site monitoring methods (Greening and Holland 2003), dock construction guidelines (NMFS and USACE 2002, Shafer et al. 2008), and best management practices to minimize the impact of docks on Johnson's seagrass (Landry et al. 2008). While it is recognized that dredging and filling and construction and shading from in- and over-water structures can adversely affect Johnson's seagrass and its habitat, the Recovery Team determined that these activities are typically local and small-scale and the deficiencies in the permitting process were not presently a significant threat to the survival of Johnson's seagrass because they will not individually or cumulatively result in long-term, large-scale mortality of Johnson's seagrass, and preclude the species from its strategy of recolonizing areas.

Propeller scarring and improper anchoring are known to adversely affect seagrasses (Sargent et al. 1995, Kenworthy et al. 2002). These activities can severely disrupt the benthic habitat by

uprooting plants, severing rhizomes, destabilizing sediments, and significantly reducing the viability of the seagrass community. Propeller dredging and improper anchoring in shallow areas are a major disturbance to even the most robust seagrasses. This destruction is expected to worsen with the predicted increase in boating activity within Florida. The Florida Department of Motor Vehicles reported a total of 1,027,043 registered commercial and recreational vessels statewide in 2007, a peak after years of growth. Registrations declined slightly subsequently, likely due to the economic downturn, to 982,470 in 2009 (DHSMV 2010). This number is likely to increase based on Florida's projected population growth of 18 million in 2006 to 25 million in 2025 (http://www.propertytaxform.state.fl/docs/eo06141.pdf). An increase in the number of registered vessels will likely lead to an increase in adverse effects to seagrasses caused by propeller dredging/scarring. Other indirect effects associated with motor vessels include turbidity from operating in shallow water, dock construction and maintenance, marina expansion, and inlet maintenance dredging. These activities and impacts are also likely to increase (NMFS 2007). Damage to seagrasses from propeller scarring and improper anchoring by motor vessels is recognized as a significant resource management problem in Florida (Sargent et al. 1995). A number of local, state, and federal statutes protect seagrasses from damage due to vessel impacts, and a number of conservation measures, including the designation of vessel control zones, signage, mooring fields, and public awareness campaigns, are directed at minimizing vessel damage to seagrasses. Despite these efforts, vessel damage can have significant local and small-scale (1 m^2 to 100 m^2) impacts on seagrasses (Kirsch et al. 2005), but there is no direct evidence that these small-scale local effects are so widespread that they are a threat to the persistence and recovery of Johnson's seagrass.

Trampling of seagrass beds, a secondary effect of recreational boating, also disturbs seagrass habitat, but is a lesser concern. Trampling damages seagrasses by pushing leaves into the sediment and crushing or breaking the leaves and rhizomes. Since the designation of critical habitat, however, there have been no documented observations or reports of damage by trampling, and if there was, it would be small-scale and local. Therefore, the Recovery Team determined that trampling does not constitute a significant threat to the survival or recovery of Johnson's seagrass.

Large-scale weather events, such as tropical storms and hurricanes, while they often generate runoff conditions that decrease water quality, they also produce conditions (wind setup and abrupt water elevation changes) that can increase flushing rates. The effects of storms can be complex. Specifically documented storm effects on seagrasses include: (1) scouring and erosion of sediments, (2) erosion of seeds and plants by waves, currents, and surge, (3) burial by shifting sand, (4) turbidity, and (5) discharge of freshwater, including inorganic and organic constituents in the effluents (Steward et al. 2006). Storm effects may be chronic, e.g., due to seasonal weather cycles, or acute, such as the effects of strong thunderstorms or tropical cyclones. Studies have demonstrated that healthy, intact seagrass meadows are generally resistant to physical degradation from severe storms, whereas damaged seagrass beds may not be as resilient (Fonseca et al. 2000, Whitfield et al. 2002). In the late summer and early fall of 2004, 4 hurricanes passed directly over the northern range of Johnson's seagrass in the Indian River Lagoon. A post-hurricane random survey in the area of the Indian River Lagoon affected by the 4 hurricanes indicated the presence of Johnson's seagrass was similar to that reported by the SJRWMD transect surveys prior to the storms. This indicates that while the species may

temporarily decline, under the right conditions it can return quickly (Virnstein and Morris 2007). Furthermore, despite evidence of longer-term reductions in salinity, increased water turbidity, and increased water color associated with higher than average precipitation in the spring of 2005, there was no evidence of long-term chronic impacts to seagrasses and no direct evidence of damage to Johnson's seagrass that could be considered a threat to the survival of the species (Steward et al. 2006).

Silt derived from adjacent land and shoreline erosion, river and canal discharges, inlets, and internally re-suspended materials can lead to the accumulation of material on plant leaves causing light deprivation. Deposition of silt can also lead to the burial of plants, accumulation of organic matter, and anoxic sediments. Johnson's seagrass grows in a wide range of environments, including those that are exposed to siltation from all the potential sources. Documentation of the direct effects of siltation on seagrasses are generally unavailable. The absence of seagrass has been associated with the formation of muck deposits, however, and localized areas of flocculent, anoxic sediments in isolated basins and segments of the Indian River Lagoon have been observed. Furthermore, sustained siltation experimentally simulated by complete burial for at least 12 days may cause mortality of Johnson's seagrass (W.J. Kenworthy, CCFHR, NOS, Beaufort, North Carolina, unpublished data). In general, the effects of siltation are localized and not widespread and are not likely to threaten the survival of the species.

In addition to the 6 factors discussed above, we also consider the effects of altered water quality on Johnson's seagrass. Availability of light is one of the most significant environmental factors affecting the survival, growth, and distribution of seagrasses (Bulthuis 1983, Dennison 1987, Abal et al. 1994, Kenworthy and Fonseca 1996). Water quality and the penetration of light are affected by turbidity (suspended solids), color, nutrients, and chlorophyll, and are major factors controlling the distribution and abundance of seagrasses (Dennison et al. 1993, Kenworthy and Haunert 1991, Kenworthy and Fonseca 1996). Increases in color and turbidity values throughout the range of Johnson's seagrass are generally caused by high flows of freshwater discharged from water management canals, which can also reduce salinity. Wastewater and stormwater discharges, as well as from land runoff and subterranean sources, are also causes of increased turbidity. Degradation of water quality due to increased land use and poor water management practices continues to threaten the welfare of seagrass communities. Declines in water quality are likely to worsen, unless water management and land use practices can curb or eliminate freshwater discharges and minimize inputs of sediments and nutrients. A nutrient-rich environment caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural runoff stimulates increased algal growth that may smother or shade Johnson's seagrass, or shade rooted vegetation, and diminish the oxygen content of the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities.

Based on a Trophic State Index of ambient water quality obtained in the northern and central region of Johnson's seagrass geographic range provided in a long-term monitoring program implemented by the SJRWMD, overall estuarine water quality was assessed as mostly good (67%) (Winkler and Ceric 2006). Only 28% of the stations sampled had fair water quality, while 6% had poor quality. 50% of the sampled estuarine sites were improving, while 6% were degrading, so many more sites were improving than were degrading. Forty-two percent of the lagoon sites had an insignificant trend while 3% had insufficient data to determine a trend. As

water management experts have now become confident in the association between water quality and seagrass depth distribution, they have begun establishing water quality targets for the Indian River Lagoon based on seagrass as an indicator (Steward et al. 2005). There is a strong positive correlation between seagrass depth distribution and water quality which enables managers to predict where seagrasses will grow based on water quality and the availability of light. Given that at least half of the sampling stations were indicating long-term improvements in water quality, it can be assumed that seagrass abundance should not be negatively impacted if water and land use management programs continue to be effective. For example, carefully controlling or reducing water flows from discharge canals will moderate salinity fluctuations and reduce turbidity, color, and light attenuation values.

There has not been a comprehensive assessment of water quality published or reported for the southern range of Johnson's seagrass similar to the SJRWMD study. However, the South Florida Water Management District (SFWMD) is working to synthesize water quality information and to gain a more comprehensive understanding of the long-term status and trends of water quality in the southern range of Johnson's seagrass. Of particular concern is an assessment of the impacts of fluctuations in water quality corresponding with variation in climatology, especially "wet years" versus "dry years" variation. Future recovery efforts should include close coordination with the SFWMD and county environmental management agencies in Palm Beach and Dade counties to evaluate the status and trends of water quality in these regions of the species' distribution.

Here, we consider the possible effects of climate change (i.e., rising temperatures and sea levels) on seagrasses in general and on Johnson's seagrass in particular. The earth is projected to warm between 2°-4°C by 2100, and similar projections have been made for marine systems (Sheppard and Rioja-Nieto 2005). At the margins of temperate and tropical bioregions and within tidally-restricted areas where seagrasses are growing at their physiological limits, increased temperatures may result in losses of seagrasses and/or shifts in species composition (Short et al. 2007). The response of seagrasses to increased water temperatures will depend on the thermal tolerance of the different species and their optimum temperature for photosynthesis, respiration, and growth (Short and Neckles 1998). With future climate change and potentially warmer temperatures, there may be a 1-5 m rise in the seawater levels by 2100 when taking into account the thermal expansion of ocean water and melting of glaciers. Rising sea levels may adversely impact seagrass communities due to increases in water depths above present meadows reducing available light. Climate change may also reduce light by shifting weather patterns to cause increased cloudiness. Changing currents may cause erosion and increased turbidity and seawater intrusions higher up on land or into estuaries and rivers, which could increase landward seagrass colonization (Short and Neckles 1998). A landward migration of seagrasses with rising sea levels is a potential benefit, so long as suitable substrate is available for colonization.

It is uncertain how Johnson's seagrass will adapt to rising sea levels and temperatures. Much depends on how much temperatures increase and how quickly. For example, Johnson's seagrass that grows intertidally (e.g., in some parts of the Lake Worth Lagoon) may be affected by a slight change in temperature (since it may already be surviving under less than optimal conditions); however, this may be ameliorated with rising sea levels, assuming Johnson's seagrass would migrate landward with rising sea levels and assuming that suitable substrate would be available

for a landward migration. However, rising sea levels could also adversely impact seagrass communities due to increases in water depths above present meadows reducing available light.

Reduction in light availability may benefit some seagrass species (e.g., *Halophila* species that require less light compared to the larger, canopy-forming species); therefore, much depends on the thermal tolerance of the different seagrass species and their optimum temperature for photosynthesis, respiration, and growth (Short and Neckles 1998). While sea level has changed many times during the evolutionary history of Johnson's seagrass, it is uncertain how this species will fare when considering the combined effects of rising temperatures and sea levels (in conjunction with other stressors, such as reduced salinity from freshwater runoff). It has been shown that evolutionary change in a species can occur within a few generations (Rice and Emery 2003), thus making it possible for seagrasses to cope if the changes occur at a rate slow enough to allow for adaptation.

Status Summary

Based on the results of 14 years of monitoring in the species' northern range (1994-2007) and 3 years of monitoring in the species' southern range (2006-2009), there has been no significant change in the northern or southern range limits of Johnson's seagrass (NMFS 2007). It appears that the populations in the northern range are stable and capable of sustaining themselves despite stochastic events related to severe storms (Steward et al. 2006) and fluctuating climatology. Longer-term monitoring data is needed to confirm the stability of the southern distribution of the species (NMFS 2007). Larger seagrasses, predominantly turtle grass (*Thalassia testudinum*), begin to out-compete Johnson's seagrass in this area. While there has been a slight extension in the known northern range (Virnstein and Hall 2009), the limits of the southern range appear to be stable (Latitude 25.75ºN in the vicinity of Virginia Key). There have been no reports of this species farther south of the currently known southern distribution.

As discussed in the Threats section, NMFS has determined that the most clearly identified threat to date is the possibility of mortality due to reduced salinity over long periods of time. The other potential threats discussed above (i.e., dredging/filling, construction and shading from in and over-water structures, propeller scarring and anchor mooring, trampling, storms, and siltation) were determined to be generally local and small-scale and are not considered threats to the survival and recovery of the species (NMFS 2007). It is uncertain how Johnson's seagrass and other seagrass species will fare due to the synergistic effects of rising temperatures and sea levels (in combination with other stressors, such as reduced salinity from freshwater runoff). It has been shown that evolutionary change in a species can occur within a few generations (Rice and Emery 2003), thus making it possible for seagrasses to cope if the changes occur at a rate slow enough to allow for adaptation.

5 Environmental Baseline

This section is a description 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

ecosystem, within the action area.[8] The environmental baseline is a "snapshot" of a species' health at a specified point in time. It does not include the effects of the action under review in the 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. 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 action 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.

5.1 Sea Turtles

5.1.1 Status of Sea Turtles within the Action Area

Green and loggerhead sea turtles occur in the action area and may be adversely affected by the project. The action area does not include any nesting beach, important foraging habitat (e.g. nearshore hardbottom), or known breeding habitat. Sea turtles found in the immediate project area may travel widely throughout the Atlantic, Gulf of Mexico, and Caribbean Sea, and individuals found in the action area can potentially be affected by activities anywhere within this wide range. These impacts outside of the action area are discussed and incorporated as part of the overall status of the species as detailed in Section 3 above. Sea turtles that occur in the action area are highly migratory, as are all sea turtles species worldwide. For the species that are globally listed, the status of these species in the Atlantic (see Section 4) most accurately reflects the species' status within the action area. In Section 4, we presented available information on sea turtle population abundance and trends by species. The action area does not contain any important developmental habitat (e.g. nearshore hardbottom) and it is not near any nesting beaches.

5.1.2 Factors Affecting Sea Turtles in the Action Area

[8] The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02).

NMFS has completed a number of Section 7 consultations to address the effects of federally-permitted fisheries and other federal actions on threatened and endangered sea turtle species, and when appropriate, has authorized the incidental taking of these species. Each of those consultations sought to minimize the adverse impacts of the action on sea turtles. NMFS has undertaken conservation actions under the ESA to address sea turtle takes in the fishing and shipping industries and other activities such as USACE dredging operations. The summary below of federal actions and the effects these actions have had or are having on sea turtles includes only those federal actions in, or with effects within, the action area that have already concluded or are currently undergoing formal Section 7 consultation.

Federal Vessel Activity and Operations

Potential sources of adverse effects from federal vessel operations in the action area include operations of the USN and USCG. NMFS has conducted formal consultations with the USCG and the USN on their vessel operations. Through the Section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. Refer to the biological opinions for the USCG (NMFS 1995) and the USN (NMFS 1996, 1997a) for details on the scope of vessel operations for these agencies and conservation measures being implemented as standard operating procedures.

Dredging

The construction and maintenance of federal navigation channels and sand mining sites ("borrow areas") conducted by the USACE has been identified as a source of sea turtle mortality. Hopper dredges in the dredging mode are capable of moving relatively quickly, compared to sea turtle swimming speeds and can thus overtake, entrain, and kill sea turtles as the suction draghead of the advancing dredge overtakes the resting or swimming turtle. Entrained sea turtles rarely survive. NMFS completed a regional biological opinion on the impacts of USACE's South Atlantic coast hopper-dredging operations in 1997 for dredging in the USACE's South Atlantic Division (NMFS 1997b). The regional biological opinion on South Atlantic hopper dredging (SARBO) of navigational channels and borrow areas determined that hopper dredging would not adversely affect leatherback sea turtles in the South Atlantic Division (i.e., coastal states of North Carolina through Key West, Florida). The opinion did determine hopper dredging in the South Atlantic Division would adversely affect 4 sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads) but would not jeopardize their continued existence. An ITS for those species was issued. Reinitiation of consultation on the SARBO has been triggered for a number of reasons, including listing of new species and designation of critical habitat that may be affected by these dredging activities.

ESA Permits

Sea turtles are the focus of research activities authorized by Section 10 permits under the ESA. Regulations developed under the ESA allow for the issuance of permits allowing take of certain ESA-listed species for the purposes of scientific research under Section 10(a)(1)(a) of the ESA. Authorized activities range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, to blood sampling, tissue sampling (biopsy), and performing laparoscopy on intentionally captured sea turtles. The number of authorized takes varies widely depending on the research and species involved, but may involve the taking of hundreds of sea turtles annually.

Most takes authorized under these permits are expected to be (and are) nonlethal, although lethal takes are sometimes authorized. Before any research permit is issued, the proposal must be reviewed under the permit regulations. In addition, since issuance of the permit is a federal activity, issuance of the permit by NMFS must also be reviewed for compliance with Section 7(a)(2) of the ESA to ensure that issuance of the permit does not result in jeopardy to the species or adverse modification of its critical habitat.

Federally-Managed Fisheries

Threatened and endangered sea turtles are adversely affected by fishing gears used throughout the continental shelf of the action area. Hook-and-line gear, trawl, and pot fisheries have all been documented as interacting with sea turtles.

For all fisheries for which there is a Fishery Management Plan (FMP) or for which any federal action is taken to manage that fishery, impacts have been evaluated under Section 7.

Finfish Fisheries

Adverse effects on threatened and endangered species from several types of fishing gear occur in the action area of the proposed action. Efforts to reduce the adverse effects of commercial fisheries are addressed through the ESA Section 7 process. Trawl, hook-and-line, gillnet, and cast net gear fisheries have all been documented as interacting with sea turtles. Several formal consultations have been conducted on the following fisheries that NMFS has determined are likely to adversely affect threatened and endangered species (including sea turtles): the South Atlantic and Gulf of Mexico coastal migratory pelagic fishery, and the Atlantic Highly Migratory Species shark fishery. An Incidental Take Statement (ITS) has been issued for interactions with sea turtles in each of these fisheries.

NMFS completed a Section 7 consultation on the continued authorization of the coastal migratory pelagic fishery in the South Atlantic (NMFS 2007c) where hook-and-line, gillnet, and cast net gears are used. The recreational sector uses hook-and- line gear. The hook-and-line effort is primarily trolling. The biological opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by operation of the fishery.

In 2012, NMFS issued a biological opinion on the continued authorization of Highly Migratory Species Atlantic shark fisheries (NMFS 2012). This commercial fishery uses bottom longline and gillnet gear. The recreational sector of the fishery uses only hook-and-line gear. To protect declining shark stocks, the proposed action seeks to greatly reduce the fishing effort in the commercial component of the fishery. These reductions are likely to greatly reduce the interactions between the commercial component of the fishery and sea turtles. The biological opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by operation of the fishery but that the proposed action was not expected to jeopardize the continued existence of any of these species.

Southeastern Shrimp Trawl Fisheries
Southeast U.S. shrimp fisheries target primarily brown, white, and pink shrimp in inland waters and estuaries through the state-regulated territorial seas and in federal waters of the EEZ. As sea turtles rest, forage, or swim on or near the bottom, they are captured by shrimp trawls pulled along the bottom. In 1990, the National Research Council (NRC) concluded that the Southeast shrimp trawl fisheries affected more sea turtles than all other activities combined and was the most significant anthropogenic source of sea turtle mortality in the U.S. waters, in part due to the high reproductive value of turtles taken in this fishery (NRC 1990).

On May 9, 2012, NMFS completed a Biological Opinion that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act (NMFS 2012). The Opinion also considered a proposed amendment to the sea turtle conservation regulations that would withdraw the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*) for skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) and instead require all of these vessels to use TEDs. The Opinion concluded that the proposed action would not jeopardize the continued existence of any sea turtle species. An ITS was provided that used trawl effort and capture rates as proxies for sea turtle take levels. The Biological Opinion requires NMFS to minimize the impacts of incidental takes through monitoring of shrimp effort and regulatory compliance levels, conducting TED training and outreach, and continuing to research the effects of shrimp trawling on listed species. Consultation for this fishery has recently been reinitiated.

Beach Nourishment
The USACE issues Clean Water Act permits for disposal of material in navigable waters of the United States, including beach nourishment. The activity of beach nourishment, especially when impacts include the loss of nearshore hardbottom habitat along the east coast of Florida, has been documented to result in injury and death of juvenile green sea turtles. Juvenile green turtles are known to utilize these high-energy, dynamic habitats for foraging and as refuge, and show a preference for this habitat even when abundant deeper-water sites are available. The loss of such limited habitat, especially when considering the cumulative loss as a result of beach nourishment activities occurring along the entire range of the habitat and continually over time, is expected to result in loss of foraging opportunities and protective refuge. The stresses are also expected to contribute to mortality of individuals already in poor condition as a result of disease or other factors (NMFS 2008a). Beach nourishment permitted by the USACE also often involves use of a hopper dredge to collect nourishment material, thus posing another route of adverse effects to sea turtles.

State or Private Actions
Maritime Industry
Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with ESA-listed species. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. Commercial traffic and recreational pursuits can also adversely affect sea turtles through propeller and boat strikes. The Sea Turtle Stranding and Salvage Network (STSSN) includes many records of

vessel interaction (propeller injury) with sea turtles where there are high levels of vessel traffic. The extent of the problem is difficult to assess because of not knowing whether the majority of sea turtles are struck pre- or post-mortem. It is important to note that minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglements. NMFS and the USCG have completed several formal consultations on individual marine events that may affect sea turtles.

Coastal Development
Beachfront development, lighting, and beach erosion control all are ongoing activities along the Florida coastline. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Nocturnal human activities along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties are adopting stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting.

State Fisheries
Commercial state fisheries are located in the nearshore habitat areas that comprise the action area. Recreational fishing from private vessels also occurs in the area. Observations of state recreational fisheries have shown that loggerhead sea turtles are known to bite baited hooks and frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, and beach, banks, and jetties and from commercial anglers fishing for reef fish and for sharks with both single rigs and bottom longlines (NMFS 2001). Additionally, lost fishing gear such as line cut after snagging on rocks, or discarded hooks and line, can also pose an entanglement threat to sea turtles in the area. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead sea turtles can be found in the TEWG reports (1998; 2000).

In August of 2007, NMFS issued a regulation (72 FR 43176, August 3, 2007) to require any fishing vessels subject to the jurisdiction of the United States to take observers upon NMFS's request. The purpose of this measure is to learn more about sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle takes, and to determine whether additional measures to address prohibited sea turtle takes may be necessary.

Other Potential Sources of Impacts in the Environmental Baseline
Marine Debris and Acoustic Impacts
A number of activities that may affect listed species in the action area of this consultation include anthropogenic marine debris and acoustic impacts. The impacts from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources.

Marine Pollution and Environmental Contamination
Sources of pollutants along the coastal areas include atmospheric loading of pollutants such as polychlorinated biphenyls (PCBs), stormwater runoff from coastal towns and cities into rivers and canals emptying into bays and the ocean, and groundwater and other discharges (Carpenter et al, 1986). Nutrient loading from land-based sources such as coastal community discharges is

known to stimulate plankton blooms in closed or semi-closed estuarine systems (Bowen and Valiela, 2001; Rabalais 2002, Rabalais et al 2002). The effects on larger embayments are unknown. Although pathological effects of oil spills have been documented in laboratory studies of marine mammals and sea turtles (Vargo et al. 1986), the impacts of many other anthropogenic toxins have not been investigated.

Coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise and boat traffic can degrade marine habitats used by sea turtles (Colburn et al. 1996). The development of marinas and docks in inshore waters can negatively impact nearshore habitats. An increase in the number of docks built increases boat and vessel traffic. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Although these contaminant concentrations do not likely affect the more pelagic waters, the species of turtles analyzed in this biological opinion travel between near shore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles.

There are studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Aguirre et al. 1994; Caurant et al. 1999; Corsolini et al. 2000). Mckenzie et al. (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in sea turtle tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles (Storelli et al. 2008). Dietary preferences were likely the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age. Sakai et al. (1995) found the presence of metal residues occurring in loggerhead turtle organs and eggs. Storelli et al. (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law et al. 1991).

Conservation and Recovery Actions Benefiting Sea Turtles

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for Atlantic HMS and Gulf of Mexico reef fish fisheries, and TED requirements for the southeastern shrimp fisheries. These regulations have relieved some of the pressure on sea turtle populations.

Under Section 6 of the ESA, NMFS may enter into cooperative research and conservation agreements with states to assist in recovery actions of listed species. NMFS has agreements with the state of Florida. Prior to issuance of these agreements, the proposal must be reviewed for compliance with Section 7 of the ESA.

Other Actions
A revised recovery plan for the loggerhead sea turtle was completed December 8, 2008 (NMFS and USFWS 2008). Recovery teams comprised of sea turtle experts have been convened and are currently working towards revising other plans based upon the latest and best available information. Five-year status reviews have recently been completed for green and loggerhead sea turtles. These reviews were conducted to comply with the ESA mandate for periodic evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Each review determined that no delisting or reclassification of a species status (i.e., threatened or endangered) was warranted at the time. However, further review of species data for the green sea turtles was recommended, to evaluate whether DPSs should be established for this species (NMFS and USFWS 2007).

Summary and Synthesis of Environmental Baseline for Sea Turtles
In summary, several factors adversely affect sea turtles in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action. Fisheries in the action area likely had the greatest adverse impacts on sea turtles in the mid to late 80s, when effort in most fisheries was near or at peak levels. With the decline of the health of managed species, effort since that time has generally been declining. Over the past 5 years, the impacts associated with fisheries have also been reduced through the Section 7 consultation process and regulations implementing effective bycatch reduction strategies. However, interactions with commercial and recreational fishing gear are still ongoing and are expected to occur contemporaneously with the proposed action. Other environmental impacts including effects of vessel operations, additional military activities, dredging, oil and gas exploration, permits allowing take under the ESA, private vessel traffic, and marine pollution have also had and continue to have adverse effects on sea turtles in the action area in the past.

5.2 Corals

5.2.1 Status of Listed and Proposed Corals within the Action Area
In Section 4.2.2, we described the range-wide status of listed and proposed corals. Within the Broward County, staghorn coral occurs in some of the largest densities within the U.S. Recent surveys conducted by the National Coral Reef Institute have identified 35 dense patches of staghorn coral between Hollywood and Fort Lauderdale. Seven patches are near previously known existing locations and 28 newly identified areas. Initial approximations of areal coverage suggest the sites totaled over 110,000 m² of previously unknown dense patches of staghorn coral. These new discoveries have the potential of more than tripling the area of previously documented staghorn coral (B. Walker, National Coral Reef Institute, pers. comm. to J. Karazsia, NMFS, October 21, 2013).

Within Broward County, all of the proposed corals occur in varying, but relatively low densities (Gilliam 2011). Recent surveys adjacent to the Port Everglades expansion indicate that 6 of the proposed corals as well as staghorn coral are present nearby the action area, see Table 3 (Gilliam and Walker 2011). Within the Port Everglades expansion area, knobby star coral, mountainous star coral, lobed star coral, elliptical star coral, rough cactus coral, and Lamarck's sheet coral occurs on the middle reef tract and outer reef tract adjacent to the channel and within the proposed extension and flare area.

Table 3. Summary Data for Staghorn and Proposed Coral Species Adjacent to Port Everglades (Gilliam and Walker 2011)

Species Name	Number of Colonies	Density (colonies/acre)
Acropora cervicornis	823	1.12
Agaricia lamarcki	912	1.24
Dichocoenia stokesii	376	0.51
Orbicella annularis	262	0.36
Orbicella faveolata	4030	5.48
Orbicella franksi	298	0.41
Mycetophyllia ferox	26	0.04

5.2.2 Factors Affecting Listed and Proposed Corals within the Action Area

Coral colonies are non-motile and susceptible to relatively localized adverse effects as a result. Localized adverse effects to listed and proposed corals in the action area are likely from many of the same stressors affecting these species throughout their range, namely ocean warming, ocean acidification, disease, anthropogenic breakage and intense weather events (i.e., hurricanes and extreme cold water disturbances). NMFS has completed a number of Section 7 consultations to address the effects of federal actions on staghorn corals, and when appropriate, has authorized the incidental taking of this species. Each of those consultations sought to minimize the adverse impacts of the action on staghorn coral. The summary below of federal actions and the effects of these actions includes only those federal actions in, or with effects within, the action area that have already concluded or are currently undergoing formal Section 7 consultation.

Federal Actions

Federal actions that may adversely affect listed and proposed corals in the action area include:

- **Commercial and recreational fisheries authorized by the National Marine Fisheries Service.** Certain types of fishing gear (e.g., hook-and-line, trap gear, nets) may adversely affect coral species. NMFS previously completed a biological opinion evaluating the impacts of Gulf of Mexico/South Atlantic spiny lobster fishery on *A. cervicornis*. The opinion concluded trap gear used in the fishery may adversely affect *A. cervicornis* corals via fragmentation/breakage and abrasion (primarily from storm mobilized trap gear), but those effects were not likely to jeopardize the species continued existence. NMFS is continuing to collect data to analyze the impacts of federal fisheries and will conduct ESA Section 7 consultations as appropriate.

EPA and USACE-permitted discharges to surface waters and dredge-and-fill. Shoreline and riparian disturbances (whether in the riverine, estuarine, marine, or floodplain environment) resulting in discharges may retard or prevent the reproduction, settlement, reattachment, and development of listed or proposed corals (e.g., land development and runoff, and dredging and disposal activities, result in direct deposition of sediment on corals, shading, and lost substrate for fragment reattachment or larval settlement). These activities can directly affect *A.*

cervicornis via fragmentation/breakage or abrasion. The activities may also affect listed and proposed coral species by physically altering or removing benthic habitat suitable for colonization. Dredge-and-fill activities may also cause increases in sedimentation that may cause shading, deposition of sediment onto coral colonies, and/or loss of substrate for fragment reattachment or larval settlement. The 1997 RBO is currently undergoing a reinitiation of consultation due to the listing of *A. cervicornis* and *A. palmata,* among other things.

- **EPA-regulated discharge of pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water, including sewage water, into the waters of the United States.** Elevated discharge levels may cause direct mortality, reduced fitness, or habitat destruction/modification. The EPA has been involved in ongoing litigation over the sufficiency of standards promulgated by the State of Florida to regulate discharges of nutrients into state waters, including habitats occupied by the listed and proposed corals. NMFS is engaged in consultation with the EPA regarding their approval of the state's standards.

- **Coral Nurseries.** NMFS has issued 3 separate biological opinions for the establishment of staghorn coral nurseries and restoration projects within Broward County (one to Biscayne National Park, one to NMFS Habitat Conservation/Restoration Center, and one to The Nature Conservancy). The activities include collecting coral fragments and growing them within nurseries and then outplanting them onto the natural reefs. In all cases NMFS has determined that the nursery and restoration activities would not jeopardize the continued existence of staghorn corals.

Other Non-Federal Actions Affecting Listed and Proposed Corals.
Poor boating and anchoring practices, as well as poor diving and snorkeling techniques cause abrasion and breakage of *Acropora cervicornis*. Commercial and recreational vessel traffic can adversely affect listed and proposed corals through propeller scarring, propeller wash, and accidental groundings. Anthropogenic sources of marine pollution, while difficult to attribute to a specific federal, state, local or private action, may indirectly affect corals in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs, storm water runoff from coastal towns, and runoff into canals and rivers that empty into bays and groundwater. Nutrients, contaminants, and sediment from point and non-point sources cause direct mortality and the breakdown of normal physiological processes. Additionally, these stressors create an unfavorable environment for reproduction and growth.

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, are known to have adverse effects on corals. Lapointe et al. (2004) directly linked wastewater discharges in the Florida Keys with adverse effects to the nearby coral reef communities. Within the past 6 years, offshore wastewater outfalls in Broward County have been decommissioned, as part of implementation of Chapter 2008-232, Laws of Florida, which prohibits the construction of new domestic wastewater ocean outfalls, sets out a timeline for the elimination of existing domestic wastewater ocean outfalls by 2025, and requires that a majority of the wastewater previously discharged be beneficially reused. This law was enacted in part because of the adverse effects of effluent to corals.

Diseases have been identified as a major cause of coral decline. Although the most severe mortality resulted from an outbreak in the early 1980s, diseases (i.e., white band disease) are still present in *Acropora cervicornis* populations and continue to cause mortality.

Hurricanes and large coastal storms could also significantly harm *Acropora cervicornis*. Due to its branching morphology, it is especially susceptible to breakage from extreme wave action and storm surges. Historically, large storms potentially resulted in an asexual reproductive event, if the fragments encountered suitable substrate, attached, and grew into a new colony. However, in the recent past, the amount of suitable substrate is significantly reduced; therefore, many fragments created by storms die. Hurricanes are also sometimes beneficial, if they do not result in heavy storm surge, during years with high sea surface temperatures, as they lower the temperatures providing fast relief to corals during periods of high thermal stress (Heron et al. 2008). However, major hurricanes have caused significant losses in coral cover and changes in the physical structure of many reefs. According to the NOAA Historical Hurricane Tracks website, approximately, 29 hurricanes or tropical storms have impacted the area within 20 nautical miles of Fort Lauderdale, since records have been kept (1859-2013).

Several types of fishing gears used within the action area may adversely affect listed and proposed corals. Longline, other types of hook-and-line gear, and traps have all been documented as interacting with corals in general, though no data specific to listed corals are available. Available information suggests hooks and lines can become entangled in reefs, resulting in breakage and abrasion of corals. Traps have been found to be the most damaging; lost traps and illegal traps were found to result in greater impact to coral habitat because they cause continuous habitat damage until they degrade.

Conservation and Recovery Actions Benefiting Listed Corals

Research, restoration, and education and outreach activities, as part of the NMFS's ESA program, as well as through NOAA's Coral Reef Conservation Program (CRCP), are ongoing through the southeast region. NOAA's Restoration Center and state and territorial partners conduct grounding response and restoration activities throughout the U.S. jurisdictions. The summaries below discuss these measures in more detail.

Regulations Reducing Threats to Listed Corals

Numerous management mechanisms exist to protect corals or coral reefs in general. Prior to the ESA listing of elkhorn and staghorn corals, federal regulatory mechanisms and conservation initiatives most beneficial to branching corals have focused on addressing physical impacts, including damage from fishing gear, anchoring, and vessel groundings. NMFS has implemented a Section 4(d) rule to establish "take" prohibitions for listed corals. Such regulations are determined to be necessary and advisable to provide for the conservation of threatened species, and may prohibit many actions automatically prohibited for endangered species, including but not limited to: importing or exporting species from or into the United States; taking of species from U.S. waters, its territorial sea, or the high seas; or possessing or selling species. On October 29, 2008, NMFS published a final Section 4(d) rule extending all the Section 9 take prohibitions to listed elkhorn and staghorn corals. These prohibitions include the import, export, or take of elkhorn or staghorn corals for any purpose, including commercial activities. The 4(d)

rule for listed *Acropora* has exceptions for some activities, including scientific research and species enhancement, and restoration carried out by authorized personnel.

In addition, the Coral Reef Conservation Act and the two Magnuson-Stevens Act Coral and Reef Fish Fishery Management Plans (Caribbean) require the protection of corals and prohibit the collection of hard corals. Depending on the specifics of zoning plans and regulations, marine protected areas (MPAs) can help prevent damage from collection, fishing gear, groundings, and anchoring.

The State of Florida regulates activities that involve and occur in coral reefs in Florida. Statutes and rules protect all corals from collection, commercial exploitation, and injury/destruction on the sea floor (FS 253.001, 253.04, Chapter 68B-42.008 and 68B-42.009), except as authorized by a Special Activity License for the purposed of research. Additionally, Florida has a comprehensive state regulatory program that regulates most land, including upland, wetland, and surface water alterations throughout the state.

Other Listed Coral Conservation Efforts
Recovery Planning and Implementation
A draft recovery plan for elkhorn and staghorn corals is required by a settlement agreement to be published no later than September 7, 2014. The recovery team is comprised of fishers, scientists, managers, and agency personnel from Florida, Puerto Rico, and U.S.V.I., and federal representatives. Similar plans will be identified for proposed coral species should the listings become finalized.

Even in the absence of a recovery plan, NMFS and its partners have implemented numerous recovery actions since the time of listing, consistent with NMFS's Recovery Outline for elkhorn and staghorn corals. Generally, these activities fall into the following categories:

- Monitoring and mapping
- Life history, disease, and threat impact research
- In-situ and ex-situ propagation and outplanting
- Reduction of and restoration of impacts from physical disturbances
- Reduction of impacts from land-based sources of pollution
- Outreach and education

Summary and Synthesis of Environmental Baseline for Listed and Proposed Corals
In summary, several factors are presently adversely affecting listed and proposed corals within the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action:

- Disease outbreaks
- Temperature-induced bleaching events
- Ocean acidification
- Major storm events
- Upland and coastal activities that will continue to degrade water quality and decrease water clarity necessary for coral growth
- Dredge-and-fill activities

- Interaction with fishing gear and adverse effects of fishing
- Vessel traffic that will continue to result in abrasion and breakage due to accidental groundings and poor anchoring techniques
- Poor diving and snorkeling techniques that will continue to abrade and break corals

These activities are expected to combine to adversely affect the recovery of staghorn and proposed corals throughout their ranges, and in the action area.

5.3 Status of Elkhorn and Staghorn Coral Designated Critical Habitat within the Action Area

In Section 4.2.6, we described the range-wide status of designated *Acropora* critical habitat. In summary, the Florida area of *Acropora* spp. critical habitat comprises approximately 1,329 square miles (3,442 sq km) of marine habitat offshore of Palm Beach, Broward, Miami-Dade, and Monroe counties, Florida, and encompasses the entire Florida Reef Tract beginning east of Palm Beach County and extending south along the Florida Keys. Within the action area, there are approximately 19,200 acres (~30 square miles) of designated critical habitat, which includes both the areas affected by the Port expansion and the areas associated with the blended mitigation plan (discussed in Consultation History section of this Opinion) in which the nurseries and outplanting sites will occur.

Factors Affecting Critical Habitat within the Action Area

Localized adverse effects to designated critical habitat in the action area are likely from many of the same stressors affecting the critical habitat throughout their range, namely activities that may increase turf- or macroalgal cover (i.e., releases of nutrients or reduction in herbivory) or increase sediment cover.

Federal Actions

Numerous activities funded, authorized, or carried out by federal agencies have been identified as threats and may affect elkhorn and staghorn corals' critical habitat in the action area. To date, however, few consultations on activities affecting critical habitat within the action area have been completed.

- **USACE-permitted dredge-and-fill activities.** The activities may impact critical habitat by physically altering or removing benthic habitat suitable for colonization. Dredge-and-fill activities may also cause increases in sedimentation that may cause loss of substrate for fragment reattachment or larval settlement. The 1997 RBO on navigation channel maintenance using hopper dredges is currently undergoing a reinitiation of consultation, to address the impacts of these activities on coral critical habitat among other things, and will evaluate the effects of certain dredge-and-fill activities that occur within the action area. In the past century, 3 major ports have been constructed in southeast Florida. A total of approximately 772 acres of coral reef habitat has been impacted via direct removal and burial (Walker et al. 2012a). Several beach renourishment projects have been completed in Broward County. In 2006, Segment III renourishment project resulted in over 43 acres of nearshore reef impacts via sediment burial (Prekel et al. 2008).

- **EPA-regulated discharge of pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water, including sewage water, into the waters of the United States.** Elevated nutrients can lead to increased algal growth. The EPA has been involved in ongoing litigation over the sufficiency of standards promulgated by the State of Florida to regulate discharges of nutrients into state waters, including habitats occupied by the listed and proposed corals. NMFS is engaged in consultation with the EPA regarding their approval of the state's standards.

Other Non-Federal Actions Affecting Elkhorn and Staghorn Critical Habitat.
The State of Florida regulates activities that involve and occur in coral reefs in Florida. Statutes and rules protect all corals from collection, commercial exploitation, and injury/destruction on the seafloor (FS 253.001, 253.04, Chapter 68B-42.008 and 68B-42.009), except as authorized by a Special Activity License for the purposed of research. Therefore, the State regulates alterations to the reef. Additionally, Florida has a comprehensive state regulatory program that regulates most land, including upland, wetland, and surface water alterations throughout the state, resulting in regulation of land-based sources of nutrients or sediment that may adversely affect *Acropora* critical habitat.

Vessel groundings and anchor damage from commercial and recreational vessels within southeast Florida have historically resulted in severe negative impacts to the Florida Reef Tract. According to Sansgaard (2013) the Florida Department of Environmental Protection's (FDEP) Coral Reef Conservation Program (CRCP) has responded to, and managed, 124 of incidents related to vessel groundings and anchor damage. Typically only large vessel groundings alter the substrate to render it unconsolidated. However, several of the documented events have been large vessels. For example, in 2006, the M/V Clipper Lasco (a 645-ft cargo ship) grounded offshore of Fort Lauderdale resulting in over 6,000 square feet (ft^2) of reef impacted. However, due to the large number of vessel groundings in the area, the U.S. Coast Guard relocated the anchorage and no large vessel groundings have occurred since 2009.

Conservation and Recovery Actions Benefiting Coral Critical Habitat in the Action Area
The NOAA Coral Reef Conservation Program provides funding for several activities with an education and outreach component for informing the public about the importance of the coral reef ecosystem and the status of listed corals. The Southeast Regional Office of NMFS has also developed outreach materials regarding the listing of elkhorn and staghorn corals, the Section 4(d) regulations, and the designation of critical habitat. These materials have been circulated to constituents during education and outreach activities and public meetings, and as part of other Section 7 consultations, and are readily available on the website: http://sero.nmfs.noaa.gov/pr/esa/acropora.htm.

Numerous management mechanisms exist to protect corals and the habitats on which they grow, thus indirectly benefiting *Acropora* designated critical habitat. The Coral Reef Conservation Act and the two Coral and Coral Reef Fishery Management Plans under the Magnuson-Stevens Act require the protection of corals and prohibit the collection of hard corals. Depending on the specifics of zoning plans and regulations, marine protected areas (MPAs) can help prevent

damage from collection, fishing gear, groundings, and anchoring; however, no MPAs occur within the action area.

5.4 Johnson's Seagrass

5.4.1 Status of Johnson's Seagrass within the Action Area

Based on the results of the southern transect sampling, it appears there is a relatively continuous, although patchy, distribution of the species from Jupiter Inlet to Virginia Key, at least during periods of relatively good environmental conditions and no significant large-scale disturbances (NMFS 2007).

The project area includes several small patches of Johnson's seagrass, mostly intermixed with other seagrass species. The majority of the seagrass found in the action area will not be affected by the project.

5.4.2 Factors Affecting Johnson's Seagrass within the Action Area

A wide range of activities funded, authorized, or carried out by federal agencies may affect the essential habitat requirements of Johnson's seagrass.

Federal Actions

- **Dock/Marina Construction, boat shows, bridge/highway construction, residential construction, and shoreline stabilization.** NMFS has consulted on numerous projects in or near the action area that have adversely affected Johnson's seagrass. The majority of these projects were single- or multi-family dock construction that resulted in a few hundred square feet of impacts to Johnson's seagrass. However, a few projects resulted in more significant impacts. Newer construction is encouraged to follow the NMFS-USACE dock construction guidelines and the Johnson's Seagrass Key in order to minimize shading impacts to Johnson's seagrass. NMFS and the USACE have covered many of the impacts to Johnson's seagrass in several programmatic biological opinions on regional general permitting activities, which ensure that issuance of the general permits as a whole are not likely to jeopardize the affected species.

- **EPA and the USACE permitted freshwater discharges into waterways**. Freshwater discharges can alter the salinity essential feature for Johnson's seagrass. Water quality and transparency within the range of Johnson's seagrass are affected by storm water and agricultural runoff, wastewater discharges, and other point and non-point source discharges. The most clearly identified and manageable threat to the survival and recovery of Johnson's seagrass is the possibility of mortality due to reduced salinity over long periods of time (NMFS 2007). High-volume freshwater discharges from Lake Okeechobee flow downstream to the mouth of the St. Lucie River and have the potential to adversely affect Johnson's seagrass. NMFS recently completed consultation with the USACE on the programmatic impacts of the Comprehensive Everglades Restoration Plan (CERP), which may help to alleviate the frequency of high-volume freshwater discharges from Lake Okeechobee to Johnson's seagrass habitats.

Other Non-Federal Actions Affecting Johnson's seagrass

Natural Disturbances
Large-scale weather events, such as tropical storms and hurricanes, while they often generate runoff conditions that decrease water quality, also produce conditions (wind setup and abrupt water elevation changes) that can increase flushing rates. The effects of storms can be complex. Specifically documented storm effects on healthy seagrass meadows have been relatively minor and include: (1) scouring and erosion of sediments; (2) erosion of seeds and plants by waves, currents, and surge; (3) burial by shifting sand; (4) turbidity; and (5) discharge of freshwater, including inorganic and organic constituents in the effluents (Oppenheimer 1963, van Tussenbroek 1994, Whitfield et al. 2002, Steward et al. 2006). Storm effects may be chronic, e.g., due to seasonal weather cycles, or acute, such as the effects of strong thunderstorms or tropical cyclones. Studies have demonstrated that healthy, intact seagrass meadows are generally resistant to physical degradation from severe storms, whereas damaged seagrass beds may not be as resilient (Fonseca et al. 2000, Whitfield et al. 2002). In the late summer and early fall of 2004, 4 hurricanes passed directly over the northern range of Johnson's seagrass in the Indian River Lagoon. A post-hurricane random survey in the area of the Indian River Lagoon affected by the 4 hurricanes indicated the presence of Johnson's seagrass was similar to that reported by the SJRWMD transect surveys prior to the storms. This indicates that while the species may temporarily decline, under the right conditions it can recover quickly (Virnstein and Morris 2007). Furthermore, despite evidence of longer-term reductions in salinity, increased water turbidity, and increased water color associated with higher than average precipitation in the spring of 2005, there was no evidence of long-term chronic impacts to seagrasses and no direct evidence of damage to Johnson's seagrass that could be considered a threat to the survival of the species (Steward et al. 2006).

State and Federal Activities That May Benefit Johnson's Seagrass
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). 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.

5.5 Summary and Synthesis of Environmental Baseline
In summary, several factors are presently adversely affecting green and loggerhead sea turtles, Johnson's seagrass, listed and proposed for listing corals, and designated critical habitat for elkhorn and staghorn corals in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action:

- Interaction with commercial and recreational fishing gear
- Dredge-and-fill activities, including channel dredging and beach re-nourishment/restoration activities
- Runoff containing toxins and pollutants from land-based sources
- Disease outbreaks
- Major storm events
- Upland and coastal activities will continue to degrade water quality and decrease water clarity necessary for coral growth

- Poor vessel anchoring as well as poor diving and snorkeling techniques will continue to abrade and break corals

These activities are expected to combine to adversely affect the recovery of green and loggerhead sea turtles, Johnson's seagrass, and proposed and listed corals throughout their ranges, and in the action area.

6 Effects of the Action

As described below, NMFS believes that the proposed action may adversely affect loggerhead and green sea turtles, Johnson's seagrass, staghorn coral and corals proposed for listing under the ESA, and designated critical habitat for staghorn coral. Because the action will result in adverse effects to these species, we must evaluate whether the action is likely to jeopardize the continued existence of any of these species or likely to cause destruction or adverse modification to critical habitat.

6.1 Effects of the Action on Sea Turtles

In Section 3, we determined listed species of sea turtles likely to be adversely affected via any or all portions of the proposed action include green and loggerhead sea turtles. Potential routes of adverse effects of the proposed action on sea turtles are limited to hopper dredging.

Previous NMFS biological opinions have determined that hopper dredges may adversely affect loggerhead and green sea turtles through entrainment by the draghead. Hopper dredges will only be used to suction off accumulated shoal material from the existing. This may take anywhere from a few days to a few weeks depending on the amount of material that has shoaled into the entrance channel. Between 2005 and 2013 approximately 100,000 cy of material shoaled in the Port Everglades entrance channel (pers. comm. Terri Jordan-Sellers, USACE, to K. Logan, NMFS, February 2014). Assuming a similar amount of shoal material is to be removed by hopper dredge and assuming that the contractor uses a smaller, 3,000-cy-capacity hopper dredge (with an average load value of 2,500 cy), they would need to complete approximately 40 trips total to the ODMDS.

During dredging operations, protected species observers will live aboard the dredge, monitoring every load, 24 hours a day, for evidence of dredge-related impacts to protected species, particularly sea turtles. Observers will also maintain a bridge watch for protected species and keep a logbook noting the date, time, location, species, number of animals, distance and bearing from dredge, direction of travel, and other information, for all sightings. During all phases of dredging operations, the dredge and crew will be required to adhere to NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*.

Since there has never been a reported sea turtle take from hopper dredging in Port Everglades, Port of Miami, or Key West, we relied on data from the nearest harbor with reported takes, Palm Beach Harbor, in order to estimate potential take by hopper dredges in the action area during the proposed 5-year dredging action. From 1994 through 2011, hopper dredging of the Palm Beach Harbor generated approximately 2,446,916 cy of material (Table 4). Eleven sea turtles were

documented/observed as taken in hopper dredges during these dredging events. This equates to a catch per unit effort (CPUE) of 0.00000449 turtles per cubic yard dredged.

Table 4. Dredged Material Removed and Sea Turtle Takes During Dredging in the Palm Beach Harbor, 1994-2011 (USACE Sea Turtle Data Warehouse 2014)

Year	Quantity of Dredged Material (Cubic yards) Palm Beach Harbor	Loggerhead	Green	Total Turtles
1994	181,338			
1995	179,330	3	2	5
1996	154,847	1	1	2
1997	219,177			
1998	73,349			
1999	64,779			
2000	187,340	1		1
2001	112,446			
2002	184,935			
2003	111,625	1		1
2004	343,770	1		1
2005	318,874	1		1
2006	70,698			
2007	12,000			
2008	157,828			
2009	43,735			
2010	64,068			
2011	66,777			
Total	2,446,916	8	3	**11**
CPUE	0.00000449			

Using this data we can calculate that the proposed project will take 0.45 turtles (0.00000449 X 100,000 = 0.45), rounded up to 1 turtle.

NMFS has previously determined that dredged material screening is only partially effective at detecting entrained turtles, and observed interactions likely provide only partial estimates of total sea turtle mortality. NMFS believes that some turtles killed by hopper dredges go undetected because body parts are forced through the sampling screens by water pressure and are buried in the dredged material, or animals are crushed or killed but their bodies or body parts are not entrained by the suction and so the interactions may go unnoticed. Mortalities are only noticed and documented when body parts float, are large enough to be caught in the screens, and can be identified as sea turtle parts. Body parts that are forced through the suction dragheads' 4-inch (or greater) inflow screens by the suction-pump pressure and that do not float are very unlikely to be

observed, since they will sink to the bottom of the hopper and not be detected by the overflow screening.

Unobserved interactions are not documented, thus, observed interactions may under-represent actual lethal interactions. There may have been unobserved takes in previous dredging operations at Port Everglades.

It is not known how many turtles are killed but unobserved. Thus, to be conservative, in the 1993 Regional Biological Opinion on hopper dredging issued to the U.S. Army Corps of Engineers for their Gulf of Mexico District's (i.e., Jacksonville, Mobile, New Orleans, and Galveston) maintenance dredging and beach renourishment operations, NMFS estimated that up to 1 out of 2 impacted turtles may go undetected (i.e., that observed interactions constitute only 50% of total takes). We will apply this longstanding conservative assumption in the present opinion, since we have no new information that would change the basis of that previous conclusion and estimate. Therefore, our jeopardy analysis will account for total takes (observed takes plus undetected takes). Our Incidental Take Statement (ITS) is based on observed takes, not only because observed mortality gives us an estimate of unobserved mortality, but because observed, documented take numbers serve as triggers for some of the reasonable and prudent measures, and for potential reinitiation of consultation if actual observed takes exceed the anticipated/authorized number of observed takes.

Experience has shown that the vast majority of hopper-dredge impacted turtles are immediately killed by being crushed or through dismemberment from being trapped underneath and rolled under the heavy suction dragheads and/or by the violent forces they are subjected to during entrainment through the dredges' powerful, high-velocity dredge pumps. A very few turtles (over the years, a fraction of a percent) survive entrainment in hopper dredges, usually smaller juveniles that are sucked through the pumps without being dismembered or badly injured. Often they will appear uninjured only to die days later of unknown internal injuries, while in rehabilitation. Therefore, we are conservatively predicting that all takes by hopper dredges will be lethal.

As discussed above, NMFS estimates that there will be 2 incidental, lethal interactions (1 observed and 1 unobserved). Because more loggerheads were taken than greens in dredging activity in Palm Beach Harbor (approximately 2.5 times as many), we anticipate that the turtles taken will be loggerheads, but we cannot rule out that greens may be taken. Green sea turtles made up 27% of entrainments at Palm Beach Harbor hopper dredging. Given the growth of the green sea turtle population over the past decade and increased nesting of greens on Florida beaches, we believe green sea turtles are relatively more abundant in nearshore Florida waters than previously (see Figure 7). By comparison, the loggerhead population has not enjoyed the same rate of long-term increase (see Figure 6). Therefore, we believe that the observed take might well consist of 1 green or 1 loggerhead, and, for the purposes of this Opinion, that is our anticipated observed take by species. However, to be most conservative, in our jeopardy analysis, we will assume that both takes will occur to just reproductively mature females of just one species, i.e., that 2 loggerheads or 2 greens will be lethally taken.

6.2 Effects of the Action on Johnson's Seagrass

NMFS believes the proposed action is likely to adversely affect Johnson's seagrass, which is listed as threatened under the ESA. The ESA expressly provides only limited prohibitions on take of endangered plants (*See* ESA section 9(a)(2), 16 U.S.C. § 1538(a)(2)), and NMFS has not promulgated any 4(d) rule for Johnson's seagrass. Thus, take of Johnson's seagrass resulting from the proposed action is not prohibited, and no incidental take statement or reasonable and prudent measures will be issued. However, because the action will result in adverse effects to Johnson's seagrass, we must evaluate whether the action is likely to jeopardize the continued existence of the species.

Johnson's seagrass will be directly removed via dredging; no other types of effects, such as sedimentation, are expected to impact this species. Utilizing data from surveys conducted by Dial Cordy, Inc., in 2000, 2006, and 2009, we performed an independent GIS analysis to determine cumulative coverage of Johnson's seagrass. This approach is consistent with the methodology used by NOAA's Habitat Conservation office in determining seagrass impacts for this project. We determined that 4.67 acres of Johnson's seagrass will be permanently removed via dredging (see Table 5 and Figure 11).

Table 5. Cumulative Coverage of Johnson's Seagrass

	Cumulative Average Coverage (acres)
Johnson's Seagrass	4.379
Mixed Seagrass*	0.289
Total	4.668

*Mixed seagrass beds were calculated assuming 50% coverage of Johnson's seagrass. Transect data indicated a range of coverages from less than 1% to approximately 50%; therefore, to be conservative, we will use 50% for all the mixed beds.

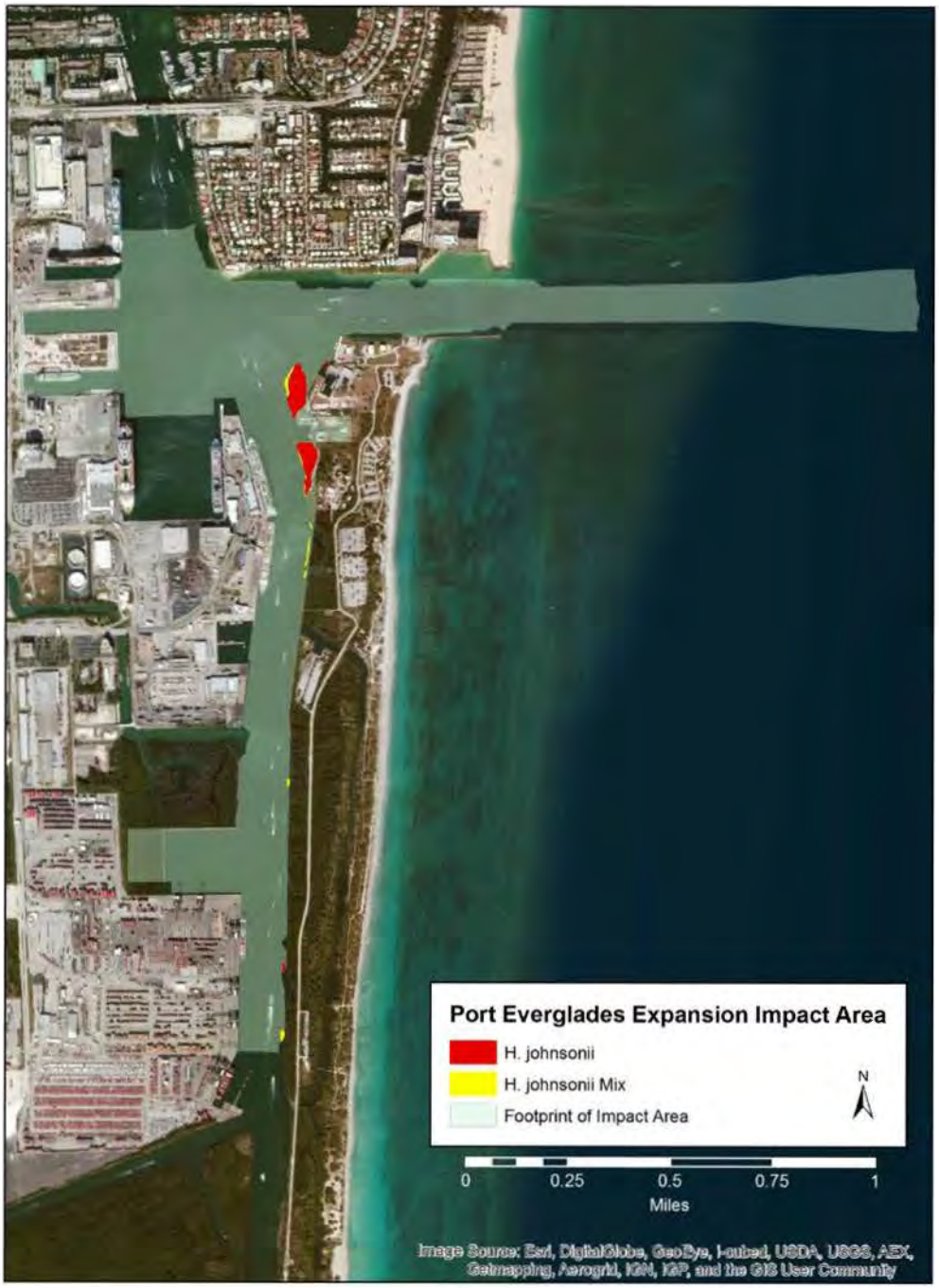

Figure 11. Johnson's seagrass within the project area

6.3 Effects of the Action on Coral Designated Critical Habitat

As described below, NMFS believes the proposed action will both adversely affect and benefit designated critical habitat for staghorn coral. The Florida area, which will be affected by the proposed action, comprises approximately 1,329 square miles of listed coral critical habitat. The physical feature essential to the conservation of staghorn coral is defined as substrate of suitable quality and availability, in water depths from mean high water to 30 m, to support larval settlement and recruitment, and reattachment of asexual fragments. Substrate of suitable quality and availability is defined as natural consolidated hardbottom or dead coral skeleton that is free from turf or fleshy macroalgae cover and sediment cover. We used hardbottom mapping data for south Florida (Walker et al., 2008b) to determine the amount of the critical habitat essential feature that could be affected by the project. Approximately 139 acres of coral critical habitat will be adversely affected by the project. Additionally, approximately 22 acres of reef will be populated with dense stands of staghorn coral as part of the blended mitigation plan, accelerating the conservation function of these areas of coral critical habitat. Based on these adverse and beneficial effects to critical habitat, we must evaluate whether the proposed action may result in the destruction or adverse modification of critical habitat; if so, NMFS must develop reasonable and prudent alternatives to avoid such impacts.

The Port Everglades Expansion project includes various types of impacts to coral reef and hardbottom habitats through directly dredging or blasting, anchoring and cable dragging, and sedimentation. To determine the nature and extent of impacts to coral critical habitat from the proposed action, we used Figure 12 below which has been adapted from Walker et al. (2008b) and includes the project boundaries (black lines) overlaid on the benthic habitat map produced by Dr. Walker (colored areas). The figure shows the dredge footprint (inner black lines) and the adjacent 150 meter area (outer black line). The area at the end of the channel (in yellow) includes the 6.11 acre area below the -57 ft dredge depth where we believe that fracturing and other impacts will occur from removing the reef structure above this depth. Hardbottom habitat types are identified and color coded, sand areas are indicated in grey. As indicated in Table 6, below, we believe that there will be permanent impacts from dredging and blasting to the habitat areas within the dredge footprint (channel) and sedimentation impacts (both permanent and temporary) to the area within 150 meters adjacent to the channel. Additionally, we believe there will be permanent impacts (fracturing, etc.) to the hardbottom area located along the outer reef tract, below the -57 ft dredge depth. Furthermore, there may be some additional anchor and cable drag impacts (potential impacts) to 19.31 acres of habitat within the 150 meters adjacent to the channel in the event that the USACE selects a contractor that will need to anchor outside of the channel[9].

[9] At this time the mitigation plan and incremental cost analysis is in draft form and may contain different inputs than what is analyzed in this Opinion. Impact estimates used in this Opinion are the most conservative to be consistent with the requirements of the ESA. Any changes made to the mitigation plan as a result of inputs used will not result in less than 38,254 staghorn colony outplants.

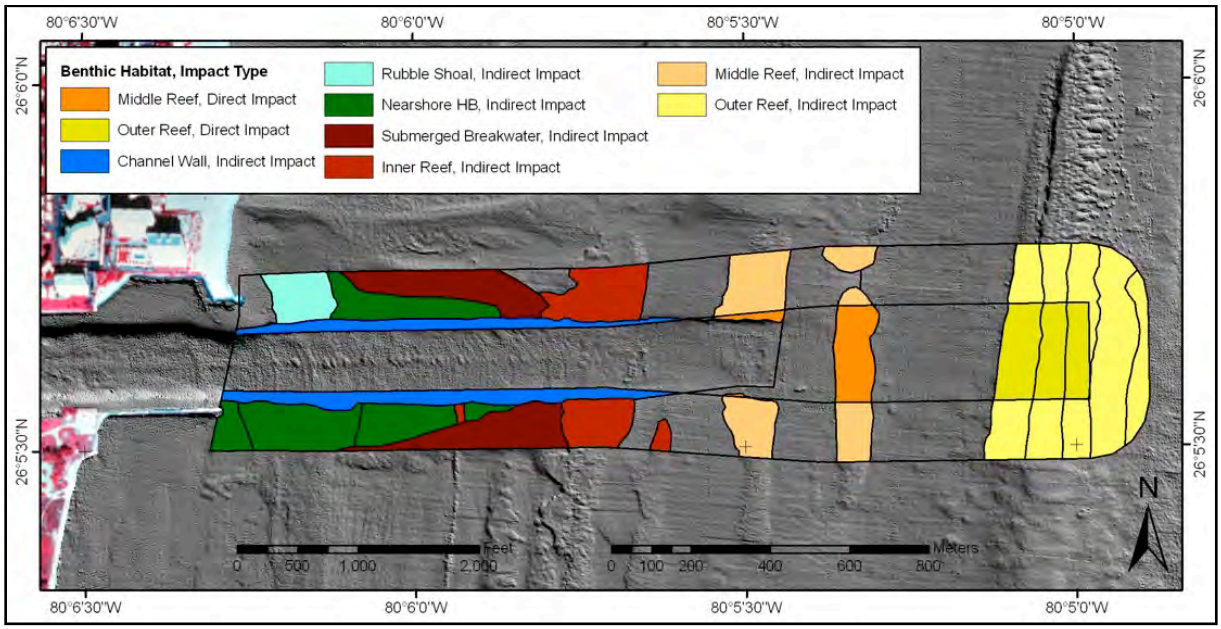

Figure 5. Coral reef habitat impact types within the Port Everglades Expansion Area (from Walker et al. 2008b)

Table 6 summarizes the types, area, and duration of effects to designated critical habitat for elkhorn and staghorn corals. The activities associated with the Port Everglades Expansion project will result in both permanent and temporary effects, as described below. In addition, some of the effects are certain or judged likely to occur (the "confirmed" and "predicted" impacts), while others are contingent upon the ultimate methods used by the contractor (the "potential" impacts). Because we must use a precautionary approach to analyzing effects, we will assume that the maximum potential adverse effects will occur.

Table 6. Summary of Adverse Effects to *Acropora* Designated Critical Habitat from the Port Everglades Expansion Project

Type of Impact	Duration	Area (acres)
Direct removal via explosives and dredging	Confirmed Permanent	15.55
Reef fracturing and sediment/rubble deposition	Confirmed Permanent	6.11
Anchor placement and drag	Potential Permanent	19.31
Sedimentation	Predicted Permanent	1.96
Sedimentation	Predicted Temporary	96.22
Total Impacts		**139.15**

While it may appear that coral reefs and hardbottom habitats are solid rock and extremely structurally stable, the opposite is actually true. Up to 40% of the reef structure may be void spaces because the reef is created by layering dead skeleton, other calcifying organisms, and sediments (Jaap et al. 2006). Therefore, reef and hardbottom (i.e., the essential feature of staghorn critical habitat) is susceptible to damage from physical impacts. The proposed project will permanently adversely affect 21.66 acres of designated critical habitat for staghorn coral. Approximately 15.55 acres of designated critical habitat will be adversely affected through direct removal of the essential feature by explosives and dredging of the middle and outer reef (Figure

12). The underlying reef framework (essential feature) will be permanently destabilized via fracturing and rubble formation, making this area unsuitable and unavailable for coral recruitment and growth. An additional 6.11 acres of critical habitat on the middle and outer reefs located below dredge depth of -57 ft will be impacted due to fracturing of the reef framework and downslope movement of sediments and rubble as a result of dredging. Fracturing the reef framework will permanently destabilize the essential feature rendering it unsuitable and unavailable for coral recruitment and growth. Further, depending on the size and density of the created rubble, it may stay within the impact area indefinitely, also making the area unsuitable for coral recruitment and growth. Similar impacts from ship groundings and explosive use have resulted in significantly lower recruitment rates compared to un-impacted adjacent reef (Fox et al. 2003; Piniak et al. 2010; Rubin et al. 2008). Therefore, we believe that a total of 21.66 acres of designated critical habitat will be permanently adversely affected by the dredging activities.

Based on benthic habitat maps (Walkeret al. 2008b) for the area (including the 150-m indirect impact zone adjacent to the existing channel), the project may potentially permanently impact up to an additional 19.31 acres of critical habitat adjacent to the channel via anchor placement and cable drag (Figure 12, indirect impact areas). The USACE does not anticipate that this impact will occur because the most cost-effective dredging methods will likely avoid these impacts. However, given the potential for these impacts, we are identifying how they may adversely affect critical habitat. Anchor placement and drag may result in the deconsolidation of the hardbottom, rendering it into rubble or smaller fragments. Such impacts can have lasting effects on the physical structure of the site and decrease its abiltiy to support coral recruitment and growth (Rogers and Garrison 2001). Thus, this area would no longer be suitable or available for coral recruitment or growth. So, should a dredging method be selected that results in anchor placement and cable drag, we believe that an additional 19.31 acres of designated critical habitat may be affected.

In addition to the permanent physical impacts from blasting, dredging and/or anchoring identified above, we predict another 98.09 acres of critical habitat in the 150 m areas adjacent to the channel will be impacted by sedimentation caused by dredging. The creation and resuspension of sediments during construction will result in sediment transport and deposition onto the essential feature, rendering it temporarily unsuitable and unavailable for coral recruitment and growth. Sedimentation affects larval settlement and recruitment, and fragment attachment. Sediment accumulation on dead coral skeletons and exposed hard substrate reduces the amount of available substrate suitable for coral larvae settlement and fragment reattachment. Even small increases in sedimentation can significantly reduce coral recruitment and survivorship (Babcock and Smith 2000), and sediments coupled with turf algae further impede recruitment (Birrell et al. 2005). Further supporting the impact sedimentation has on recruitment, coral larvae of some species settle preferentially on vertical surfaces to avoid sediments and cannot successfully establish themselves in shifting sediment (U.S. Army Engineer Research Development Center 2005). Last, survivorship of branching coral fragments is significantly affected by the type of substrate, with increased mortality being linked to the presence of sandy sediments (Lirman 2000). Therefore, if sediments are present and deposited on the area adjacent to the channel, critical habitat may be unavailable for coral larval and fragment recruitment and growth.

Even so, coral reefs are dynamic systems and sediments are often removed from the reef substrate by currents, tides, or storm events, especially those on exposed coasts like the Florida Reef Tract. The residence time of sediments is dependent on several factors including grain size and the hydrodynamics of the system (i.e., higher energy is needed to mobilize larger grained materials). According to the DEIS (USACE 2013), sediment constituents encountered at the Port vary greatly according to location and elevation. The majority of substrate materials within the dredging area include inter-bedded layers of sand and rock. A minority of the material includes silts, clays, and peat/organics. Approximately 80%-90% of the softer excavated rocks are classified as sands with mixed gravel. The harder materials are classified as boulders of varying size. Based on monitoring of nearby beach nourishment projects, it is likely that the impacts of sedimentation are likely to be temporary, with the majority of the area returning to suitable conditions after approximately 18 months (Prekel et al. 2008). Previous monitoring from dredge events at Key West and Port Everglades show no permanent impacts from sedimentation, but some NCRI scientists believe some permanent impacts due to sedimentation may occur from the proposed action. NMFS and USACE agreed meetings held in November 2013 that the majority of the sediment effects are likely to be temporary. To be conservative we will consider a maximum of 2% or 1.96 acres of the area predicted to be impacted by sedimentation will be permanently adversely affected and 96.22 acres of the area predicted to be impacted by sedimentation will only be temporarily adversely affected by dredging. Given that there are no elkhorn or staghorn corals in the area which could use this area for fragment or larvae settlement, we believe that the temporary effects from sedimentation to this 96.22 acres of critical habitat are insignificant.

While there are 133 acres of hard substrate along the bottom and walls of the existing channel, it does not provide the essential feature for *Acropora* settlement and recruitment. As discussed in the final rule designating critical habitat, we determined that existing federally-authorized channels do not provide the essential feature. This is based on the disturbed nature of the substrate within channels and channel walls (i.e., it has been dredged from its natural condition). Further, sediment movement, suspension, and deposition levels are high within existing channels. Hard substrate found within these channels and along their walls are ephemeral in nature and are frequently covered by sand or disturbed by maintenance dredging, thus not meeting the definition of the essential feature. Therefore, the impacts to the hardbottom that occurs in the channel bottom and channel walls are not considered impacts to *Acropora* critical habitat and thus are not part of our critical habitat impact analysis.

Depending on vessel operations and waterway safety, it may be necessary to temporarily or permanently move some or all of the fixed and floating ATONs within the project area (up to 20 total). If ATONs are moved temporarily, all relevant and applicable USCG ATON PDCs (project design criteria) and BMPs (best management practices) will be followed as laid out in NMFS's previous Biological Opinion to the USCG (SER-2011-3196) governing ATON placement and maintenance. This includes the temporary placement of ATONs in areas that are not likely to adversely affect endangered species or habitats. If ATONs are to be moved permanently based on considerations by the U.S. Coast Guard not related to this dredging project, independent consultation with NMFS will take place before the permanent placement of ATON. Generally, fixed ATONs will be removed and replaced with temporary floating ATONs during the dredge project to allow for contractor flexibility and safety of vessels transiting the

waterway. The temporary floating ATONs will be placed on the fixed ATONs' prior assigned positions until consultation with NMFS is concluded. ATONs will be temporarily relocated within 30 ft of the existing channel, within the indirect impact zone. Therefore, we believe that effects from the temporary relocation of ATONs will insignificant.

The proposed project includes creation of 5 acres of boulder reef with approximately 12,500 corals relocated from within the dredge footprint. Because the boulder reefs will not be placed on the essential feature of critical habitat, we believe there will be no effect to critical habitat resulting from this activity.

The proposed project also includes enhancement of degraded reef sites with propagation and/or outplanting of additional corals, including 35,000-50,000 colonies of *Acropora cervicornis* at appropriate densities, as mitigation required by the USACE under its authorities to compensate for the impacts to corals and coral reefs. For purposes of this opinion, degraded reef sites are those that are not currently healthy coral dominated reefs due to a previous impact or environmental condition but that could easily be improved through outplanting activities; transplant sites will not include areas with ongoing environmental conditions that would prevent newly outplanted corals from surviving. A comprehensive transplantation and monitoring plan will be developed and approved by NMFS prior to construction to ensure the success of the propagation and outplanting portion of the project. We believe that this portion of the mitigation proposal will have a beneficial effect on designated critical habitat, by accelerating the provision of its intended conservations functions for staghorn coral. The following analysis shows how we determined that the propagation and outplanting component of the project would provide for the conservation of the species.

Facilitating increased incidence of successful sexual and asexual reproduction is the key objective to the conservation[10] of staghorn coral identified for its designated critical habitat (73 FR 72224, November 26, 2008), based on the species' life history characteristics, population declines, and extremely low recruitment. Therefore, the critical habitat designation identifies the essential feature within the areas occupied by the species that need protection to support that goal. Corals are sessile and depend upon external fertilization in order to produce larvae. Fertilization success is reduced as adult density declines (known as the Allee effect) (Levitan 1991). Since *Acropora* is not able to self-fertilize it requires a certain density (discussed in further detail below) of adult colonies to promote sexual reproduction (*Acropora* Biological Review Team 2005).

Another activity that supports the goal of increased incidence of successful sexual and asexual reproduction is artificial propagation of the species. The Recovery Outline for Elkhorn and Staghorn Coral (NMFS 2013) identifies the following key action necessary to promote conservation:

> *Develop and implement appropriate strategies for population enhancement, through restocking and active management, in the short to medium term, to increase the likelihood of successful sexual reproduction and to increase wild populations.*

[10] Under the ESA, conservation is equated with recovery of a species (i.e., the species no longer needs the protection of the ESA).

Numerous nurseries for staghorn coral have been established to support this recovery activity in the past 15 years with the expressed purpose of enhancing wild populations with sufficient densities of the species to promote natural sexual reproduction (Johnson et al. 2011). To date, hundreds of thousands of staghorn corals have been propagated and outplanted throughout the species' range, with high survival rates (i.e., 75%-90%; T. Moore, NOAA Restoration Center pers. comm. to J. Moore, NMFS PRD, January 22, 2014). Therefore, we are highly confident that propagation and outplanting of staghorn corals support the intended goal.

One of the objectives identified in the Recovery Outline is to ensure the population viability of each species. The NMFS *Acropora* recovery team, working on a draft recovery plan for elkhorn and staghorn corals, has determined that population viability for staghorn coral requires achieving a density of one colony (≥ 0.5 m diameter in size) per square meter, throughout approximately 5% of consolidated reef habitat in 5-20 m water depth throughout the species' range (A. Moulding, NMFS Recovery Team liason pers. comm. To K. Logan, NMFS PRD, February 2014). Based on estimates of the proportion of habitat historically occupied by staghorn thickets, the recovery team has determined that this is the density of adult staghorn coral colonies necessary to facilitate sustained sexual reproduction. We assume that the maximum conservation potential of critical habitat can be calculated by applying this metric of a recovered population. Therefore, we applied this criterion to the area of critical habitat predicted to be permanently adversely affected by the proposed action, to calculate the number of colonies of certain size and density the area would have needed to support, to fulfill the population viability requirements identified by the recovery team. First we determined the proportion of the area that will be permanently adversely affected that would satisfy the habitat requirement, by calculating the acreage representing 5% of the permanently adversely affected area. This results in an area of 4,382.7 m^2 (5% of 23.62 acres = 1.181 acres = 4,779.34 m^2). To determine the size and density requirements, we considered that a colony 0.5 m in diameter will occupy 0.2 m^2 if we assume the colony is roughly circular in shape (area of a circle = $3.14 \times r^2 = 3.14 \times (0.25)^2 = 0.2$ m^2). Consequently, 0.2 m^2 coral occupancy per square meter of hardbottom is necessary to achieve the size and density goal identified by the recovery team, and to achieve full functionality of critical habitat. The staghorn colonies required to be outplanted by the blended mitigation agreement will be approximately 0.2 m (20 cm) in diameter. Therefore, again assuming the colonies are roughly circular in shape and applying the equation for the area of a circle, the area of an outplanted colony will be 0.03 m^2 ($3.14 \times (0.1)^2 = 0.03$ m^2). Consequently, approximately 7 colonies of staghorn coral per square meter of hardbottom would be required to provide the full conservation benefit of the critical habitat which will be permanently lost due to the project (0.2 m^2/0.03 m^2 = 6.67 colonies/m^2). This is consistent with data presented by Vargas-Angel et al. (2003), who have determined that the highest average cover in surveyed staghorn thickets was 25.9%, and the highest average density was 3.3 colonies per m^2 (average colony size 40.8 cm). Multiplying the habitat requirement calculated above (4,779.34 m^2) by the number of colonies needed per square meter (6.67 colonies) results in a total of 31,878 staghorn colonies. Further calculations regarding recruitment, mortality, and growth rates support this conclusion (see Appendix C).

6.4 Effects of the Action on Staghorn Coral

The blended mitigation plan includes using coral nurseries to grow and subsequently outplant between 35,000 and 50,000 colonies of staghorn coral at appropriate densities. Corals may be

collected from existing nurseries or from "corals of opportunity" (i.e., unattached wild colonies or those proposed to be impacted by an authorized activity that can be rescued and relocated). Collecting coral fragments involves directed take (via collection) of *A. cervicornis*. However, the protective regulations pursuant to ESA Section 4(d) for staghorn provides for certain exceptions to the ESA Section 9 prohibitions for scientific research and species enhancement, and restoration carried out by authorized personnel (73 FR 64264; October 29, 2008). Thus, the take that may result from this project's propagation and outplanting of staghorn corals is currently not prohibited, as long as the actions are carried out pursuant to: (1) the exceptions in the 4(d) rule; and (2) the Biological Opinion on the issuance of the rule. Because all activities related to coral propagation (i.e., wild collection, nursery establishment and operation, and outplanting) in Broward County require a State of Florida Special Activity License (SAL), the USACE will be required to hold a valid permit (SAL) and they will be in compliance with the 4(d) rule. However, NMFS has proposed to reclassify staghorn coral from threatened to endangered and proposed to list 6 additional coral species that occur within the action area. Should that proposal become final (decision due June 2014), the aforementioned 4(d) rule for staghorn corals will be void because there are no exceptions to the take prohibitions allowed for endangered corals. Therefore, the take that will result from the propagation activities will need authorization. If the proposed reclassification is finalized in June 2014, the USACE will need to contact NMFS to determine the mechanism for authorizing the take of corals necessary to implement this action as proposed.

While the take of staghorn coral is not currently prohibited, we must still include the take that will result from coral nurseries in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

Active coral propagation has been identified as a priority for staghorn coral by NMFS and by the *Acropora* Recovery Team. Over the course of the mitigation portion of the project, it is likely that fragments will be taken from fewer than 250 wild healthy colonies and brought into nurseries. The rest will be sourced from "corals of opportunity." Typically, collection of donor coral fragments is only necessary during the first year of a nursery. No additional coral collection is required after the first year of establishing a nursery since the nurseries produce enough coral tissue for both expansion and outplanting. Typically, approximately 20% of the corals in the nursery are designated to serve as broodstock while the remaining 80% will be outplanted. The broodstock corals are divided into multiple segments/fragments, which are maintained and grow in the nursery until they are ready to be outplanted.

NMFS believes that the collection of small fragments from wild *A. cervicornis* colonies will result in temporary effects on coral colonies. The collection of branch tip fragments from single staghorn coral colonies will result in a small reduction of coral colony biomass; however, this effect is expected to be temporary with recovery through tissue replacement and/or coral colony growth. *Acropora cervicornis*' dominant mode of reproduction is through asexual fragmentation. In the congener *Acropora palmata*, lesions at the point of fragment detachment have been shown to begin regeneration within 2 weeks of fragmentation (Lirman 2000), with regeneration rates being positively correlated with decreasing size of lesion and proximity to growing tip. The size of the lesion created in this project will be a function of the diameter of the branch being clipped. The diameter of staghorn coral branches ranges from 0.25 to 1.5 cm. Lirman (2000) showed that a 3-cm^2 lesion regenerated completely within 100 days. Given that

the rate of recovery is an exponential decay, it is expected that lesions 0.25 to 1.5 cm in diameter (less than 2.25 cm^2) will recover much faster than in Lirman's experiment.

Furthermore, the proposed collection of fragments from *A. cervicornis* colonies will occur at the outermost portion of the branch tip of the coral colony. Soong and Lang (1992) observed that, in *A. cervicornis*, large polyps and basal tissues located 1.0 to 4.5 cm from the colony base were infertile, and larger eggs were located in the mid-region of colony branches. Gonads located within 2 to 6 cm of the colony's branch tips always had smaller eggs than those in the mid-region (Soong and Lang 1992). Larger colonies (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). Thus, the effect of this activity on coral colony reproduction is insignificant. Given that the collected tissue samples are small in size (~20 cm) relative to coral colony size, that the effects of collecting such fragments are temporary, that fragmentation is a natural reproductive mode, and that these fragments will be collected from the outermost portion of the coral branch tip where smaller eggs are found, it is not likely that survival or reproductive output of staghorn coral colonies will be measurably reduced by the collection of staghorn fragments for nursery propagation.

The blended mitigation plan estimates that between 35,000 and 50,000 colonies of staghorn coral will be produced and outplanted to degraded reef sites, in the sizes and densities discussed above as needed to facilitate sustained, successful sexual reproduction. These colonies will supplement the wild populations within Broward County. Successful sexual reproduction is a goal of the recovery outline and identified as the key conservation goal of the critical habitat designation for staghorn (and elkhorn) corals. The purpose of outplanting staghorn coral into the wild is to enhance the wild population and provide additional potential for successful sexual reproduction. Outplanting will achieve the proper density and provide a source of varied genetic material which will increase the likelihood of sexual reproduction. Therefore, the survival and reproductive potential of staghorn coral will be enhanced by this action.

6.5 Effects of the Action on Proposed Coral Species

The analyses in this section are based upon the best available biological data on the proposed coral species and the effects of the proposed action. Data pertaining to effects from the proposed action relative to interactions with proposed species are limited. In such circumstances, we are often forced to make assumptions to overcome the limits in our knowledge. Frequently, different analytical approaches may be applied to the same data sets. In those cases, in keeping with the direction from the U.S. Congress to resolve uncertainty by providing the "benefit of the doubt" to threatened and endangered species [House of Representatives Conference Report No. 697, 96th Congress, Second Session, 12 (1979)], we will generally select the value yielding the most conservative outcome (i.e., the value which would lead to conclusions of higher, rather than lower, risk to endangered or threatened species).

We believe the proposed project will adversely affect 6 coral species that are proposed to be listed under the ESA (elliptical star coral, Lamarck's sheet coral, rough cactus coral, mountainous star coral, knobby star coral, and lobed star coral). Table 7 summarizes our estimates of the number of colonies of each proposed coral species that occur in the direct and indirect impacts areas. These estimates were calculated by applying the average species densities based on survey data provided by Dial Cordy, Inc. to each of the impact areas. In order to estimate the numbers of *O. annularis, O.fanksi,* and *O. faveolata* (because the Dial Cordy survey only identified the *Orbicella* complex) we applied the species densities from the study completed by Gillam and Walker (2011) to the total number of *Orbicella* complex identified in

the Dial Cordy, Inc. survey area. The Dial Cordy, Inc. survey was only conducted in the middle- and out-reef areas. No surveys have been conducted within the channel bottom and channel walls. Therefore, to be conservative we are applying the densities of the proposed corals from the middle and outer reefs to the channel and channel wall hardbottom. However, it is unlikely that the proposed corals occur at the same densities as on the reef itself. Due to the shipping activity in the channel, there is likely much poorer water quality conditions within the channel as compared to the reef. Therefore, we assume the coral densities are likely much lower. Further, the channel has been dredged within the last 30 years. Given the relatively slow growth rates of the proposed corals, it is likely that the colonies that do exist within the channel and channel walls are smaller sizes than those on the reef. Thus, we anticipate that the estimates we provide for mortality of proposed corals within the channel and channel walls are likely an overstimate; however, it is the best available information and provides a conservative assessment of impacts to the species.

Table 7. Estimated Proposed Coral Colonies Within the Impact Area

Proposed Coral Species	Mortality (Middle and Outer Reef <57ft 15.55 ac)	Relocation Survival (Middle and Outer Reef 15.55 ac)	Relocation Mortality (Middle and Outer Reef 15.55 ac)	Mortality (Middle and Outer Reef >57ft 6.11 ac)	Mortality (Channel Bottom and Walls 133 ac)	Mortality (Indirect Impact Area 1.96 acres)	Mortality Total
Lamarck's sheet	0	35	6	16	352	5	379
Elliptical star	1522	105	19	646	14,071	207	16465
Lobed star	1121	773	657	792	17,238	254	20062
Mountainous star	36	25	21	29	24	517	627
Knobby star	36	25	21	29	24	517	627
Rough cactus	82	35	6	48	1,055	16	1207

We assume that all the proposed corals that occur in impact areas other than the middle and outer reef shallower than 57 ft will be killed as a result of the dredging operations. The USACE has proposed to relocate all proposed corals greater than or equal to 10 cm longest linear dimension from the middle and outer reef impact areas shallower than 57 ft.

Even though the relocation of proposed coral colonies involve directed take (collection), the USACE has proposed the relocation because the effect to the species is significantly reduced as compared to the level of almost certain lethal take of the proposed coral that would occur through direct removal via dredging, anchor placement, and cable drag. Relocations will result in: (1) a high likelihood of continued survival of the coral transplants, (2) the survival of the unique genetic material of the transplanted colonies, and (3) the potential for use of the material in future restoration activities. The Consultation Handbook (USFWS and NMFS 1998) expressly authorizes such directed take as an RPM (see page 4-53). Therefore, NMFS will evaluate the expected level of take through relocation so that these levels can be included in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

Coral transplantation can successfully relocate colonies that would likely suffer injury or morality if not moved. Thornton et al. (2000) documented a 13% mortality rate for transplanted scleractinian corals in southeast Florida. The high rate of survival is attributed to the methods used and life history of corals. Lindahl (2003) showed that skilled handling does not significantly affect coral fragments or, by extension, coral colonies. Many different species of coral have shown high survival after transplantation, provided that colonies are handled with skill, are reattached properly, and the environmental conditions at the reattachment site are conducive to their growth (Maragos 1974, Birkeland et al. 1979, Harriott and Fisk 1988, Hudson and Diaz 1988, Guzman 1991, Kaly 1995, Becker and Mueller 1999, Tomlinson and Pratt 1999, Hudson 2000, Lindahl 2003, NCRI 2004).

The USACE and NMFS agree that all of the colonies of elliptical star, mountainous star, knobby star, lobed star, rough cactus, and Lamarck's sheet coral could be lethally taken during dredging if not relocated. Therefore, the USACE is proposing to relocate all colonies over 10 cm. We believe coral transplantation will be highly successful and relocating these corals outside the project area is an appropriate alternative to the take that would otherwise occur. The corals will be transplanted to the newly created artificial reef nearby the proposed project. Corals will be transplanted using the appropriate transplantation protocols (see Appendix B) by properly trained personnel. Corals will be placed on the artificial reef in area appropriate densities and grouped by species. Because suitable transplantation habitat is nearby and proper handling techniques are available and will be required, we have confidence that transplantation survival rates similar to those noted elsewhere will be likely in this case. We believe that a 15% coral morality rate of these corals being transplanted from their natural environment to areas nearby is a reasonable estimate; therefore, we anticipate an 85% survival rate of transplanted colonies.

The mitigation plan also includes the propagation and outplanting of corals to compensate for the impacts to corals and coral reef habitats. This portion of the mitigation plan is not finalized; therefore, it is unknown if any of the proposed species will be affected by this activity. None of the proposed coral species is currently in active propagation in any of the existing coral nurseries in Broward County. As described in Section 6.4, coral propagation and outplanting is beneficial to corals despite the initial take required to begin the nursery operations. Therefore, should any of the proposed species be propagated as part of the mitigation plan, the effects to them would also be beneficial.

In summary, we estimate that a maximum of 379 colonies of Lamarck's sheet coral, 16,465 colonies of elliptical coral, 20,062 colonies of lobed coral, 627 colonies of mountainous coral, 627colonies of knobby star coral, and 1207 colonies of rough cactus coral will be lethally taken during dredging activities. We also estimate that a maximum of 35 colonies of Lamarck's sheet coral, 105 colonies of elliptical coral, 773 colonies of lobed coral, 25 colonies of mountainous coral, 25 colonies of knobby star coral, and 35 colonies of rough cactus coral will be relocated and survive.

7 Cumulative Effects

Cumulative effects include the effects of *future* state, tribal, or local private actions – i.e., that are not already in the baseline -- that are reasonably certain to occur in the action area considered in this opinion. 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 (50

CFR 402.14). Actions that are reasonably certain to occur would include actions that have some demonstrable commitment to their implementation, such as funding, contracts, agreements or plans.

NMFS is aware of several future projects that may contribute to cumulative effects. Broward County is planning to begin construction on a mangrove enhancement project directly adjacent to the proposed Port expansion project. The County and Port also plan to expand the turning notch under a separate project. These activities will impact mangroves and may also impact Johnson's seagrass and sea turtles depending on the final construction methodology.

Within the action area, major future changes are not anticipated in addition to the ongoing human activities described in the environmental baseline. The present human uses of the action area, such as commercial shipping, are expected to continue, though some may occur at increased levels, frequency or intensity in the near future.

8 Jeopardy Analysis

The analyses conducted in the previous sections of this opinion provide the basis on which we determine whether the proposed action would be likely to jeopardize the continued existence of green and loggerhead sea turtles, Johnson's seagrass, staghorn coral, and corals proposed for ESA listing. In Section 6, we outlined how the proposed action would affect these species at the individual level and the magnitude of those effects based on the best available data. Next, we assess each of these species' response to the effects of the proposed action, in terms of overall population effects, and whether those effects will jeopardize their continued existence in the context of the status of the species (Section 4), the environmental baseline (Section 5), and the cumulative effects (Section 7).

It is the responsibility of the action 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 species or threatened species…" (ESA Section 7(a)(2)). Action agencies must consult with and seek assistance from the NMFS to meet this responsibility. NMFS must ultimately determine in a Biological Opinion whether the action jeopardizes listed species. To *jeopardize the continued existence of* is defined as "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 a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). The following jeopardy analysis first considers the effects of the action to determine if we would reasonably expect the action to result in reductions in reproduction, numbers, or distribution of loggerhead and green sea turtles, Johnson's seagrass, staghorn coral, or proposed coral species. The analysis next considers whether any such reduction would in turn result in an appreciable reduction in the likelihood of survival of these species in the wild, and the likelihood of recovery of these species in the wild.

8.1 Green Turtles

The potential lethal take of up to 2 green sea turtles (1 observed and 1 unobserved) by hopper dredge is a reduction in numbers. These lethal takes would also result in a potential reduction in future reproduction, assuming some individuals would be females and would have survived

otherwise to reproduce. All life stages are important to the survival and recovery of sea turtles; however, it is important to note that individuals of one life stage are not equivalent to those of other life stages. For example, the take of male juveniles may affect survivorship and recruitment rates into the reproductive population in any given year, and yet not significantly reduce the reproductive potential of the population. A very low percent of hatchlings is typically expected to survive to reproductive age. The death of mature, breeding females can have an immediate effect on the reproductive rate of the species. Sublethal effects on adult females may also reduce reproduction by hindering foraging success, as sufficient energy reserves are probably necessary for producing multiple clutches of eggs in a breeding year. Different age classes may experience varying rates of mortality and resilience. Further, an adult green sea turtle can lay 1-7 clutches (usually 2-3) of eggs every 2-4 years, with 110-115 eggs/nest of which a small percentage is expected to survive to sexual maturity. Green sea turtles are highly migratory, and individuals from all Atlantic nesting populations may range throughout the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. Because all the potential interactions are expected to occur at random throughout the proposed action area and sea turtles generally have large ranges in which they disperse, the distribution of green sea turtles in the action area is expected to be unaffected.

To be conservative, we assume that the green sea turtles that will be taken will be reproductive females, with a higher potential impact on the species relative to take of other stages. If the take is of a reproducing female, it is likely that such a turtle is part of the Florida population (female returning to nesting beach).

This species is currently showing a very large increasing nesting trend in Florida, with nesting numbers already approaching or exceeding those required by the recovery plan for the species. Therefore, we believe that the reduction in numbers and reproduction as a result of the lethal take is not expected to appreciably reduce the likelihood of survival of green sea turtles in the wild.

We also considered the recovery objectives in the recovery plan prepared for the U.S. populations of green sea turtles that may be affected by the predicted reduction in numbers and reproduction. The recovery plan for green sea turtles (NMFS and USFWS 1991) lists the following relevant recovery objectives relevant to the effects of the proposed action:

> • <u>The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years. Nesting data must be based on standardized surveys</u>. Between 2001 and 2006, an average of 5,039 green turtle nests were laid annually in Florida, with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS 2007a). That average increased to 7,436 nests per year for the 6-year period of 2004-2009. Data from the index nesting beach program in Florida support the dramatic increase in nesting. In 2007, there were 9,455 green turtle nests found just on index nesting beaches, the highest since index beach monitoring began in 1989. The number fell back to 6,385 in 2008, but that is thought to be part of the normal biennial nesting cycle for green turtles (FWC Index Nesting Beach Survey Database). An additional drop to just below 3,000 nests was seen on the index nesting beaches in 2009, but the occasional break from the normal biennial pattern is not without precedent, as there were 2 consecutive years of increase from 2003-2005 (FWC Index Nesting Beach Survey Database). State nesting data for 2011 show an

increase in green turtle nests to 10,701, the highest number of nests since 1988 (FWRI Web site: http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/).

• A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds. Currently, there are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas (where they come to forage) of the southeastern United States. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant (they have averaged 215 green sea turtle captures per year since 1977) in St. Lucie County, Florida, show that the annual number of immature green sea turtles captured has increased significantly in the past 26 years (FPL 2002). Ehrhart et al. (2007) has also documented a significant increase in in-water abundance of green turtles in the Indian River Lagoon area.

The lethal take of 2 turtles will result in a reduction in numbers and reproduction, but will not have any detectable influence on the population and nesting trends noted above. The loss of 2 individuals will not have an appreciable impact on total recruitment of new sea turtles to the population given the extent of the impact versus the very rapid population increases occurring over the past decade. Thus, the proposed action will not interfere with achieving the recovery objectives above and will not result in an appreciable reduction in the likelihood of green sea turtles' recovery in the wild.

8.2 Loggerhead Turtles (NWA DPS)

The potential lethal take of up to 2 loggerhead sea turtles (1 observed and 1 unobserved) by hopper dredge is a reduction in numbers. These lethal takes would also result in a reduction in reproduction as a result of lost reproductive potential, as some of these individuals would be females who would have survived other threats and reproduced in the future, thus eliminating each female individual's contribution to future generations. All life stages are important to the survival and recovery of sea turtles; however, it is important to note that individuals of one life stage are not equivalent to those of other life stages. For example, the take of male juveniles may affect survivorship and recruitment rates into the reproductive population in any given year, and yet not significantly reduce the reproductive potential of the population. A very low percent of hatchlings is typically expected to survive to reproductive age. The death of mature, breeding females can have an immediate effect on the reproductive rate of the species. Sublethal effects on adult females may also reduce reproduction by hindering foraging success, as sufficient energy reserves are probably necessary for producing multiple clutches of eggs in a breeding year. Different age classes may experience varying rates of mortality and resilience. Further, an adult female loggerhead sea turtle can lay 3-4 clutches of eggs every 2-4 years, with 100 to 130 eggs per clutch. The annual loss of adult female sea turtles, on average, could preclude the production of thousands of eggs and hatchlings of which a small percentage would be expected to survive to sexual maturity. A reduction in the distribution of loggerhead sea turtles is not expected from lethal takes during the proposed action. Because all the potential interactions are expected to occur at random throughout the proposed action area and sea turtles generally have large ranges in which they disperse, the distribution of loggerhead sea turtles in the action area is expected to be unaffected.

Whether or not the reductions in loggerhead sea turtle numbers and reproduction attributed to the proposed action would appreciably reduce the likelihood of survival for loggerheads depends on what effect these reductions in numbers and reproduction would have on overall population sizes and trends, i.e., whether the estimated reductions, when viewed within the context of the environmental baseline and status of the species, are of such an extent that adverse effects on population dynamics are appreciable. In Section 3.2.2, we reviewed the status of the species in terms of nesting and female population trends and several recent assessments based on population modeling [i.e., (Conant et al. 2009; NMFS-SEFSC 2009d)]. Below we synthesize what that information means in general terms and also in the more specific context of the proposed action.

Loggerhead sea turtles are a slow growing, late-maturing species. Because of their longevity, loggerhead sea turtles require high survival rates throughout their life to maintain a population. In other words, late-maturing species cannot tolerate much anthropogenic mortality without going into decline. Conant et al. (2009) concluded loggerhead natural growth rates are small; natural survival needs to be high; and even low to moderate mortality can drive the population into decline. Because recruitment to the adult population is slow, population modeling studies suggest even small increased mortality rates in adults and subadults could substantially impact population numbers and viability (Chaloupka and Musick 1997; Crouse et al. 1987; Crowder et al. 1994; Heppell et al. 1995).

The best available information indicates that the NWA loggerhead DPS is still large, but is possibly experiencing more mortality than it can withstand. All of the results of population models in both NMFS SEFSC (2009d) and Conant et al. (2009) indicated western North Atlantic loggerheads were likely to continue to decline in the future unless action was taken to reduce anthropogenic mortality. With the inclusion of newer nesting data beyond the 2007 data used in those analyses, the status of loggerhead nesting is beginning to show improvement. As previously described in the Status of the Species section, in 2008 nesting numbers were high, but not enough to change the negative trend line. Nesting dipped again in 2009, but rose substantially in 2010. With the addition of data through 2010, the nesting trend for the NWA DPS of loggerheads is only slightly negative and not statistically different from zero (no trend) (NMFS and USFWS 2010). Additionally, although the best fit trend line is slightly negative, the range from the statistical analysis of the nesting trend includes both negative and positive growth (NMFS and USFWS 2010). The 2011 nesting was on par with 2010, providing further evidence that the nesting trend may have stabilized and the 2012 index nesting number was the largest since 2000.

To be conservative, we assume that the loggerhead sea turtles that will be taken will be reproductive females, with a higher potential impact on the species relative to take of other stages.

NMFS SEFSC (2009d) estimated the minimum adult female population size for the western North Atlantic in the 2004-2008 time frame to likely be between 20,000 to 40,000 (median 30,050) individuals, with a low likelihood of being as many as 70,000 individuals. Estimates were based on the following equation: Adult females = (nests/(nests per female)) x remigration interval. The estimate of western North Atlantic adult loggerhead female was considered

conservative for several reasons. The number of nests used for the western North Atlantic was based primarily on U.S. nesting beaches. Thus, the results are a slight underestimate of total nests because of the inability to collect complete nest counts for many non-U.S. nesting beaches. In estimating the current population size for adult nesting female loggerhead sea turtles, NMFS SEFSC (2009d) simplified the number of assumptions and reduced uncertainty by using the minimum total annual nest count over the relevant 5-year period (2004-2008) (i.e., 48,252 nests). This was a particularly conservative assumption considering how the number of nests and nesting females can vary widely from year to year (cf., 2008's nest count of 69,668 nests, which would have increased the adult female estimate proportionately, to between 30,000 and 60,000). In addition, minimal assumptions were made about the distribution of remigration intervals and nests per female parameters, which are fairly robust and well known parameters. Florida's long-term loggerhead nesting data (1989-2012) has shown three distinct trends. Following a 23% increase between 1989 and 1998, nest counts declined sharply for over a decade. During the period between the high-count nesting season in 1998 and the most recent (2012) nesting season, researchers found no demonstrable trend, indicating a reversal of the post-1998 decline. The overall change in counts from 1989 to 2012 is positive. Nest counts in 2012, corrected for subtle variation in survey effort, were slightly below the high nest count recorded in 1998.

Based on the total numbers of adult females estimated by NMFS SEFSC for the western North Atlantic population of loggerhead sea turtles, the anticipated lethal take of 2 loggerheads – in the extremely unlikely worst case that both are female and adult –resulting from the proposed action would represent the removal of approximately 0.006% ([2/30,000] x 100) of the estimated adult loggerhead female population. These removals are very small and contribute only minimally to the overall mortality on the population. Further, these percentages are likely an overestimation of the impact of the anticipated lethal take resulting from the proposed project on loggerhead sea turtles for the following reason. These percentages represent impacts to adult female loggerhead sea turtles only, and not to the population as a whole. Because this estimated contribution to mortality is a tiny part of our range of uncertainty across what total mortality might be for loggerhead sea turtles, we believe that the small effect posed by the lethal take resulting from the proposed project will not result in a detectable or appreciable reduction in the species' likelihood of survival in the wild.

We also considered the recovery objectives in the recovery plan prepared for the U.S. populations of loggerhead sea turtles that may be affected by the predicted reduction in numbers and reproduction. The Services' recovery plan for the Northwest Atlantic population of the loggerhead turtle (NMFS and USFWS 2009), which is in essence the same population of turtles as comprise the NWA DPS, provides explanation of the goals and vision for recovery for this population. The objectives of the recovery plan most pertinent to the threats posed by dredging associated activities are numbers 11 and 13:

11. Minimize trophic changes from fishery harvest and habitat alteration…
13. Minimize vessel strike mortality.

As discussed above, the proposed action will remove several acres of foraging habitat for sea turtles; however, the project area is surrounded by abundant seagrass meadows and the channel slopes will be recolonized by epifauna and flora once the dredging has concluded. Therefore,

there will be insignificant effects from permanent loss of habitat that may have been used for foraging by sea turtles. Thus, the action will not interfere with achieving Objective 11. The take predicted from the action is entrainment of turtles by hopper dredges and thus does not constitute vessel strike mortality as envisioned in the recovery plan. Further, the proposed action is expected to reduce the level of vessel traffic using the inlet and harbor (fewer, larger vessels are anticipated). Further, since some of the larger vessels are already coming in at high tide with the narrow channels, there is a greater chance of turtles being struck since turtles don't have adequate room to move away from an oncoming ship. The widening and deepening should help to provide more room for turtles to avoid ships. Thus, the proposed action will not interfere with achieving Objective 13.

The recovery plan anticipates that, with implementation of the plan, the western North Atlantic population will recover within 50 to 150 years, but notes that reaching recovery in only 50 years would require a rapid reversal of the declining trends of the Northern, Peninsular Florida, and Northern Gulf of Mexico Recovery Units. The potential lethal take of 2 loggerheads during the project will result in reduction in numbers when take occurs and possibly by lost future reproduction, but given the magnitude of these trends and likely large absolute population size, it is unlikely to have any detectable influence on the population objectives and trends noted above. Loggerhead nest counts on Florida's index beaches have declined from a peak of nearly 60,000 in 1998. However, 2011 counts were close to the average of the previous 5 years. Although this may be the beginning of a stabilizing trend, additional good nesting years will be required to reverse the preceding decline (FWRI Web site: http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/).

Thus, the proposed action will not interfere with achieving the recovery objectives and will not result in an appreciable reduction in the likelihood of loggerhead sea turtles' recovery in the wild.

8.3 Johnson's seagrass

The estimated loss of up to 4.67 acres of Johnson's seagrass due to the proposed action is a conservative, reasonable worst-case scenario. The actual amount is likely much lower, but to be conservative, we assumed that all of the mixed beds contained 50% coverage of Johnson's seagrass. The loss of 4.67 acres of Johnson's seagrass is a reduction in numbers of the species. However, in terms of adverse effects on a larger, population scale, the Johnson's Seagrass Recovery Team determined that effects of dredging and filling activities are generally local and small -scale in nature and are not considered threats to the survival and recovery of the species. These activities will not individually or cumulatively result in the long -term, large -scale mortality of Johnson's seagrass, particularly in light of its "pulsating patches" life history strategy, discussed above. Thus, although up to 4.67 acres of Johnson's seagrass will be lost in the immediate action area, the project will not result in any adverse effects on a larger, population scale.

Reproduction will be reduced by the up to 4.67-acre reduction in Johnson's seagrass numbers, but NMFS considers that this reproductive loss does not appreciably reduce the likelihood of survival of Johnson's seagrass in the wild. Johnson's seagrass will continue to reproduce and spread because the proposed impacts are localized and will not affect any Johnson's seagrass

outside of the dredge footprint. Johnsons's seagrass exists in the Dania Cutoff Canal, south of the action area, and will not be impacted.

The proposed action will not result in a reduction of Johnson's seagrass distribution or fragmentation of the range since we expect Johnson's seagrass will persist outside of the action area (in the Dania Cutoff Canal to the south) and will continue to be capable of spreading via asexual fragmentation. Therefore, the reproductive potential of the species in this portion of its range will persist.

Recovery for Johnson's seagrass, as described in the recovery plan, 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).
NMFS believes that the proposed action will not appreciably reduce the likelihood of recovery of Johnson's seagrass in the wild. NMFS' s 2007 5-year review of the status of the species concluded that the first recovery objective has been achieved. In fact, the range has increased slightly northward. The proposed action will not impact the status of this objective. Self-sustaining populations are present throughout the range of the species. The species' overall reproductive capacity will be only minimally reduced by the reduction in Johnson's seagrass numbers and reproduction resulting from the action. The proposed dredging will not lead to separation of self -sustaining Johnson's seagrass patches to an extent that might lead to adverse effects to one or more patches of the species. Similarly, the availability of suitable habitat in which the species can spread/flow in the future will not be adversely affected by the proposed action. While additional individual impacts may continue to occur, over the last decade the species has not demonstrated any declining trends. The proposed action will not reduce or destabilize the present range of Johnson's seagrass. Therefore, the project will not appreciably reduce the likelihood of recovery of Johnson's seagrass in the wild.

8.4 Staghorn and Proposed Corals

In the following analysis, we evaluate the effects of the lethal take and nonlethal relocation of proposed corals from the Port Everglades Channel and the nonlethal collection of staghorn coral fragments for propagation and outplanting. Over the course of the Port Expansion activities and the 7-year mitigation project, we do not expect the proposed action to have any measurable impact on the reproduction, numbers, or distribution of the species.

As discussed in Section 6 (Effects of the Action), the expansion of Port Everglades is likely to adversely affect a maximum of 379 colonies of Lamarck's sheet coral, 16,465 colonies of elliptical coral, 20,062 colonies of lobed coral, 627 colonies of mountainous coral, 627colonies of knobby star coral, and 1207 colonies of rough cactus coral, by lethal take during dredging activities. However, the majority of the lethal take results from estimating the number of colonies that occur within the channel. We also estimate that a maximum of 35 colonies of Lamarck's sheet coral, 105 colonies of elliptical coral, 773 colonies of lobed coral, 25 colonies of mountainous coral, 25 colonies of knobby star coral, and 35 colonies of rough cactus coral will be relocated and survive.

The proposed action may also collect up to 250 fragments from wild colonies of staghorn coral and collect approximately 2,500 staghorn coral fragments of opportunity to support the propagation and outplanting portion of the mitigation plan.

We must now determine if the action would reasonably be expected to appreciably reduce, either directly or indirectly, the likelihood of staghorn coral or any of the proposed coral's survival and recovery in the wild.

Proposed Corals

Since the final listing has not yet been published, a recovery plan is not available for any of the proposed species. However, we can assess the effects of the proposed action on each of the proposed coral's populations in the context of our knowledge of the statuses of the species and their environmental baselines.

Lamarck's Sheet Coral.

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 379 colonies would result in a reduction in Lamarck's sheet coral distribution in the immediate action area. However, the species is found throughout the wider Caribbean region. In Florida, Lamarck's sheet coral is found from Palm Beach County through Monroe County. The action area for this project is located in the middle of this range. The proposed action will not result in a reduction of Lamarck's sheet coral distribution or fragmentation of the range since we expect Lamarck's sheet coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in Lamarck's sheet coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species, such as substrate availability, community structure, grazing pressure, fecundity, mode, and timing of reproduction. The anticipated loss of 379 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in Lamarck's sheet coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the Lamarck's sheet coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5-1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5

years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of Lamarck's sheet corals in the wild.

An estimated maximum of 379 colonies of Lamarck's sheet coral will be lethally taken during dredging activities. While we do not have exact population estimates for this species, a high number of colonies are believed to be still in existence through the species' range. *Agaricia lamarcki* has been reported to be common (Veron, 2000). A 2011 survey conducted by Nova Southeastern University just south of Port Everglades has identified 912 colonies of Lamarck's sheet coral over just 735 acres. On reefs at 30–40 m depths in the Netherlands Antilles, *Agaricia lamarcki* has increased (Bak and Nieuwland, 1995) or shown no decline in abundance from 1973 to 1992 (Bak et al. 2005), even though other non-agariciid corals on the same deep reefs have decreased. However, it is unknown whether this relative stability at depth holds across the full range of the species. As compared to the range-wide population estimates, the potential loss of 379 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for *Agaricia lamarcki* include the potential losses of this species to bleaching or disease (Brainard et al. 2011). When bleaching occurs for this species, effects can be severe; the species also likely has limited sediment tolerance. A factor that reduces extinction risk is that it occurs primarily at great depth, where disturbance events are less frequent. Despite low rates of sexual recruitment, the species is relatively persistent compared to other deep corals. The proposed project would not cause an increase in disease or bleaching. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of Lamarck's sheet coral recovery in the wild.

Elliptical Star Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 16,465 colonies would result in a reduction in elliptical star coral distribution in the immediate action area. However, the species is found throughout the Caribbean, the Gulf of Mexico, Florida (including the Florida Middle Grounds), the Bahamas, and Bermuda (Brainard et al. 2011). In Florida, elliptical star coral has been recorded in the Florida Keys National Marine Sanctuary, Flower Garden Banks, National Marine Sanctuary, and Biscayne National Park. The action area for this project is located in the middle of this range. The proposed action will not result in a reduction of elliptical star coral distribution or fragmentation of the range since we expect that elliptical star coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in elliptical star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 16,465 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action,

assuming all other variables remained the same. Therefore, the action will result in a reduction in elliptical star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the elliptical star coral colonies occur in the smaller size classes and no corals were observed larger than 40 cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5-1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of elliptical star corals in the wild.

An estimated maximum of 16,465 colonies of elliptical star coral will be lethally taken during dredging activities. While we do not have exact population estimates for this species, a high number of colonies are believed to be still in existence through the species' range. The overall colony density of *Dichocoenia stokesi* averaged across all habitat types in the south Florida region was ~ 1.6 colonies per 10 m^2, making it the ninth most abundant coral species in this region (Wagner et al., 2010). A 2011 survey conducted by Nova Southeastern University just south of Port Everglades has identified 5,514 colonies of elliptical star coral over just 735 acres. As compared to the range-wide population estimates, the potential loss of 16,465 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for *Dichocoenia stokesi* include its documented population-level impacts from disease. The proposed project would not cause an increase in disease. Factors that reduce potential extinction risk are its relatively high abundance and persistence across many habitat types, including nearshore and mesophotic reefs. Residency in a wide range of habitat types suggests the species has a wide tolerance to environmental conditions and, therefore, better capacity to deal with changing environmental regimes. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of elliptical star coral recovery in the wild.

Lobed Star Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 20,062 colonies of lobed star coral colonies would result in a reduction in lobed star coral distribution in the immediate action area. However, the species is common throughout U.S. waters of the western Atlantic and greater Caribbean, including Florida and the Gulf of Mexico. Within its range it is found within federally protected waters in the Flower Garden Bank Sanctuary, Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of lobed star coral distribution or fragmentation of the range since we expect that lobed star coral will persist within the action area due to relocation of colonies

(from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in lobed star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 20,062 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in lobed star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the lobed star coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5 -1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of lobed star corals in the wild.

While it is now widely accepted that *O. annularis* is only 1 of 3 valid species (the others being *O. franksi and O. faveolata*), long-term monitoring data sets and previous ecological studies did not distinguish among them, referring instead to the *Orbicella* complex. Although the biological review team that conducted the status review that resulted in the proposal to list these species estimated extinction risk separately for each species, much of the information available is for the complex as a whole (Brainard et al. 2011). An estimated maximum of 20,062 colonies of lobed star coral will be lethally taken during dredging activities. There is ample evidence that it has declined dramatically throughout its range (but perhaps at a slower pace than its fast-paced Caribbean colleagues, *Acropora palmata* and *Acropora cervicornis*). However, the *Orbicella* complex has historically been a dominant species on Caribbean and Florida coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau, 1959). Therefore, we believe that, even with the recent declines, there are still high numbers of lobed star coral throughout its range. As compared to the range-wide population estimates, the potential loss of 20,062 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for lobed star coral include very low productivity (growth and recruitment), documented dramatic declines in abundance, its restriction to the degraded reefs of the wider Caribbean region, and its preferential occurrence in shallow habitats. The proposed project would not increase any of these threats. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of lobed star coral recovery in the wild.

Mountainous Star Coral
The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 627 colonies of mountainous star coral colonies would result in a reduction in mountainous star coral distribution in the immediate action area. However, the species is common throughout U.S. waters of the western Atlantic and greater Caribbean, including Florida and the Gulf of Mexico. Within its range it is found within federally protected waters in the Flower Garden Bank Sanctuary, Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of mountainous star coral distribution or fragmentation of the range since we expect that mountainous star coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in mountainous star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 627 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in mountainous star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the mountainous star coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5 -1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of mountainous star corals in the wild.

While it is now widely accepted that *O. faveolata* is only 1 of 3 valid species (the others being *O. franksi and O. annularis*), long-term monitoring data sets and previous ecological studies did not distinguish among them, referring instead to the *Orbicella* complex. Although the biological review team has estimated extinction risk separately for each species, much of the information available is for the complex as a whole (Brainard et al. 2011). An estimated maximum of 627 colonies of mountainous star coral will be lethally taken during dredging activities. There is ample evidence that it has declined dramatically throughout its range (but perhaps at a slower pace than its fast-paced Caribbean colleagues, elkhorn and staghorn corals [*Acropora palmata* and *Acropora cervicornis*]). However, the *Orbicella* complex has historically been a dominant

species on Caribbean and Florida coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau, 1959). Therefore, we believe that even with the recent declines that there are still high numbers of mountainous star coral throughout its range. A 2011 survey conducted by Nova Southeastern University just south of Port Everglades has identified 4,030 colonies of mountainous star coral over just 735 acres. As compared to the range-wide population estimates, the potential loss of 627 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for mountainous star coral include very low productivity (growth and recruitment), documented dramatic declines in abundance, its restriction to the degraded reefs of the wider Caribbean region, and its preferential occurrence in shallow habitats. The proposed project would not increase any of these threats. Therefore, NMFS believes that the proposed action is not likely to reduce the chances of mountainous star coral recovery in the wild.

Knobby Star Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 627 colonies of knobby star coral colonies would result in a reduction in knobby star coral distribution in the immediate action area. However, the species is is common throughout U.S. waters of the western Atlantic and greater Caribbean, including Florida and the Gulf of Mexico. Within its range it is found within federally-protected waters in the Flower Garden Bank Sanctuary, Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of knobby star coral distribution or fragmentation of the range since we expect that knobby star coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in knobby star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 627 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in knobby star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the knobby star coral colonies occur in the smaller size classes and no corals were observed larger than 40 cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further,

given the relatively slow growth rates of the proposed corals (~0.5-1 cm/yr), we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of knobby star corals in the wild.

While it is now widely accepted that *O. franksi* is only 1 of 3 valid species (the others being *O. faveolata and O. annularis*), long-term monitoring data sets and previous ecological studies did not distinguish among them, referring instead to the *Orbicella* complex. Although the biological review team has estimated extinction risk separately for each species, much of the information available is for the complex as a whole (Brainard et al. 2011). An estimated maximum of 627 colonies of knobby star coral will be lethally taken during dredging activities. There is ample evidence that it has declined dramatically throughout its range (but perhaps at a slower pace than its fast-paced Caribbean colleagues, *Acropora palmata* and *Acropora cervicornis*). However, the *Orbicella* complex has historically been a dominant species on Caribbean and Florida coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau, 1959). Therefore, we believe that even with the recent declines that there are still high numbers of knobby star coral throughout its range. As compared to the range-wide population estimates, the potential loss of 627 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for knobby star coral include very low productivity (growth and recruitment), documented dramatic declines in abundance, its restriction to the degraded reefs of the wider Caribbean region, and its preferential occurrence in shallow habitats. The proposed project would not increase any of these threats. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of knobby star coral recovery in the wild.

Rough Cactus Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 1,207 colonies of rough cactus coral colonies would result in a reduction in rough cactus coral distribution in the immediate action area. However, *Mycetophyllia ferox* occurs throughout the U.S. waters of the western Atlantic but has not been reported from Flower Garden Banks (Hickerson et al., 2008). Within its range it is found within federally-protected waters in the Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of rough cactus coral distribution or fragmentation of the range since we expect that rough cactus coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in rough cactus coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction.

We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 1,207 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in rough cactus coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the rough cactus coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5 -1 cm/yr), we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of rough cactus corals in the wild.

An estimated maximum of 1,207 colonies of rough cactus coral will be lethally taken during dredging activities. Mycetophyllia ferox is usually uncommon (Veron, 2000) or rare according to published and unpublished records, indicating that it constitutes < 0.1% species contribution (percent of all colonies censused) and occurs at densities < 0.8 colonies per 10 m^2 in Florida (Wagner et al., 2010) and at 0.8 colonies per 100 m transect in Puerto Rico sites sampled by the Atlantic and Gulf Rapid Reef Assessment (AGRRA database online at http://www.agrra.org). Recent monitoring data (e.g., since 2000) from Florida (National Park Service permanent monitoring stations), La Parguera (Puerto Rico), and St. Croix (USVI/NOAA Center for Coastal Monitoring and Assessment randomized monitoring stations) show *Mycetophyllia ferox* cover to be consistently less than 1%, with occasional observations up to 2% and no apparent temporal trend (available online at http://www8.nos.noaa.gov/biogeo_public/query_habitat.aspx). Given the amount of reef tract in Florida, even at <0.8 colonies per 10m^2 there is still likely to be a high number of rough cactus coral colonies throughout Florida and even higher numbers throughout the range. As compared to the range-wide population estimates, the potential loss of 1,207 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for *Mycetophyllia ferox* include disease and rare abundance. Limited available information suggests that this species suffered substantial population declines in recent decades, primarily as a result of coral disease. The proposed project would not increase coral disease. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of mountainous star coral recovery in the wild.

Staghorn Coral

The blended mitigation plan involves directed (intentional) take of coral fragments from up to 250 colonies of staghorn coral and collection of up to 2,500 "coral fragments of opportunity."

Although a recovery plan has not been finalized at this time for staghorn coral, we consider the recovery vision statement from the *Acropora* Recovery Outline (available at http://sero.nmfs.noaa.gov/pr/protres.htm) relevant to analyze the effects on recovery:

> Staghorn (and elkhorn) coral populations should be large enough so that reproducing individuals comprise numerous populations across their historical geographic range (wider Caribbean) and additionally, should be large enough to protect the species' genetic diversity. Threats to the species and habitat loss and degradation will be sufficiently abated to ensure a high probability of survival into the future.

No reduction in numbers, reproductive potential, or distribution of staghorn coral will result from the proposed actions. The directed take through fragment collection from up to 250 wild staghorn colonies will result in temporary impacts to the donor colony and will not result in the removal of any whole colonies. Corals of opportunity collected for propagation and outplanting would have likely otherwise died since they are unattached to the seafloor (e.g., as a result of ship groundings or storm events). Staghorn fragments collected from either source will be propagated and outplanted to degraded reefs within the action area. Therefore, there will be no reduction in numbers of staghorn coral. Rather, through the proposed action, there will be an increase in numbers of staghorn coral.

The collection of small fragments from the branch tips of staghorn coral is not anticipated to have any effect on the sexual or asexual reproduction of the donor colonies. Coral fragments are not collected during the summer months when the corals are producing eggs and sperm. The growing tip heals quickly and regains its reproductive potential quickly also. As stated above, corals of opportunity would likely have died without collection; therefore, collection results in preservation of the reproductive potential of the fragment. Last, the collected fragments will be propagated and outplanted resulting in an increase of reproductive output as compared to the potential the fragment had prior to collection. NMFS does not believe the proposed action is likely to impede staghorn coral's ability to reproduce sexually due to the loss or impacts to the reproductive capacity.

The proposed action is not expected to result in any lethal take of staghorn coral. We have determined that the directed take through fragment collection from up to 250 wild staghorn colonies will result in temporary impacts to the donor colony and will not result in the removal of any whole colonies. Collection of corals of opportunity will not reduce the species range, as these colonies would have died without having been collected. Further, the collected fragments will be propagated within nurseries and outplanted within the same geographic area (Broward County). Therefore, we believe that there would be no measurable effect on the distribution of the species throughout its range. The proposed action will not result in a reduction of numbers, reproduction, or distribution of staghorn corals. Hence, we have determined that the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of these coral species in the wild.

9 Analysis of Destruction or Adverse Modification of Designated Critical Habitat

Critical habitat was designated for elkhorn and staghorn corals, in part, because further declines in the low population sizes of the species could lead to threshold levels that make the chances for recovery low. More specifically, low population sizes for these species could lead to an Allee effect and lower effective density (of genetically distinct adults required for sexual reproduction), and a reduced source of fragments for asexual reproduction and recruitment. In other words, a staghorn coral mate may be too far away for successful sexual reproduction to occur. Therefore, the key conservation objective of designated critical habitat is to facilitate increased incidence of successful sexual and asexual reproduction (i.e., increase the potential for sexual and asexual reproduction to be successful), which in turn facilitates increases in the species' abundance, distribution, and genetic diversity. To this end, our analysis of whether the proposed action is likely to destroy or adversely modify designated critical habitat seeks to determine if the adverse effects of proposed action on the essential features of designated *Acropora* critical habitat will appreciably reduce the capability of the critical habitat to facilitate an increased incidence of successful sexual and asexual reproduction. This analysis takes into account the current status of each species; for example, the level of increased incidence of successful reproduction that needs to be facilitated may be different depending on the recovery status of elkhorn and staghorn corals in the action area. This analysis also takes into account the geographic and temporal scope of the proposed action, recognizing that functionality of critical habitat necessarily means that it must currently and in the future continue to support the conservation of the species and progress toward recovery.

The key objective for the conservation and recovery of listed coral species identified for the designated critical habitat is the facilitation of an increase in the incidence of sexual and asexual reproduction. Recovery cannot occur without protecting the essential feature of critical habitat from destruction or adverse modification because the quality and quantity of suitable substrate for listed corals affects their reproductive success. The proposed action will result in the permanent loss of up to 23.62 acres of critical habitat via direct removal, fracturing and rubble creation, and sedimentation. Therefore, this portion of critical habitat will be permanently unavailable and unsuitable for coral recruitment.

As described in Section 6.3 above, the permanently affected portion of the critical habitat has the conservation potential of supporting up to 31,878 colonies of staghorn coral. This conservation potential would be realized if the area was eventually occupied by that number of colonies, which is dependent on several biological and physical factors that affect future success of staghorn corals colonizing these particular reefs. At the time of the critical habitat designation, and given the severely decreased abundance and depressed sexual reproduction of staghorn and elkhorn corals, NMFS determined it was necessary to include all of the essential feature (i.e., settlement substrate) that occurs in each critical habitat area within the designation, to maximize the potential that successful recruitment could occur. However, on finer scales, not every portion of critical habitat has the exact same conservation potential at any given time. The critical habitat within the project area is subject to wave action and pollution from constant large vessel traffic (i.e., physical and chemical barriers to conservation potential of the critical habitat).

Furthermore, there are currently no visible staghorn colonies within or near the permanently affected critical habitat (Dial Cordy, Inc. 2006) which would be capable of providing gametes for sexual reproduction (i.e., there currently exists a biological barrier to the conservation potential of the critical habitat). Therefore, we believe that the critical habitat within the dredge footprint would not achieve the density of adult staghorn colonies necessary to facilitate sexual reproduction (i.e., the conservation potential) during the construction timeframe of the project (up to 10 years) and potentially not soon after construction, given the completed project may exacerbate the physical and chemical barriers to recruitment discussed above.

The blended mitigation plan will likely use existing permitted coral nurseries which could supply colonies of suitable size (20 cm or greater) immediately. Even if colonies were not immediately available, it would take less than 1 year to grow corals to the appropriate size and begin outplanting. In either case, outplanting is expected to be implemented several years before the project construction impacts would occur. The above calculations indicate the minimum number of staghorn colonies necessary to immediately attain and maintain the density and coverage area recommended to achieve the population-based goals identified by the recovery team, and therefore also, the number of colonies necessary to provide the maximum conservation potential of the permanently adversely affected critical habitat area. However, this assumes 100% survival of outplanted colonies and no partial mortality. The assumption that no mortality will occur is unrealistic based on observations of approximately 75%-90% survival of outplants. Therefore, we assume a 20% increase in the number of required outplanted colonies (20% of 31,878 = 6,376 additional colonies) to buffer against loss from sources of mortality such as disease, predation, and stochastic events. Thus, accounting for the number of colonies needed to meet the population goal and the number of colonies needed to buffer against mortality, 38,254 colonies (31,878 + 6,376 = 38,254) of the size and density described above, are necessary to fully realize the conservation potential of the permanently affected area.

As stated above, we do not believe that the critical habitat in the dredge footprint will meet the conservation goal within the lifetime of the project, if ever. The propagation and outplanting will achieve the maximum conservation benefit of appropriate numbers and densities of adult staghorn colonies within 7 years. Also, the number of staghorn colonies necessary to meet the conservation potential of the permanently affected area is at the low end of the range of staghorn coral colonies proposed in the mitigation plan (i.e., 35,000-50,000). We believe that despite the loss of 23.62 acres of habitat the proposed action will have beneficial effects on designated critical habitat, by accelerating the provision of its intended conservations functions for staghorn coral; the conservation potential of the critical habitat areas to be occupied by the outplanted colonies will be realized on a much shorter time scale than would be possible naturally due to the currently low population densities of staghorn within this portion of designated critical habitat.

Above we calculated the maximum reproductive potential of the adversely affected portion of critical habitat as supporting up to 31,878 of 20-cm-diameter colonies of staghorn coral at the densities and coverages identified by the recovery team. Thus, this portion of critical habitat would realize its full potential to support recovery if it were colonized by 31,878 colonies of staghorn coral. As noted above, we do not believe that this portion of critical habitat would reach that goal during the lifetime of this project, if ever, given the current depressed abundance of staghorn coral that could provide recruits to colonize the area, and the physical barriers to colonization resulting from the existence of the harbor. The proposed action also includes the propagation and outplanting of 35,000 to 50,000 20-cm staghorn corals as part of the USACE's

mitigation plan. These colonies will be outplanted over a 7-year period, thus contributing to the recovery of the species within this portion of the species' range over a very short time frame. The propagation and outplanting of staghorn coral will exceed the reproductive potential of the portion of critical habitat adversely affected. Further, the final blended mitigation plan will require that the outplanting be conducted in densities and genotypic composition to maximize the sexual reproductive potential. Currently, the species' low population size and patchy distribution is impeding the chances of successful sexual reproduction. The outplanting will increase the sexual reproductive potential within this portion of critical habitat as compared to status quo. Therefore, the project as a whole will not impede the recovery of the listed corals in the action area or range-wide despite the loss of 23.62 acres of critical habitat within the action area. Rather, it may even increase the likelihood of recovery of the species. As such, the proposed project would not destroy or adversely modify the designated critical habitat for listed corals.

In the event that the USACE selects a contractor who will anchor outside of the channel we have determined that there will be an additional 19.31 acres of permanent adverse impacts to critical habitat from anchor and cable drag. These impacts are considered *potential* impacts at this time, because they may or may not occur depending on the contractor selected. Therefore, they were not included in the total calculations above for the blended mitigation plan requirements. Should an additional impact of up to 19.31 acres of critical habitat result from anchor placement and cable drag, additional reef enhancement will be required via coral propagation and outplanting. An appropriate amount of staghorn corals will be included to achieve the mitigation requirements and conservation of the species. The USACE will be required to ouplant staghorn corals of the size and density described above in order to realize the full conservation potential of the additional 19.31 acres of critical habitat that would be permanently lost.

10 Conclusion

Using the best available data, we analyzed the effects of the proposed action in the context of the status of the species, the environmental baseline, and cumulative effects, and determined that the proposed action is not likely to jeopardize the continued existence of staghorn coral, any of the 6 corals proposed for listing, or Johnson's seagrass. These analyses focused on the impacts to, and population responses of, these species. Because the proposed action will not reduce the likelihood of survival and recovery of corals proposed for listing or Johnson's seagrass, it is our opinion that the proposed action is also not likely to jeopardize the continued existence of these species.

After reviewing the current status of staghorn coral critical habitat, the environmental baseline, the effects of the proposed actions, and the cumulative effects, it is our opinion that the expansion of Port Everglades will not impede the critical habitat's ability to support the conservation of staghorn (or elkhorn) corals and therefore will not destroy or adversely modify the critical habitat.

11 Incidental Take Statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit take of endangered and threatened species, respectively, without 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. *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

NMFS must estimate the extent of take expected to occur from implementation of the proposed action to frame the limits of the take exemption provided in the Incidental Take Statement. These limits set thresholds that, if exceeded, would be the basis for reinitiating consultation. The following section describes the extent of take that NMFS anticipates will occur as a result of implementing the proposed action. If actual take exceeds an amount (or geographic or temporal extent) specified here, the exemption from the prohibition on take will be invalid for the excess amount, and re-initiation of consultation is required.

The prohibitions against taking the species found in Section 9 of the Act do not apply until the species is listed. However, NMFS advises the USACE to consider implementing the following reasonable and prudent measures. If the conference consultation on species proposed to be listed in opinion is adopted as a biological opinion following final listing, these measures, with their implementing terms and conditions, will be nondiscretionary, and must be undertaken by the USACE so that they become binding conditions of any grant, permit, or contract issued, as appropriate, for the exemption in Section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this incidental take statement. If the USACE (1) fails to assume and implement the terms and conditions or (2) fails to require the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USACE must report the progress of the action and its impact on the species to NMFS as specified in the Incidental Take Statement (50 CFR §402.14(i)(3)).

11.1 Anticipated Amount of Take for Sea Turtles

Based on historical distribution data and hopper dredge observer take reports documenting previous hopper dredge takes of loggerhead and green sea turtles near the action area, we estimate that these 2 species may occur in the action area and may be taken by the hopper dredging operations of this project, by crushing and/or entrainment in suction dragheads. NMFS anticipates incidental take will consist of a total of 2 sea turtles (1 green and 1 loggerhead, or 2 greens, or 2 loggerheads) killed during hopper dredging at Port Everglades. Based on previous experience, we believe only 1 of these takes will be entrained, detected, and/or documented by onboard protected species observers. Therefore, we believe that there will be 1 *observed* take of either a green or a loggerhead.

Effect of the Take
NMFS has determined the anticipated level of incidental take specified in Section 11.1 is not likely to jeopardize the continued existence of loggerhead (NWA DPS), or green sea turtles.

11.2. Extent of Anticipated Take – Staghorn Coral

NMFS anticipates that the proposed action will result in take of this species in the form of collection. Coral nurseries will be established or augmented to support propagation of staghorn coral. Up to 250 colonies of staghorn corals are likely to be collected from the wild to supplement corals already established in nursery. Approximately 2,500 coral fragments of opportunity may also be collected. "Corals of opportunity" are the preferred source of colonies to populate coral nurseries, because they would have otherwise likely died without being collected and brought into the nursery. Sometimes, however, it is necessary to collect fragments from the wild to supplement the nursery population.

The protective regulations pursuant to ESA section 4(d) for staghorn provides for certain exceptions to the ESA section 9 prohibitions scientific research and species enhancement, and restoration carried out by authorized personnel (73 FR 64264; October 29, 2008). Thus, the take that may result from this project's propagation and outplanting of staghorn corals is not prohibited, as long as the actions are carried out pursuant to: (1) the exceptions in the 4(d) rule and (2) the Biological Opinion on the issuance of the rule. Because all activities related to coral propagation (i.e., wild collection, nursery establishment and operation, and outplanting) in Broward County require a State of Florida Special Activity License (SAL), the USACE will be required to hold a valid permit (SAL) and they will ne incompliance with the 4(d) rule. Thus, the take will not be prohibited and no incidental take statement is required. However, see the discussion below regarding consequences of the potential reclassification of this species to endangered status.

11.3 Extent of Anticipated Take – Proposed Corals Including Staghorn Listed as Endangered

As previously stated, NMFS has proposed to reclassify staghorn coral from threatened to endangered and proposed to list 6 additional coral species that occur within the action area. Should that proposal become final (decision due June 2014), the aforementioned 4(d) rule for staghorn corals will be void because there are no exceptions to the take prohibitions allowed for endangered corals. Therefore, the take that will result from the propagation activities will need authorization. Further, 6 coral species proposed for listing will be either lethally taken or relocated from the action area. Therefore, the take that would result from these activities would also have to be authorized.

In additional to take being authorized through biological opinions, NMFS may authorize take through ESA Section 10. Take that results from scientific research or enhancement activities may be authorized by an ESA Section 10(a)(1)(A) permit. Because there are multiple staghorn coral nurseries currently operational, the NOAA Restoration Center has submitted an application for an ESA Section 10(a)(1)(A) permit for propagation of the proposed endangered corals, in anticipation and preparation for the potential that they may be listed as endangered. This permit application covers activities conducted by the Restoration Center and its partners. It is anticipated that one of these entities would carry out the coral propagation activities proposed in

the Port Everglades expansion; thus, should they receive their ESA Section 10 permit, the take that would result from this project would be authorized. Should that permit not be issued by the time the propagation portion of this project commences, the USACE will need to reinitiate consultation to request authorization for the take.

Since the USACE has requested conference consultation on the proposed species, at the proper time they must request that this Conference Opinion be confirmed as NMFS's Biological Opinion should the species be listed/reclassified. At that time, the USACE will also request take authorization for the corals that are ultimately listed as endangered that are proposed to be lethally taken and/or relocated from the action area. Based on our analyses in Section 6.5, we anticipate the following take of the proposed corals:

Table 8. Estimated Maximum Amount of Take of Proposed Coral Species From the Port Everglades Expansion Project

Proposed Coral Species	Mortality (Middle and Outer Reef <57ft 15.55 ac)	Relocation Survival (Middle and Outer Reef 15.55 ac)	Relocation Mortality (Middle and Outer Reef 15.55 ac)	Mortality (Middle and Outer Reef >57ft 6.11 ac)	Mortality (Channel Bottom and Walls 133 ac)	Mortality (Indirect Impact Area 1.96 acres)	Mortality Total
Lamarck's sheet	0	35	6	16	352	5	379
Elliptical star	1522	105	19	646	14,071	207	16465
Lobed star	1121	773	657	792	17,238	254	20062
Mountainous star	36	25	21	29	24	517	627
Knobby star	36	25	21	29	24	517	627
Rough cactus	82	35	6	48	1,055	16	1207

Effect of the Take

NMFS has determined the anticipated take specified in Section 11.2 is not likely to jeopardize the continued existence of staghorn coral if the project is developed as proposed. NMFS also has determined the anticipated take specified in Section 11.3 is not likely to jeopardize the continued existence of any of the proposed corals if the project is developed as proposed.

12 Reasonable and Prudent Measures (RPMs)

Section 7(b)(4) of the ESA requires NMFS to issue a statement specifying the impact of any incidental take on listed species, which results from an agency action otherwise found to comply with Section 7(a)(2) of the ESA. It also states that the RPMs necessary to minimize the impacts of take and the terms and conditions to implement those measures must be provided and must be followed to minimize those impacts. Only incidental taking by the federal agency or applicant that complies with the specified terms and conditions is authorized.

The RPMs and terms and conditions are specified as required by 50 CFR 402.12 (i)(1)(ii) and (iv) to document the incidental take by the proposed action and to minimize the impact of that take on staghorn coral. These measures and terms and conditions are non-discretionary, and must be implemented by the USACE or the contractor in order for the protection of Section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this ITS. If the USACE or the contractor fails to adhere to the terms and conditions of the ITS through enforceable terms, and/or fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of the incidental take, the USACE or the contractor must report the progress of the action and its impact on the species to NMFS as specified in the ITS [50 CFR 402.12(i)(3)].

NMFS has determined that the following RPMs are necessary and appropriate to minimize impacts of the incidental take of staghorn coral colonies and proposed coral species during the proposed action. The following RPMs and associated terms and conditions are established to implement these measures, and to document incidental takes. Only incidental takes that occur while these measures are in full implementation are authorized. These restrictions remain valid until reinitiation and conclusion of any subsequent Section 7 consultation.

1. Pre-construction survey. The USACE will conduct a pre-construction survey to document all listed and proposed species prior to construction.

2. The USACE must ensure that all colonies of coral species proposed to be listed that are over 10 centimeters are relocated from the middle and outer reefs prior to beginning construction. The USACE is also authorized to relocate smaller colonies (4 cm and greater). (Please note: the requirement to relocate corals of 10 cm or greater is based on specific details associated with this project and may not to be used as the standard for future biological opinions. NMFS recommends that the USACE relocate all proposed species greater than 4 cm.)

3. Blended Coral Mitigation plan. The USACE must refine and implement the blended mitigation plan discussed throughout this opinion.

4. Environmental monitoring plan. USACE must conduct environmental monitoring to assess whether environmental impacts of the project exceed thresholds identified in the DEIS.

The USACE must provide NMFS with all data collected during monitoring events conducted, as well as any monitoring reports generated following the completion of the proposed project. The monitoring programs shall include reporting requirements to ensure NMFS, USACE, and other relevant agencies are aware of corrective actions being taken when thresholds are exceeded, as well as ensure NMFS receives data related to the condition of listed corals in the area due to the importance of these listed species.

13 Terms and Conditions

In order to be exempt from liability for take prohibited by Section 9 of the ESA, USACE must comply with the following terms and conditions, which implement the RPMs described above. These terms and conditions are nondiscretionary.

1. USACE must record the location and size of all listed and proposed corals during the pre-construction surveys and provide this info to NMFS. (RPM 1)

2. Relocation of proposed coral species: Since transplantation can be stressful on corals and the natural environment is variable, we believe the best way to minimize stress and ensure the survival of all transplanted colonies is to follow the established protocols (see Appendix B). Qualified individuals following the protocols in Appendix B must conduct transplantation. The USACE must ensure that all transplanted colonies are relocated to suitable habitat near their original location, but no closer than 400 ft from the edge of the channel. For the purposes of this opinion, suitable habitat is considered: similar depth as origin (+/- 5ft), uncolonized hard substrate, appropriate water quality (based on water quality data and local knowledge), and minimal chances of other disturbances (boat groundings, damage caused by curious divers/fisherman). (RPM 2)

3. USACE must record the original location of each transplanted colony, as well as the location of each colony after transplantation. (RPM 2).

4. The detailed blended coral mitigation plan will continue to be refined and implemented in coordination with NMFS. The plan includes a comprehensive monitoring plan for all relocated and outplanted corals. USACE will submit a final, detailed mitigation plan to NMFS prior to construction. USACE will report progress in implementing and monitoring the mitigation plan, as specified in the final mitigation plan (RPM 3).

5. USACE shall continue to work with the established interagency team including USACE, NMFS, EPA, FDEP, and FWC to refine the environmental monitoring plan and to evaluate its effectiveness during implementation. USACE shall submit the final refined environmental monitoring plan to NMFS prior to construction. (RPM 4).

6. The monitoring methods employed shall be capable of detecting sedimentation and turbidity and physical impacts in coral reef and hardbottom habitat within 150 meters of the dredging areas, and detecting whether impacts are likely to exceed adverse impacts considered in this Opinion in a timely manner allowing for adaptive management, during all phases of construction. USACE shall share monitoring results with the interagency team (RPM 4).

7. In the event that monitoring of coral reef and hardbottom habitat within the 150 meter zone indicates that listed coral species are likely to be adversely impacted by dredging-related turbidity, sedimentation, or physical impacts in a manner or to a degree that would exceed the adverse impacts considered in this Opinion, USACE shall implement an adaptive management plan to avoid or minimize the impacts, which may include additional transplanting and monitoring of corals and hardbottom organisms. In developing the adaptive management plan, USACE shall consult with the interagency team and consider recommendations from the team. The USACE's selected adaptive management plan shall be provided to the interagency team before the time the adverse impacts considered in this opinion are expected to be exceeded. A goal of the adaptive management plan will be to avoid the need for reinitiation of consultation on this Opinion, but additional coordination may be required with NMFS to, for example, provide authorization for additional transplanting and relocation. (RPM 4).

8. USACE must ensure that all appropriate natural resource permits are obtained prior to relocation, propagation, and outplanting of corals. (RPMs 2, 3, and 4)

14 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 further the conservation of listed and proposed coral species. NMFS strongly recommends that these measures be considered and implemented, and requests to be notified of their implementation.

1. NMFS recommends that in addition to the proposed sharing of monitoring and reporting data, the USACE provide NMFS's Southeast Region Protected Resource Division (PRD), with the collected data submitted for all projects permitted concerning listed and proposed coral species.

2. NMFS continues to recommend that the USACE relocated all proposed and listed coral species 4 cm and greater. This is consistent with the best available science and the NMFS Habitat Office's conservation recommendations.

3. NMFS recommends that the USACE provide the location and size of all proposed and listed corals to all persons who hold the proper permits and who may be interested in rescuing those corals for use in research or educational activities.

4. NMFS strongly recommends that the USACE, in consultation with PRD, utilize its authority to carry out programs for the conservation of listed and proposed corals. Pursuant to ESA Section 7(a)(1), the USACE should develop a program to donate a

fragment of each acroporid colony directly impacted by all authorized or permitted activities to an appropriate coral nursery.

5. NMFS recommends that USACE prepare and use a report of all current and proposed USACE projects in the range of Johnson's seagrass 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.

6. NMFS recommends that the USACE conduct and support research to assess trends in the distribution and abundance of Johnson's seagrass. USACE should contribute data collected 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.

7. 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.

8. 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.

9. NMFS recommends that the USACE promote 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.

10. 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).

11. 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).

In order to keep NMFS informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

15 Reinitiation of Consultation

As provided in 50 CFR Section 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) 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, (2) 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 (3) a new species is listed or critical habitat designated that may be affected by the identified action. In addition, if the USACE chooses a contractor or dredging methodology which may result in impacts to listed species or critical habitat above that which is considered in this Opinion, in particular, the impacts to critical habitat from anchoring discussed in section 6.3 above, reinitiation will be required.

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APPENDIX A

Background

Vessel Strike Avoidance Measures and Injured or Dead Protected Species Reporting NOAA Fisheries Service, Southeast Region

NOAA Fisheries Service has determined that collisions with vessels can injure or kill protected species (e.g., endangered and threatened species, and marine mammals). The following standard measures are recommended to reduce the risk associated with vessel strikes or disturbance of these protected species. NOAA Fisheries Service should be contacted to identify any additional conservation and recovery issues of concern for protected species in your operating area.

Protected Species Identification Training

Vessel crews should use an Atlantic and Gulf of Mexico reference guide that helps identify the species of marine mammals and sea turtles that might be encountered in U.S. waters of the Atlantic Ocean, including the Caribbean and Gulf of Mexico. Additional training should be provided regarding information and resources available regarding federal laws and regulations for protected species, ship strike information, critical habitat, migratory routes and seasonal abundance, and recent sightings of protected species.

Vessel Strike Avoidance

The following measures must be taken in order to avoid causing injury or death to marine mammals and sea turtles:

1. Vessel operators and crews will maintain a vigilant watch for marine mammals and sea turtles to avoid striking sighted protected species.

2. When whales are sighted, maintain a distance of 100 yards or greater between the whale and the vessel.

3. When sea turtles or small cetaceans are sighted, attempt to maintain a distance of 50 yards or greater between the animal and the vessel whenever possible.

4. When small cetaceans are sighted while a vessel is underway (e.g., bow-riding), attempt to remain parallel to the animal's course. Avoid excessive speed or abrupt changes in direction until the cetacean has left the area.

5. Reduce vessel speed to 10 knots or less when mother/calf pairs, groups, or large assemblages of cetaceans are observed near an underway vessel, when safety permits. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity; therefore, prudent precautionary measures should always be exercised. The vessel will attempt to route around the animals, maintaining a minimum distance of 100 yards whenever possible.

6. Whales may surface in unpredictable locations or approach slowly moving vessels. When an animal is sighted in the vessel's path or in close proximity to a moving vessel, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area.

Additional Requirements for the North Atlantic Right Whale

1. If a sighted whale is believed to be a North Atlantic right whale, federal regulation requires a minimum distance of 500 yards be maintained from the animal (50 CFR 224.103 (c)).

2. Vessels entering North Atlantic right whale critical habitat are required to report into the Mandatory Ship Reporting System.

3. Mariners should check with various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sighting locations. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.

Injured or Dead Protected Species Reporting

Vessel crews will report sightings of any injured or dead protected species immediately, regardless of whether the injury or death is caused by your vessel.

Report marine mammals to the Southeast U.S. Stranding Hotline: 305-862-2850
Report sea turtles to the Southeast Regional Office: 727-824-5312

If your vessel is responsible for the injury or death, the responsible parties will remain available to assist the respective salvage and stranding network as needed. In addition, if the injury or death was caused by a collision with your vessel, you must notify the Southeast Regional Office immediately of the strike by telephone at (727) 824-5312, or by fax at (727) 824-5309. The report should include the following information:

a. the time, date, and location (latitude/longitude) of the incident;

b. the name and type of the vessel involved;

c. the vessel's speed during the incident;

d. a description of the incident;

e. water depth;

f. environmental conditions (e.g., wind speed and direction, sea state, cloud cover, and visibility);

g. the species identification or description of the animal, if possible; and
h. the fate of the animal.

For additional information, please contact the Protected Resources Division at:

NOAA Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701

Tel: (727) 824-5312
Visit us on the web at http://sero.nmfs.noaa.gov

APPENDIX B

Transplantation Protocols for Port Everglades Expansion Project.

All relocation field activities, data collection, analysis and reporting will be supervised by a marine biologist (minimum academic requirement is M.S. degree in related field, or equivalent experience) with experience in coral transplantation and survival monitoring. The qualifications of any persons conducting transplantation work must be submitted to NMFS Protected Resources Division, for review.

The colonies will be collected carefully using a hammer and chisel. Upon collection, the colonies must be kept in bins and maintained in seawater at all times. During transportation to the transplant site, the corals must be covered. Transplantation should occur as soon as operationally feasible, and no more than 24 hours after the colony is removed from its original location. The collected colonies must be kept at the original depth until transplantation commences (i.e., cached on site).

The USACE must ensure that all transplanted colonies are re-located to suitable habitat near their original location. The colonies must be transplanted no closer than 400 feet (ft) from the project area (550 ft from the edge of channel) in an area of suitable habitat/substrate resembling that of the colonies original location as soon as operationally feasible. For the purposes of this opinion, suitable habitat is considered: similar depth as origin (+/- 5 ft); means consolidated hardbottom (to include the artificial boulder reef site) or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover occurring in water depths from the mean high water (MHW) line to 30 meters (98 ft); appropriate water quality (based on water quality data and local knowledge), and minimal chances of other disturbances (boat groundings, damage caused by curious divers/fisherman). All efforts should be made to transplant the fragment to the same depth from which it was removed (i.e., +/- 5 ft).

The material used to attach the colonies to suitable substrate must be Portland cement. Before applying the Portland cement to the substrate, it must be cleaned of any sediment or algae. The Portland cement should then be taken out of the dry lock bag and pressed against the clean substrate. The transplanted colonies must then be pressed gently into the Portland cement with proper care. Transplanted colonies must be no closer than 0.75 meters from one another.

To assist in monitoring efforts, a plastic identification tag must be attached adjacent to each transplanted colony. Finally, the collected location, length, width, depth and orientation of each colony to be transplanted will be recorded. The transplanted location and depth of each colony, as well as the species and identification number, will be recorded.

APPENDIX C

Calculations for Port Everglades mitigation

Area of impact = 21.66 acres
From the draft *Acropora* Recovery Plan, density of 1 colony (≥0.5 m diameter) per m^2 in 5% of consolidated habitat 5-20 m depth.
5% of 21.66 acres = 1.083 acres = 4,382.7 m^2
Area of a square: Colony 0.5*0.5 m = 0.25 m^2 coral occupancy per m^2 of hardbottom
Assume outplanted colonies will be 0.2 m diameter: 0.2*0.2 m=0.04 m^2 in area
0.25m^2/0.04m^2=6.25 colonies needed per m^2 hardbottom
4,382.7 m^2 * 6.25 colonies ≈ **27,392 colonies needed**
Area of a circle: colony 0.5 m diameter = 0.2 m^2 coral occupancy per m^2 of hardbottom
Assume outplanted colonies will be 0.2 m diameter: 0.1^2 * 3.14 = 0.03 m^2 in area
0.2 m^2/0.03 m^2=6.67 colonies needed per m^2 hardbottom
4,382.7 m^2 * 6.67 colonies ≈ **29,233 colonies needed**

Based on data from Gilliam (see table below)
Assume colony mortality of 44% per year
Assume partial mortality rate of 25% per year (75% tissue survival)
Assume colony growth rate of 8 cm per year (diameter)
Assume recruitment rate of 22% per year

Per m^2 hardbottom:
colonies: 6.25-2.75+1.4=4.9 colonies
coral tissue growth: 4.9 colonies* (0.28 m*0.28 m)=0.38 m^2
tissue survival: 0.75*0.38 m^2= 0.28 m^2

Conclusion: With the very rough estimates of recruitment, mortality, and growth rates, an estimated 27,392 to 29,233 colonies will need to be outplanted to maintain the density/coverage criteria from the Acropora Recovery Plan.

Notes for Port Everglades expansion mitigation

Brian Walker (Pers. Comm.) NSU/NCRI

Broward County	m^2	km^2	acres	hectares
Coral Reef and Colonized Hardbottom	44,689,106	44.68911	11,042.92	4,468.911
Known *A. cervicornis* area	155,000	0.155	38.30133	15.5

K. Wirt (Pers. Comm.) FL FWC/USF

Approximately 600 *A. cervicornis* sightings in Broward (see map)

(Vargas-Angel et al. 2003)

Thickets: 1,000 m^2 to ~8,000 m^2 in area

% cover: ~5-28%

Recruit (< 5 cm dia) density: 0-1 m^{-2}; mean 0.1 m^{-2}

Largest colony diameter: 1.8 m

Largest colony density: 3 m^{-2}

Mean cover affected by WBD: 1.8%

(Walker et al. 2012)

Thickets: ~10,400 m^2 and 22,500 m^2

(Hollarsmith et al. 2012)

Outplanted 1 yr old colonies 20-40 cm diameter

Data from D. Gilliam, NSU

Nova Southeastern University Oceanographic Center											
David S. Gilliam											
15-Nov-2013											
***Acropora cervicornis* data**											
Project	**Duration of Project**	**n_i**	**n_e**	**% Survival**	**Mean change in whole colony diameter (cm) ± SD**	**Mean % Live**					

Broward *Acropora* mapping project	2 yrs	63	33	52%	10.5 ± 22	71 ± 29					
2007 Nursery Donor Colonies	1.5 yrs	10	6	60%	8 ± 31	66 ± 39					
2010 Nursery Donor Colonies	2 yrs	20	11	55%	5.5 ± 22	87 ± 19					
Recruitment											
Site 1-Broward	Fall 2010	Winter 2011	Summer 2011	Fall 2011	Winter 2012	Summer 2012	Fall 2012	Winter 2013	Summer 2013	Fall 2013	
Colonies	271	392	548	405	599	681	390	412	419	501	
Fragments	514	364	410	526	462	249	506	394	315	403	
Site 2-Broward											
Colonies	122	125	163	159	201	233	147	202	202	203	
Fragments	111	48	87	235	266	108	190	129	98	139	
Notes											
Survivorship											
n_i= number of colonies at beginning of project											
n_e= number of colonies remaining at end of project monitoring											
Colonies were considered "dead" if they went missing. A majority of the colonies that we lost were due to colony dislodgement, this does not necessarily mean they are dead, but may have fragmented and attached elsewhere at the site.											
Growth											

Only whole colony size was measured for these projects. Change in colony size came from the change in final colony max diameter from the initial colony max diameter over the length of the project											
Recruitment											
Colonies and fragments are counted 3 times a year within permanent monitoring stations. These are not fate tracked but may give an indication of recruitment through asexual reproduction.											

Map from K. Wirt (FWC)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

SEP 05 2012

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

Mr. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
263 13th Ave South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

This letter and associated information package supplements the consultation requests provided to your office on March 25, 2002 and September 17, 2004 for the Port Everglades Feasibility Study.

The U.S. Army Corps of Engineers, Jacksonville District (Corps) is currently conducting a feasibility study to assess the Federal interest in cost sharing the recommended navigational improvements and their continued maintenance. This assessment includes evaluation of engineering, environmental and overall economic effect of the proposed project. The Feasibility Study was congressionally authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan main elements include:

a. deepen and widen the Outer Entrance Channel (OEC) from an existing 45-foot project depth over a 500-foot channel width to 57 feet* by 800 feet and extend 2,200 feet seaward;

b. deepen the Inner Entrance Channel (IEC) from 42 feet to 50* feet;

c. deepen the Main Turning Basin (MTB) from 42 feet to 50* feet;

d. widen by approximately 300 feet the rectangular shoal region to the southeast of the MTB (Widener) and deepen to 50* feet;

e. widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and relocate the United State Coast Guard (USCG) facility, easterly on USCG property;

f. shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back to the existing Federal channel limits;

g. deepen the SAC from about berth 23 to the south end of berth 32 from 42 feet to 50* feet;

h. deepen the Turning Notch (TN), including the expanded portion from 42 feet to 50* feet with an additional 100-foot north-south widening parallel to the SAC channel on the eastern edge of the SAC over a length of about 1,845 feet and widen the western edge of the SAC for access to the TN from the existing Federal channel edge near the south end of berth 29 to a width of about 130 feet at the north edge of the TN;

(*All dredging depths have an additional two feet of potential dredging added to them for overdepth – one foot of required overdepth and one foot of allowable overdepth).

i. construct environmental mitigation for unavoidable, minimized impacts;

j. pre-treat rock substrates as necessary and take appropriate measures to safeguard protected species during that process;

k. dispose of dredged material not used for mitigation construction east of the Port at the Offshore Dredged Material Disposal Site (ODMDS), which is currently proposed for expansion by USEPA. If it is not expanded, the maximum amount of material that can be placed within the existing site will be deposited, and alternatives will be explored for the deposition of remaining material (NEPA coordination to that effect are currently underway).

Enclosed please find the Corps' Biological Assessment of the effects of the proposed project on listed species in the action area. Attached to this Biological assessment are the following:

a. A chronologic history of the consultation
b. September 17, 2004 Biological Assessment
c. March 25, 2002 Biological Assessment
d. August 28, 2008 – Meeting Notes from *Acropora* Survey Meeting held in St. Petersburg
e. March 26, 2008 – Letter from NMFS to Marie Burns regarding need for Acropora survey
f. October 18, 2006 – Letter from Marie Burns to David Bernhart regarding USACE effects determination for *Acropora*.
g. October 13, 2006 - Letter from NMFS to Marie Burns regarding USACE effects determination for *Acropora*.
h. August 18, 2006 – Letter from NMFS to Terri Jordan regarding USACE Reef Assessment Report.
i. Benthic Habitat Characterization for the South Florida Ocean Measurement Facility. Protected Stony Coral Assessment. Prepared by NOVA SE University. December 2011.
j. Port Everglades Feasibility Study *Acropora* Coral Survey Final Report. October 2010.
k. Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel. December 2009.
l. Environmental Baseline Study and Impact Assessment for Port Everglades Harbor. Final Report. May 31, 2001
m. Seagrass Mapping and Assessment Port Everglades Harbor. Final Report. October 5, 2006
n. Seagrass Mapping and Assessment Port Everglades Harbor. Final Report. December, 2009

Although all of this material has been previously provided to your staff over the 10-year course of this consultation, due to staff changes, etc., per your request in addition to the *Acropora* specific information, we are providing a complete copy of all materials associated with the consultation in one.

We request continuation and completion of consultation under section 7 of the Endangered Species Act concerning the effects of the proposed action on listed-species under NMFS' jurisdiction and any designated critical habitat.

If you have any questions, please contact Ms. Terri Jordan-Sellers at 904-232-1817 or Terri.Jordan-Sellers@usace.army.mil.

Sincerely,

Jason J. Spinning
Chief, Coastal Section
Environmental Branch

Enclosure

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CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT-PORT EVERGLADES NAVIGATION PROJECT

The Corps is supplementing the ongoing consultation under Section 7 of the Endangered Species Act (ESA) for the Port Everglades expansion project. Specifically this Biological Assessment (BA) addresses potential effects of the proposed harbor expansion project to the *Acropora sp.* corals and designated critical habitat (DCH) during project construction. The original consultation for this project was initiated by letter dated March 25, 2002 (logged into NMFS system as F/SER/2002/00626) and amended by letter dated September 17, 2004. That consultation assessed the effects of the proposed project on green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Johnson's seagrass (*Halophila johnsonii*), blue (*Balenoptera musculus*), humpback, (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balenoptera physalus*) and sperm (*Physeter macrocephalus*) whales and smalltooth sawfish (*Pristis pectinata*). A summary of each species is restated in this assessment with new information added where applicable and the reader referred to the original information included in the previous consultation documents.

This additional supplement is triggered by the listing of Acroporid corals as threatened and designation of critical habitat under the ESA, as required by 50 CFR 402.16(d). Per agreement with National Marine Fisheries Service (NMFS) during an April 28, 2008 meeting, the Corps and NMFS would move ahead with the consultation.

Consultation History

A detailed history of the consultation is included in the Consultation package, appendix 1 and is incorporated by reference. The Corps also incorporates the meeting notes from the April 23, 2008 meeting between NMFS-PRD leadership and CORPS staff and leadership concerning the path forward with regard to the consultation and the listing of *Acropora* species. The meeting notes are found in Appendix 4 of the consultation package. In 2010, CORPS was able to conduct *Acropora* surveys utilizing the new protocol for deep draft navigation harbors developed with NMFS in response to the April 2008 meeting.

Project Location

Port Everglades (Port), located in Broward County, is the seventh largest seaport on the Atlantic coast of the US and located on the southeast coast of Florida (Figure 1). It is located within the cities of Hollywood, Dania Beach, and Fort Lauderdale, with immediate access to the Atlantic Ocean. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. The existing authorized Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide (Figure 2), an Inner Entrance Channel (IEC) that is 450 feet wide and 42 foot deep,

a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (NTB) that is 31 feet deep, a South Turning Basin (STB) that is 31 to 36 feet deep, a Southport Access Channel (SAC) that is 390 to 400 feet wide and 42 feet deep, and a Turning Notch (TN) that is 42 feet deep.

Figure 1 - Location of Port Everglades Harbor

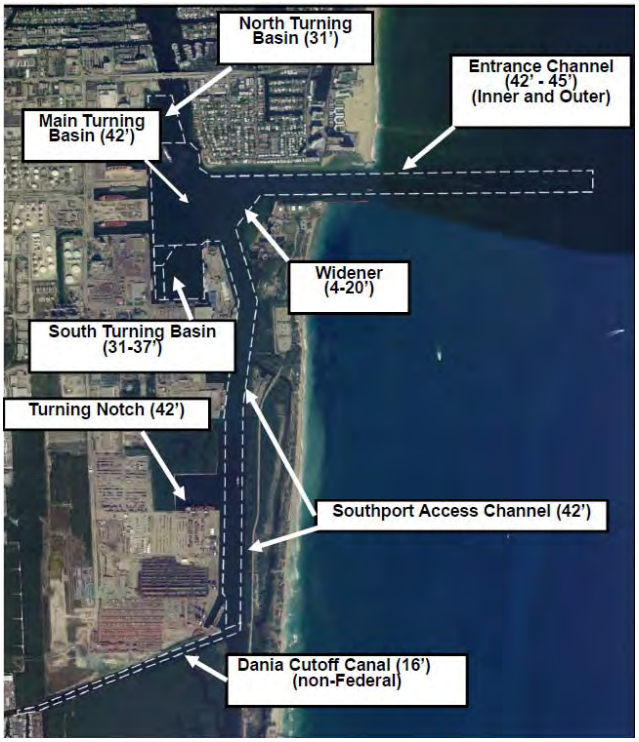


Figure 2 - Existing Project Components

Figure 3 shows Port-associated facilities and berths. To the east of the Port is a barrier island that contains a U.S. Navy (USN) facility, the Nova Southeastern University Oceanographic Center (NSUOC) , a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park (JUL) and its adjacent beaches. South of the Dania Cutoff Canal (DCC)

is the West Lake Park area. West of the Port is Federal Highway which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.

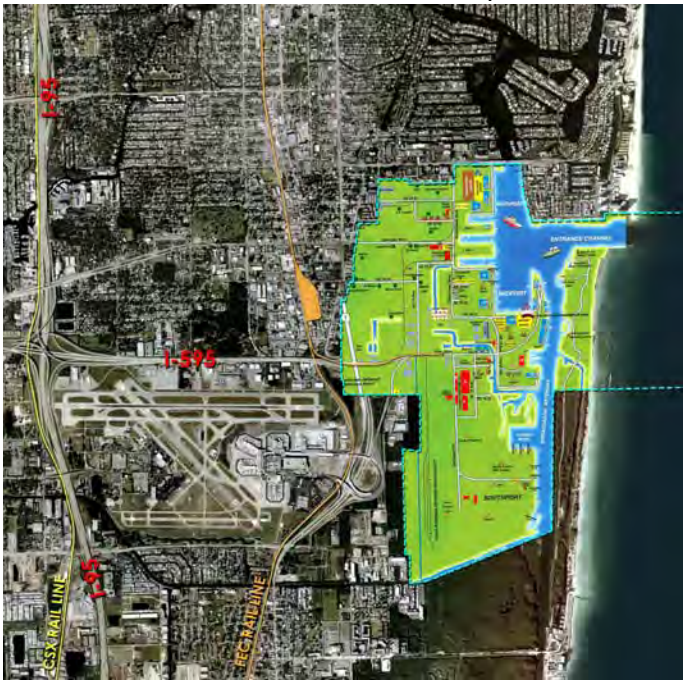


Figure 3 - Existing Port Infrastructure and Surrounding Properties

The port was originally dredged by private interests between 1927 and 1928. The first modifications to Port Everglades were authorized by Congress in 1930 and since then, several additional modifications to accommodate larger vessels have been congressionally authorized or federally permitted (1935, 1938, 1946, 1958, 1974, 1980 and 1989). Additionally, various berths and channels in Port Everglade have been maintenance dredged over the last 25 years (Table 1).

Table 1 - O&M Dredging History of Port Everglades

Year	Area Dredged	Dredge Company	Volume (CY)	Disposal Area
1971	S Turn Basin	Hendry Corp.		Present Berth 29 Area
1978	Slips 1,2,3	Ajax Co.	60,000	Present Berth 29 Area
1979	S Turn Basin	Merritt Dredging	120,000	Present Berth 29 Area
1980	Slips 1,3	Powell Bros.	40,000	Present Berth 29 Area
1991	Slip 1	Southport Dredging	9,782	Dockside-trucked off port
1994	Slip 3	Frenz Enterprises	7,000	Dockside-trucked off port
2000	Slips 1,2,3	Subaqueous Services	11,053	Southport-used as backfill
2004	slip 3	Shoreline Foundation	200	Dockside-use for rip rap
2005	Slip 3, Berth 21,22	Subaqueous Services	7,335	Southport-used as backfill
2005	North Turning Basin 7+60 to 18+67	Great Lakes Dock & Dredge	60,210	ODMDS
2005	Outer Entrance Channel	Great Lakes Dock & Dredge	547,000	John U Lloyd State Beach Park
2007	Berth 29	Subaqueous Services	8,070	Southport- used as backfill

Description of the Proposed Action

After twelve years of development, review, analysis and component minimization, the Tentatively Selected Plan (TSP) has been selected. The Project will require the removal of approximately five (5) million cubic yards of shallow sands and massive, hard rock. Features of the current TSP, (Figure 4), include;

a. extending the Outer Entrance Channel (OEC) 2,200 feet seaward with an 800-foot wide flare, and deepening the existing 500-foot wide OEC from 45 feet to 57 feet, plus one foot of required overdepth and one foot of allowable overdepth for a total of 59 feet;
b. deepening the Inner Entrance Channel (IEC) from 42 feet to 50 feet, plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
c. deepening the Main Turning Basin (MTB) from 42 feet to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
d. widening the rectangular shoal region southeast of the MTB (Widener) by approximately 300 feet and deepening it to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
e. widening the Southport Access Channel (SAC) in the proximity of berths 23 to 26 (the knuckle) by approximately 250 feet and relocating the USCG facility, easterly on USCG property;

f. shifting the existing 400-foot wide SAC approximately 65 feet to the east near berth 26 to the south end of berth 29 to transition from the knuckle area widening to the existing Federal channel limits;
g. deepening the SAC from approximately berth 23 to the south end of berth 32 from 42 feet to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
h. deepening the Turning Notch (TN), including the Port Authority planned expansion (if completed by the port), from 42 feet to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet, with nearby widening including (1) widening the eastern edge of the SAC 100 feet along a 1,845 stretch parallel to the SAC and (2) widening the western edge of the SAC for access to the TN from the existing Federal channel near the south end of berth 29 to a width of about 130 feet at the north edge of the TN, and
i. Deepening the port's berthing areas adjacent to the federal channel and basins.

Figure 4 - Tentatively Selected Plan

Overview of Dredging and Rock Pre-Treatment Methods

Based on geotechnical boring data from the entrance channel, sand, silt, clay, and rock of varying hardness are expected to be encountered in the entrance channel. Sand, silt, clay, soft rock, rock fragments, and loose rock will be removed via traditional dredging methods. Where hard rock is encountered, the Corps anticipates that contractors will utilize other methods, including confined blasting or large cutterhead dredge equipment

to pre-treat the rock prior to removal. Blasting will be implemented only in those areas where standard construction methods, including large cutterhead dredges, are anticipated to be unsuccessful. Dredged material will be deposited at two locations. Some rock and coarse materials will be transported by barge and may be placed at an artificial reef site as potential compensatory mitigation for unavoidable and minimized impacts to reef/hardbottom communities. The balance of rock and coarse materials that cannot be beneficially utilized for mitigation will be transported to the Offshore Dredged Materials Disposal Site (ODMDS).

Five separate dredging and pre-treatment methodologies may be utilized in the deepening and expansion of the port's channels and basins. Each one will be evaluated separately since they rely on differing equipment, and thus different effects may occur. Construction methodology of the project will be determined by the contractor selected by the Corps during the bid process. However, certain assumptions can be made regarding various techniques that may be needed to complete construction; those assumptions are the basis for this consultation. If an alternative construction methodology, not included in this consultation is proposed by the selected contractor, that result in effects to the species under NMFS' jurisdiction that are different than those analyzed here, the Corps will reinitiate consultation.

Dredging equipment is classified as either hydraulic or mechanical based upon the means of transporting the dredged material from the channel bottom. Hydraulic dredges use water to pump the dredged material as slurry to the surface and mechanical dredges use some form of bucket to excavate and raise the material from the channel bottom. The most common hydraulic dredges include cutter-suction and hopper dredges and the most common mechanical dredges include clamshells and backhoes (also referred to as marine excavator or dipper dredges). In addition to clamshell and backhoe dredges, mechanical dredges also include bucket ladder dredges, however, US law requires that dredges working on federally funded projects have US built hulls and no large scale bucket ladder dredges capable of conducting rock dredging are currently available for US work. Various project elements influence the selection of the dredge type and size. These factors include the type of material (rock, clay, sand, silt, or combination); the water depth; the dredge cut thickness, length, and width; the sea or wave conditions, vessel traffic conditions, environmental restrictions, other operating restrictions; and the required completion time. All of these factors impact dredge production and as a result costs. Multiple dredges of the same or different types may be used on projects where conditions vary between dredging locations or to expedite the work.

The following discussion of dredges and their associated impacts will be limited to potential dredging equipment suitable for the Port Everglades deepening project. The key project elements for this deepening project include:

•Material is primarily rock, much of which is classified as hard to very hard and may require pretreatment (such as blasting) prior to dredging.
•The widening areas include an overburden of silt, sand, and soft rock over the hard rock areas.
•Significant environmental resources including reefs are located adjacent to project.
•Project includes open water dredging in a channelized environment.
•Project depth is -50 MLLW plus 7 feet of underkeel clearance + 1 foot required overdepth +1 foot allowable overdepth for a total dredge depth of 59 feet in the outer entrance channel and -50 MLLW + 1 foot required overdepth +1 foot allowable overdepth for a total dredge depth of 52 feet in the inner channels and basins.

Dredged material will most likely be excavated using either a hydraulic cutterhead dredge or mechanical excavator with some or all of the material pretreated using confined blasting or some other method to break the hard rock prior to dredging. If a mechanical dredge is used, the larger dredged material may be removed and segregated at the construction site for use in constructing the mitigation sites. Larger rock material will be placed on one barge/scow to be transported to an artificial reef site, while other materials would be placed on a separate barge/scow for placement in the offshore disposal site. In any event, disposal of all dredged material would be in the ODMDS and/or an artificial reef site. Any unconsolidated material in the channel (beach quality sand) that may have filled in the channel south of the south jetty, may be removed by a hopper dredge and placed in accordance with the Environmental Assessment for Operations and Maintenance Dredging completed with a Finding of No Significant Impact signed on April 28, 2005, that the Corps completed two ESA consultations for in 2004 and 2012, both resulting in concurrence with the Corps' determination that O&M dredging of Port Everglades was either already covered by the 1997 South Atlantic Regional Biological Opinion (NMFS, 2004) or a determination that placement of beach quality O&M material, "may affect, but is not likely to adversely affect" listed species under NMFs' purview. Additionally, NMFS concurred that the placement of beach quality O&M material was not likely to adversely modify designated critical habitat offshore of the dredged material placement area, John U Lloyd state park (NMFS, 2012).

The project scale limits potential equipment to large-scale hydraulic or mechanical dredges. Potential equipment must be able to reach 55 to 60 feet in depth, depending upon wave and tide conditions as well as excavate large material volume.

Hydraulic Dredges

Hydraulic dredges are characterized by their use of a pump to dredge sediment and transport slurry of dredged material and water to identified discharge areas. The ratio of water to sediment within the slurry mixture is controlled to maximize efficiency. The main types of hydraulic dredges are pipeline and hopper dredges.

Pipeline Dredges - Cutterhead Suction Dredge

Pipeline dredges are designed to handle a wide range of materials including clay, hardpan, silts, sands, gravel, and some types of rock formations without blasting. They are used for new work and maintenance in projects where suitable placement/disposal areas are available and operate in an almost continuous dredging cycle resulting in maximum production, economy, and efficiency. Limitations of pipeline dredges include relative lack of mobility, long mobilization and demobilization, inability to work in high wave action and currents, and are impractical in high traffic areas.

Pipeline dredges are rarely self-propelled and; therefore, must be transported to and from the dredge site. Pipeline dredge size is based on the inside diameter of the discharge pipe which commonly ranges from 6" to 48." They require an extensive array of support equipment including pipeline (floating, shore, and submerged), boats (crew, work, survey), barges, and pipe handling equipment. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device that has rotating teeth to break up or loosen the bottom material so that it can be sucked through a pipe to the dredge (Figure 5).

Large cutter-suction dredges, or cutterhead dredges, are mounted on barges. The key parts of a cutter-suction dredge include:

- The cutter-suction head that resembles an egg beater with teeth that break up the dredged material as it rotates. The broken material is hydraulically moved into the suction pipe for transport.
- The cutter suction head is located at the end of a ladder structure that raises and lowers it to and from the bottom surface.
- The discharge pipeline connects the cutter suction dredge to the disposal location. The dredged material is hydraulically pumped from the bottom, through the dredge, and through the discharge pipeline to the disposal location. This is generally an upland site, but can be a scow for transport to a remote location, ODMDS or an in-water site.
- Dredge pumps are located on the barge with additional pump(s) often located on the ladder, especially for deep water dredging projects such as Port Everglades. Booster pumps can also be added along the discharge pipeline to move the material greater distances.

Depending upon their design, cutterhead dredges can be used to remove blasted or unblasted rock and unconsolidated material. During the dredging operation a cutterhead suction dredge is held in position by two spuds at the stern of the dredge, only one of which can be on the bottom while the dredge swings. There are two swing anchors some distance from either side of the dredge, which are connected by wire rope to the swing wenches. The dredge swings to port and starboard alternately, passing the cutter through the bottom material until the proper depth is achieved. The dredge advances by "walking" itself forward on the spuds. This is accomplished by swinging the dredge to the port, using the port spud and appropriate distance, then the

starboard spud is dropped and the port spud is raised. The dredge is then swung an equal distance to the starboard and the port spud is dropped and the starboard spud is raised.

A large cutterhead dredge could be used for the entire Port Everglades deepening project. Some pretreatment may be required for portions of the rock prior to dredging. Disposal options include transport by barges to the ODMDS or use as mitigation site creation material. When the material will be taken to the ODMDS, the material maybe loaded into scows using a barge known as a Spider barge. This barge allows for one scow to be loaded and a second to begin loading immediately after the first is complete, ensuring more efficient dredging due to lessened down time waiting for scows to return from the ODMDS. A spider barge was used at Miami Harbor during the 2005-2006 in a similar dredging event (Figure 6).

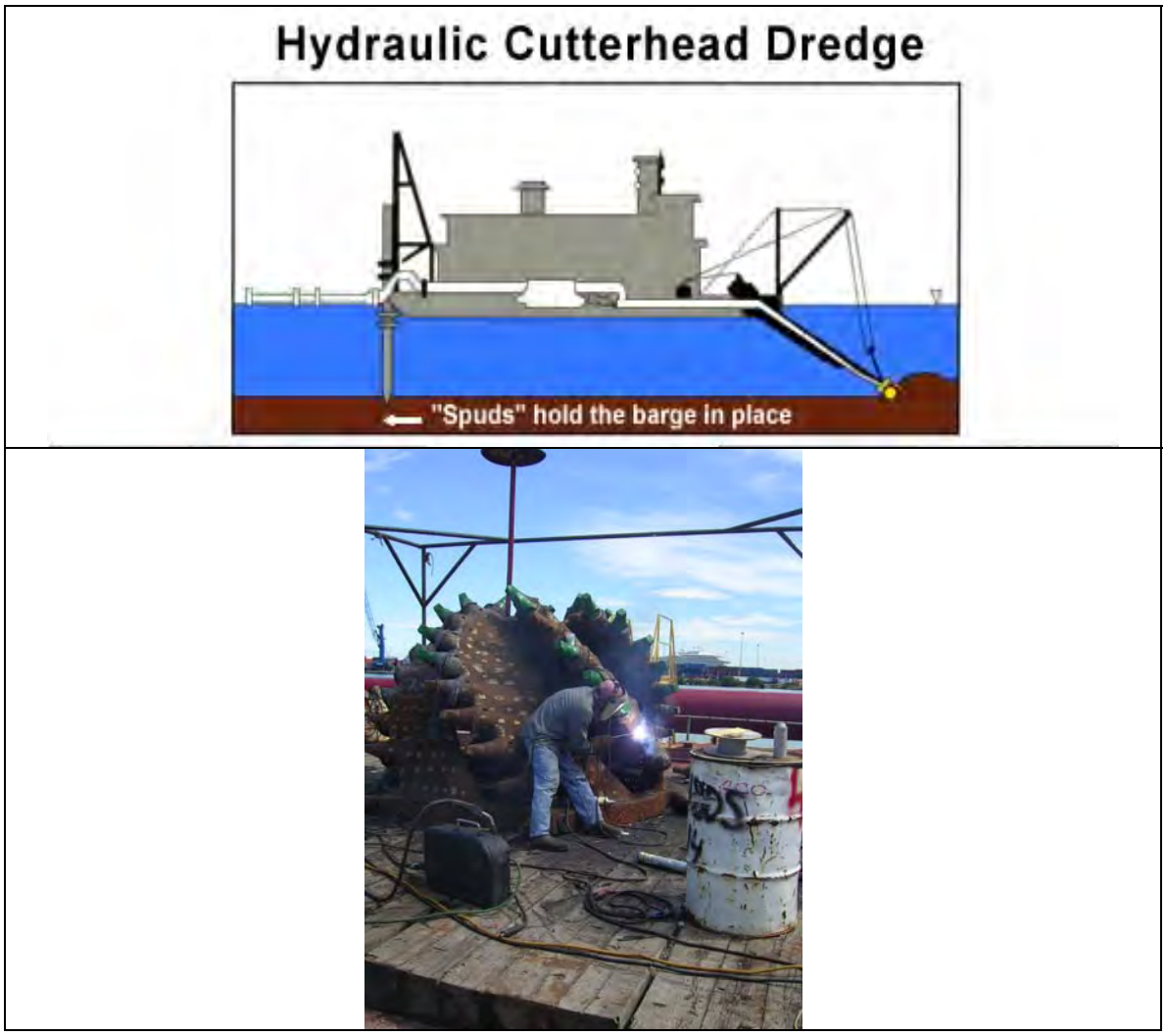


Figure 5 - Cutterhead pipeline dredge schematic and representative close-up photographs. (Video of cutterhead dredge: http://el.erdc.usace.army.mil/dots/doer/anima/cutterside.avi)

Figure 6 - A spider barge loading material into two scows from the cutterhead dredge, Texas, during Miami Harbor Phase II 2005-2006.

Hopper Dredge.

The hopper dredge, or trailing suction dredge, is a self-propelled ocean-going vessel with a section of the hull compartmented into one or more sediment containment chambers called hoppers. Fitted with powerful pumps, the dredges suck sediment from the channel bottom through long intake pipes, called drag arms, and store it in the hopper(s). Normal hopper dredge configuration has two dragarms, one on each side of the vessel. A dragarm is a pipe suspended over the side of the vessel with a suction opening called a draghead for contact with the bottom (Figure 7). Depending on the hopper dredge, a slurry of water and sediment is generated from the plowing of the draghead "teeth," the use of high pressure water jets, and the suction velocity of the pumps. The dredged slurry is distributed within the vessels hopper allowing for solids to settle out and the water portion of the slurry to be discharged from the vessel during operations through its overflow system. When the hopper attains a full load, dredging stops, the dragarms are lifted off the bottom and the ship travels to an in-water disposal site, where the dredged material is discharged through the bottom of the ship by splitting the hull, or opening doors located in the bottom of each hopper. Some hopper dredges are capable of pumping the material back out of the vessel and through a series of shore-pipe to a designated placement/disposal location.

Hopper dredges are well suited to dredging heavy sands. They can maintain operations safely, effectively, and economically in relatively rough seas and because they are mobile, they can be used in high-traffic areas. They are often used at ocean entrances and offshore, but cannot be used in confined or shallow areas. Hopper dredges also have several limitations. Considering their normal operating conditions, hopper dredges cannot dredge continuously. The precision of hopper dredging is less than other types of dredges; therefore, they have difficulty dredging steep side banks and cannot effectively dredge around structures.

Figure 7 - Hopper dredge and dragarm being lowered into the water (Video of hopper dredge - http://el.erdc.usace.army.mil/dots/doer/anima/turtle.avi)

The Corps will incorporate the Terms and Conditions in NMFS' 1997 "Regional Biological Opinion (RBO) on Hopper Dredging along the South Atlantic Coast" into the project specifications, or any subsequent Regional Biological Opinion issued for hopper dredging. Although the SARBO does not include new harbor deepening projects in the project description, the Corps expects that that protective measures of the SARBO are sufficient to protect sea turtles in Port Everglades where the Corps has dredged on previous occasions with a hopper dredge without incidental take of sea turtles (2005 O&M dredging; 2004-2005 Broward Shore Protection project). The 1997 RBO incorporates (by reference) NMFS' 1995 Biological Opinion on hopper dredging of channels and beach nourishment activities in the southeastern US from North Carolina through Florida East Coast. The Corps' specifications will require their contractor(s) to follow the Terms and Conditions in the 1997 and 1995 Biological Opinions mentioned above, with the exception of the conditions related to the southeast United States' North Atlantic Right Whale calving area, because the proposed project is not located in or near the calving area. The Corps will also incorporate the protective measures of NMFS' March 23, 2006, Sea Turtle and Smalltooth Sawfish Construction Conditions into the project plans and specifications.

Mechanical Dredges

Mechanical dredges are characterized by the use of some form of bucket to excavate and raise the bottom material (Figure 8). They remove material by scooping it from the bottom and then placing it onto a waiting barge/scow or directly into a placement/disposal area. Mechanical dredges work best in consolidated, or hard-packed, materials and can be used to clear rocks and debris. Dredging buckets have difficulty retaining loose, fine materials, which can be washed from the bucket as it is raised. Special buckets have been designed for controlling the flow of water and material from buckets and are used when dredging contaminated sediments. Mechanical dredges are rugged and can work in tightly confined areas. They are mounted on a large barge and are towed to the dredging site and secured in place by anchors or spuds. They are often used in harbors, around docks and piers, and in relatively protected channels, but are not suited for areas of high traffic or rough seas.

Backhoe dredges and clamshell dredges, named for the scooping buckets they employ, are the two most common types. For clamshell dredges, a bucket dredge begins the digging operation by dropping the bucket in an open position from a point above the sediment. The bucket falls through the water and penetrates into the bottom material. The sides of the bucket are then closed and material is sheared from the bottom and contained in the bucket compartment. The bucket is raised above the water surface, swung to a point over the barge, and then released into the barge by opening the sides of the bucket. Usually two or more disposal barges, called dump scows, are used in conjunction with the mechanical dredge. While one barge is being filled, another is being towed to the disposal site by a tug and emptied. If an upland disposal area is used, the material must be unloaded using mechanical or hydraulic equipment. Using numerous barges, work can proceed continuously, only interrupted by changing scows or moving the dredge. This makes mechanical dredges particularly well suited for dredging projects where the disposal site is many miles away.

The backhoe dredge is essentially a power shovel mounted on a barge. The backhoe digs toward the machine with the bucket penetrating from the top of the cut face. The operation cycle is similar to the clamshell dredge, as are the factors affecting production. Backhoe marine excavators have accurate positioning ability and are able to excavate firm or consolidated materials. However, they are susceptible to swells and have low to moderate production. Backhoe marine excavators could be used to excavate unconsolidated overburden, fractured rock, and possibly some unfractured rock. It should be noted that one of the largest backhoe marine excavators in the U.S. was unsuccessful in dredging rock within Miami Harbor in the early 1990s in some locations without a pretreatment fracturing technology, and the rock at Port Everglades is expected to be harder based on geotechnical analysis.

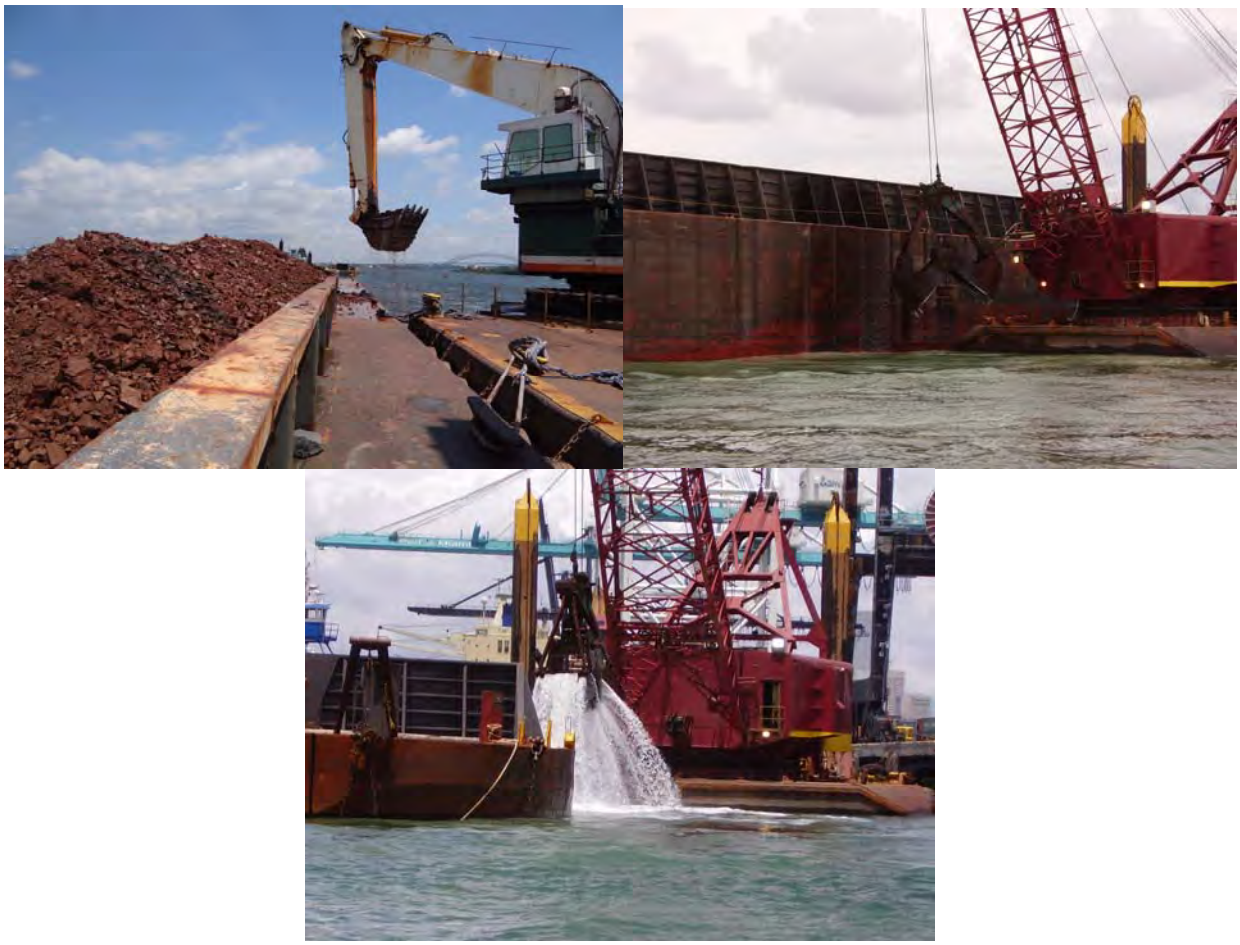


Figure 8 - Mechanical dredges (clamshell bucket/back-hoe dredge and barge). (Video of clamshell dredge - http://el.erdc.usace.army.mil/dots/doer/anima/clamshel.avi.)

Dredged Material Disposal

As previously stated, for the Port Everglades project, two disposal options are available. The first the disposal option is placement of dredged material in the EPA designated ODMDS located approximately four statute miles east of the entrance of the Port Everglades outer entrance channel in water depths ranging from 640-705 feet. Detailed information concerning this site is located on EPA's Ocean Dumping homepage located at http://www.epa.gov/region4/water/oceans/sites.html#portevergladesharbor and the Corps' Environmental documents website - http://www.saj.usace.army.mil/Divisions/Planning/Branches/Environmental/DocsNotices_OnLine_BrowardCo_PBPE.htm. The second disposal option is the potential creation of a potential artificial reef for mitigation with rock dredged from the project area. Any unconsolidated material in the channel (beach quality sand) that may have filled in the channel south of the south jetty, may be removed by a hopper dredge and placed in accordance with the Environmental Assessment for Operations and Maintenance Dredging completed with a Finding of No Significant Impact signed on April 28, 2005, that the Corps completed two ESA consultations for in 2004 and 2012, both resulting in concurrence with the Corps' determination that O&M dredging of Port Everglades was

either already covered by the 1997 South Atlantic Regional Biological Opinion (NMFS, 2004) or a determination that placement of beach quality O&M material, "may affect, but is not likely to adversely affect" listed species under NMFs' purview. Additionally, NMFS concurred that the placement of beach quality O&M material was not likely to adversely modify designated critical habitat offshore of the dredged material placement area, John U Lloyd state park (NMFS, 2012).

Transportation Methodology – Hopper Dredges, Tugs/Scows, and Barges

Depending on the dredging and disposal site conditions, as a component of hydraulic and mechanical dredging operations, accompanying equipment such as tugs and barges (hopper, scow, spider barge, etc.) may be used in association with dredging activity in order to transport the dredged material to the pre-determined disposal sites. Methods of transporting dredged material to disposal sites include self propelled transport via hopper dredges or towing/pushing of loaded barges to disposal sites via tugboats. Tugboats are a component of all dredging operations and may be used to move immobile equipment into place as well as towing loaded barges to the disposal sites. Hopper dredges or bucket and barge operations are often used when disposal areas are beyond the pumping distance of pipeline dredges considering that hopper dredges and barges can transport material over long distances to the placement/disposal sites. Depending on a myriad of factors such as the type of dredged material, cubic yardage to be dredged, barge capacity, overflow capability, distance of the placement/disposal site, weather, etc., there may be types of dredges that consistently rotate from the dredge site to the placement/disposal site to achieve maximum efficiency and productivity. The number of hopper loads or barges towed, the transport interval, and the speed to the placement/disposal site will vary depending on these factors.

Hopper/scow locations are monitored at all times via the Dredging Quality Management (DQM) system and the contractor can be penalized for violating the specifications. The ullage (loaded draft) of each scow is recorded approximately every 30-seconds to determine if there is any loss of material from the scow during transit. This data is reviewed after each load by the contractor and the Corps/EPA and if the if a barge has a net loss of more than one foot in draft between the dredge site and disposal site(s) (averaged between the bow and stern monitoring locations), this serves as a "red flag" to conduct an investigation as to why the draft loss occurred. If the draft loss can be determined due to high seas and sloshing of material, no other action is required. However, if the loss is not as a result of high seas and sloshing, the barge is temporarily removed from the rotation and has the seals tested and repaired (if necessary). If a particular barge demonstrates a trend of material loss that does not resolve itself after seal testing and repair, the barge is removed from the dredging operation. One-foot of loss has been determined by Corps and EPA to be a good threshold for notification, because all barges have some amount of draft loss through leakage or water sloshing out of the barge due to sea conditions and weather, although the amount is typically minimal.

Hopper dredge and scows will be loaded with dredged material and taken to the ODMDS or approved artificial reef site. As part of the Corps' standard environmental protection specifications, the vessels are required to remain the marked channel until passing the outer buoy to prevent any accidental release of material from the scow/hopper that might settle on adjacent reef habitats.

> *"Due to the presence of hardbottom reefs adjacent to the channel, the Contractor shall stay within the marked entrance channel while in transit from the dredging area to the ODMDS, and on the return trip, until past the last channel marker."*

Hopper dredge and disposal tug/scow transit tracks will be recorded by the Contractor and reviewed within 24 hours of the transit to the disposal site to ensure the vessel remained in the marked channel or approved corridor to the mitigation site. If the dredge/tug & scow leaves the channel or approved corridor, the location will be marked and recorded in GIS, water depths of the location will be determined by reviewing existing surveys and, draft of the vessel will be determined by the DQM system. If it is determined that the potential exists for an impact to have occurred as a result of the vessel leaving the channel or approved corridor, a survey team will be deployed to assess any impact that may have occurred and conduct immediate remediation. Remediation work (including re-attachment of scleractinian corals and octocorals) will be conducted immediately after the survey by the survey crew. Remediation activities should follow the FLDEP-SEFCRI "Rapid Response and Restoration for Coral Reef Injuries in Southeast Florida, Guidelines and Recommendations" dated June 2007.

Split Hull Barge

A split hull barge (Figure 9) has two hulls connected with hinges at the front and back. The two-door hinged configuration, allows the hulls to swing apart, opening at the bottom to allow dredged material to fall from the barge. This provides a rapid disposal of dredged material, which, as a result, is placed within a small area. The rapid descent of material through the water column reduces the potential for resuspension of sediments into the water column during disposal. Such a barge may be used for ODMDS disposal. A rubber seal (similar to a gasket or weather-stripping on a door), is pinched between the two doors, limiting the leakage from the barge of water and dredged material. This seal does not prevent 100% of water and dredged material from leaking; however it minimizes it to the maximum extent practicable. During transport, the barge's draft and ullage are monitored and recorded and this data is reviewed after each load to detect loss of draft, which is assumed to represent loss of material. If a barge has a net loss of more than one foot in draft between the dredge site and disposal site(s) (averaged between the bow and stern monitoring locations), this serves as a "red flag" to conduct an investigation as to why the draft loss occurred. If the draft loss can be determined due to high seas and sloshing of material, no other action is required. However, if the loss is not as a result of high seas and sloshing, the barge is temporarily removed from the rotation and has the seals tested and repaired (if necessary). If a particular barge demonstrates a trend of material loss that does not resolve itself after

seal testing and repair, the barge is removed from the dredging operation. One-foot of loss has been determined by Corps and EPA to be a good threshold for notification, because all barges have some amount of draft loss through leakage or water sloshing out of the barge due to sea conditions and weather, although the amount is typically minimal.

Figure 9 - Split-hull barge

Bottom Dump Barge

A bottom dump barge has doors on the bottom of the hopper, which opens at the disposal site to allow the dredged material to fall to the bottom. This type of barge has slower disposal than split hull dump barges and material spreads over a larger area. This barge may be used for ODMDS disposal. As with split hull barge, the bottom dump barge has seals around each of the doors to minimize leakage of material and water from the barge. The barge is monitored in the same method as the split hull barge and the same response is taken if the barge loses more than a net foot of draft. This type of barge may be used either for ODMDS disposal or construction of artificial reef sites.

Flat Top Barge

A flat top barge transports dredged material stacked on a barge deck and must be unloaded mechanically at the disposal site. As a result disposal time is slow but it is possible to drain dredged material with filters prior to disposal.

All three barge types are typically pushed or pulled to the disposal site by a tug (Figure 10) and for split hull and bottom dump barge, the disposal action is triggered remotely from the tug to the barge. The exact time the signal is given to the barge, and when the doors open and close are recorded in a tracking system for further data analysis and compliance tracking.

Figure 10 - Split Hull Barge Being Pushed by Tug

NMFS has previously consulted on disposal operations at the Port Everglades ODMDS under the EIS for designation of the ODMDS with EPA and determined "that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities" (EPA 2005) and with the Corps (NMFS 2004).

Rock Pre-Treatment with Confined Blasting

The focus of the proposed blasting work at Port Everglades is to pre-treat bedrock prior to removal by a dredge utilizing confined blasting, meaning the shots would be "confined" in the rock. In confined blasting, each charge is placed in a hole drilled in the rock approximately 5-10 feet deep below the desired depth (see Figure 11) depending on how much rock needs to be broken and the intended project depth. The hole is then capped with an inert material, such as crushed rock (Figure 12; each bag as shown contains approximate volume of material used per discharge). This process is referred to as "stemming the hole." The blasting charge is set and then the chain of explosives within the rock is detonated.

For the Port of Miami Phase II expansion in 2005, which used confined blasting as a pre-treatment technique, the stemming material was angular crushed rock. The optimum size of stemming material is material that has an average diameter of approximately 0.05 times the diameter of the blast hole. Material must be angular to perform properly (Konya 2003). For the Corps project, project-specific specification will be prepared by the geotechnical branch of the District. In the Miami Harbor Phase II project, the following requirements were in the specifications regarding stemming material:

"*1.22.9.20 Stemming.* All blast holes shall be stemmed. The Blaster or Blasting Specialist shall determine the thickness of stemming using blasting industry conventional stemming calculation. The minimum stemming shall be 2 feet thick. Stemming shall be placed in the blast hole in a zone encompassed by competent rock. Measures shall be taken to prevent bridging of explosive materials and stemming within the hole. Stemming shall be clean, angular to subangular, hard stone chips without fines having an approximate diameter of 1/2-inch to 3/8-inch. A barrier shall be placed between the stemming and explosive product, if necessary, to prevent the stemming from settling into the explosive product. Anything contradicting the effectiveness of stemming shall not extend through the stemming."

It is expected that the specifications for any construction utilizing blasting at Port Everglades would have similar stemming requirements as those that were used for the Miami Harbor Phase II project. The length of stemming material will vary based on the length of the hole drilled, however minimum lengths will be included in the project specific specifications. Studies have shown that stemmed blasts have up to a 60-90% decrease in the strength of the pressure wave released, compared to open water blasts of the same charge weight (Nedwell and Thandavamoorthy, 1992; Hempen *et al*. 2005; Hempen *et al*. 2007). However, unlike open-water, i.e., unconfined blasts (Figure 13), very little peer-reviewed research exists on the effects that confined blasting can have on marine animals near the blast (Keevin *et al*. 1999). The visual evidence from a typical confined blast is shown in Figure 14.

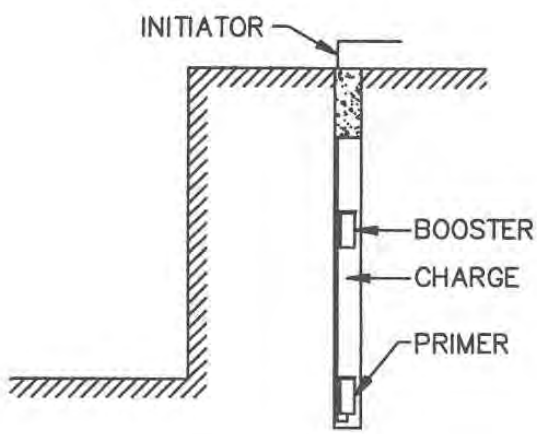


Figure 11 - Typical Stemmed Hole for Loading Charges

Figure 12 - Stemming Material and model for scale

Figure 13 - Unconfined Blast of Seven Pounds of Explosives

Figure 14 - Confined Blast of 3,000 Total Pounds of Explosives

To estimate the maximum poundage of explosives that may be utilized for this project, Corps has reviewed two previous blasting projects, one at San Juan Harbor, Puerto Rico in 1994 and one at Miami Harbor in 2005. The San Juan Harbor project's heaviest delay was 375 lbs per delay and in Miami it was 376 lbs per delay. Based on discussions with Corps's geotechnical engineers, it is expected that the maximum weight of delays for Port Everglades will be larger since the rock is much harder than what is seen at the Port of Miami. It is unknown at this time what the maximum delay weight will be for Port Everglades. This will be determined during the test blast program.

Minimization of Confined Blasting Impacts to Fish and Wildlife

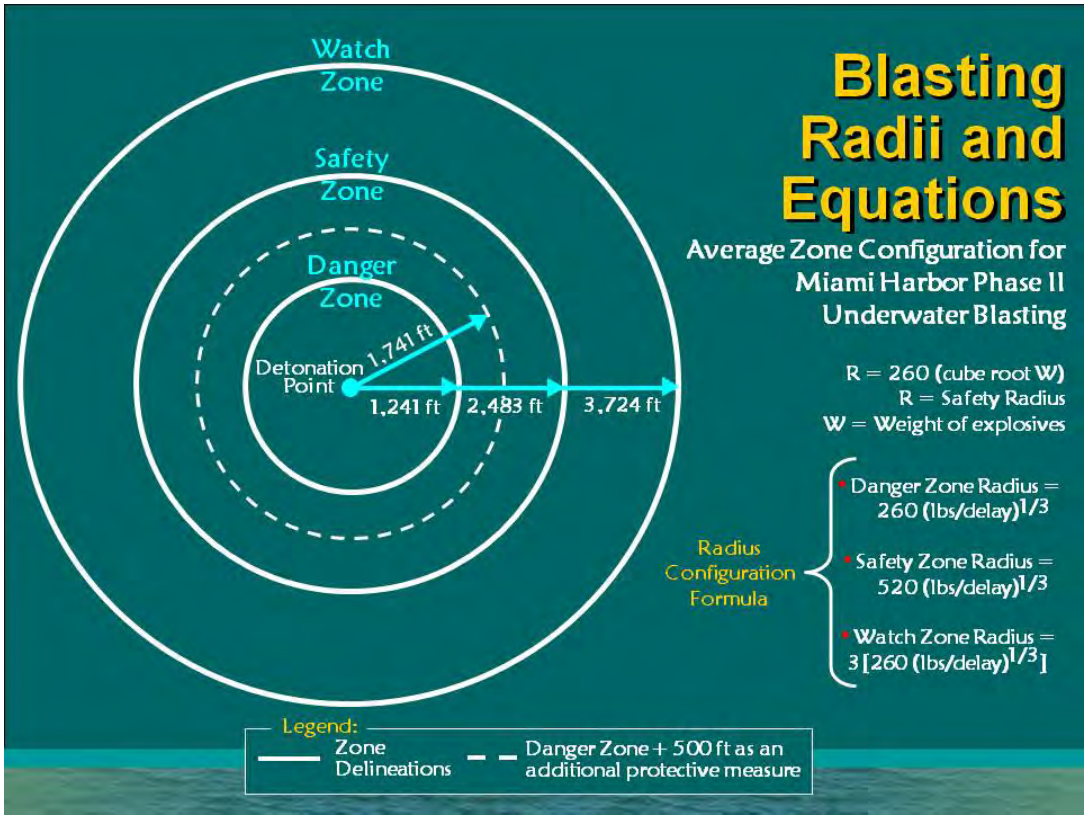
Blast specifications. Although the rock at Port Everglades is believed to be harder than Miami or San Juan Harbors, as noted above, Corps biologists, working with senior geologists, concluded that the assumptions set forth concerning minimization of the effects of blasting are applicable and accurate for the Port Everglades project. To that effect, based upon industry standards and Corps Safety & Health Regulations, the blasting program may consist of the following:

1) The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock.
2) Drill patterns are restricted to a minimum of 8-foot separation from a loaded hole.
3) Hours of blasting are restricted from two hours after sunrise to one hour before sunset to allow for adequate observation of the project area for protected species.

4) Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.
5) Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.
6) The blast design will consider matching the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.
7) Delay timing adjustments to a minimum of 8 ms between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water.

Safety radii. Furthermore, the confined blasting program will incorporate the use of three safety radii (Figure 15) typically utilized for projects involving unconfined blasts. This conservative use of an *unconfined* blast in development of the safety radii for a *confined* blast will increase the protections afforded marine species in the area. These three zones are referred to as the "Danger zone" – which is the inner most zone, located closest to the blast; the "Safety zone" – which is the middle zone and the "Watch zone" the outer most zone.

The danger zone radius will be calculated to determine the maximum distance from the blast at which mortality to protected marine species is likely to occur. The danger zone was determined by the amount of explosives used within each delay (which can contain multiple boreholes). These calculations are based on impacts to terrestrial animals in water when exposed to a detonation suspended in the water column (unconfined blast) as researched by the U.S. Navy in the 1970s (Yelverton *et al*. 1973; Richmond *et al.* 1973) as well as observations of sea turtle injury and mortality associated with unconfined blasts for the cutting of oil rig structures in the Gulf of Mexico (Young 1991). The reduction of impact by confining the shots would more than compensate for the presumed higher sensitivity of marine species. Corps believes that the danger zone radius, coupled with a strong protected species observation and protection plan is a conservative, but prudent, approach to the protection of marine wildlife species. Based on a review by NMFS-OPR for the Miami Harbor phase II project, where these radii were first used, NMFS and FWS found these protective measures sufficient to protect marine mammals under their respective jurisdictions (NMFS 2005c; FWS 2002, NMFS 2011).



These zone calculations will be included as part of the specifications package that the contractors will bid on before the project is awarded. Ideally the safety radius should be large enough to offer a wide buffer of protection for marine animals while still remaining small enough that the area can be intensely surveyed.

Radii specifications are as follows:

1) Danger Zone: The radius in feet from the detonation beyond which no expected mortality or injury from an open water explosion is likely to occur (NMFS 2005). The danger zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

2) The Safety Zone is the approximate distance in feet beyond which injury (Level A harassment as defined in the MMPA) is unlikely to occur from an open water explosion (NMFS 2005). The safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

3) The Watch Zone is three times the radius of the Danger Zone to ensure that animals entering or traveling close to the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

4) Exclusion Zone extends to 500 feet outside the Danger Zone radius. Detonation will not occur if a marine mammal or reptile may be within that zone (based on observational data).

It is crucial to balance the demands of the blasting operations with the overall safety of protected species in the project area. A radius that is excessively large will result in significant delays that prolong the blasting, construction, traffic and overall disturbance to the area. A radius that is too small puts the animals at too great of a risk should one go undetected by the observers and move into the blast area. Because of these factors, the goal is to establish the smallest radius possible without compromising animal safety and provide adequate observer coverage for whatever radius is agreed upon.

Monitoring/watch plan.
A watch plan will be formulated based on the required monitoring radii and optimal observation locations. The watch plan will be consistent with the program that was utilized successfully at Miami Harbor in 2005 and will consist of at least five observers including at least one (1) aerial observer, two (2) boat-based observers, and two (2) observers stationed on the drill barge (Figures 16, 17, 18 & 19). The 6th observer will be placed in the most optimal observation location (boat, barge, fixed structure or aircraft) on a day-by-day basis depending on the location of the blast and the placement of dredging equipment, as determined by the blaster in charge and the chief protected species observer. This process will insure complete coverage of the three zones as well as any critical areas. The watch will begin at least one-hour prior to each blast and continue for one-half hour after each blast (Jordan *et al*. 2007).

A blast-day (or blast-event) is made up of all the actions during a blast from the Notice to Project Team and Local Authorities two hours before the blast is detonated through the end of the protected species watch 30 minutes after the blast detonation. The typical events in a blast-event are:

<u>Typical Blast Timeline</u>

- T minus 2 HOURS - Notice to Project Team and Local Authorities
- T minus 1 HOUR - Protected Species Watch Begins
- T minutes 15 MINUTES - Notice to Mariners (channel closes)
- T minus 1 MINUTE - Fish Scare
- Blast detonation
- T plus 5 MINUTES - All Clear Signal
- T plus 30 MINUTES - Protected Species Watch Ends
- DELAY CAPSULE (can occur between T - 1 hour and detonation): If an animal is observed in either the danger or safety zones, the blast is delayed to monitor the animal until it leaves, on its own, from both the danger and safety zones

This timeframe lasts a minimum of 2 hours and 35 minutes, although it can be extended if a protected species (like a dolphin or turtle) enters the exclusion zone. The animal is monitored until it leaves, on its own, from both the danger and exclusion zones. There can be more than one blast-day (blast event) in a calendar day, although two is typically the maximum.

Data provided by Broward County Aviation Department on June 22, 2004 indicated that there do not appear to be flight path/altitude conflicts with a helicopter hovering 300-400 feet from the water surface in the MTB/upper SAC. Specific flight and observing plans will be coordinated with the FAA and Broward County Aviation Department to determine if aerial overflights are authorized throughout the entire project area due to the Port's proximity to Fort Lauderdale/Hollywood International Airport (FLL). If any conflicts develop due to the proximity of FLL to the Port that would prevent overflights of specific areas of the project that have been determined to require blasting, alternative monitoring methodologies will be investigated and coordinated with the resource agencies with jurisdiction for those issues. During the blasting conducted at Port Everglades in 1981, boat-based manatee surveys were conducted using a color fish-finder and located two additional manatees that were not located by aerial observers.

Figure 16 - Typical observer helicopter

Figure 17 - View of typical altitude of aerial observer operations

Figure 18 - Typical vessel for boat-based observer

Figure 19 - Observer on Drill Barge

Fish repulsion.
In the past, to reduce the potential for fish to be injured or killed by the blasting, Corps has allowed, and the resource agencies have requested, that blasting contractors utilize a small, unconfined explosive charge, usually a 1-lb booster, detonated about 30 seconds before the main blast to drive fish away from a blasting zone. It is assumed that noise or pressure generated by the small charge will drive fish from the immediate area, thereby reducing impacts from the larger and potentially more-damaging blast. Blasting companies use this method as a "good faith effort" to reduce potential impacts to aquatic resources. The explosives industry recommends firing a "warning shot" to frighten fish out of the area before seismic exploration work is begun (Anonymous 1978 in Keevin *et al*. 1997).

There is limited data available on the effectiveness of fish scare charges at actually reducing the magnitude of fish kills and the effectiveness may be based on the fish's life history. Some states require the use of fish scares (Illinois, New Jersey and Washington) while others (Alaska and Texas) have determined that they are ineffective and "potentially harmful to piscivorous fishes, marine mammals and birds which are attracted to feed on fish that are stunned or wounded by the repelling charge." Florida does not have a regulation specific to the use of scare charges associated with blasting (Lisa Gregg, pers. Comm., August 5, 2011), but FWC has requested the use of scare charges associated with previous projects that utilized blasting like the 2005 blasting at Miami Harbor. Numerous incidental observations (cited in Keevin *et al.* 1997) during blasting operation suggest that these charges are not effective in scaring fish from the blasting zone.

Keevin *et al.* (1997) conducted a study to test if fish scare charges are effective in moving fishes away from blast zones. They used three freshwater species, largemouth bass; channel catfish and flathead catfish, equipping each fish with an internal radio tag to allow the fishes movements before and after the scare charge to be tracked. Fish movement was compared with a predicted LD 0% mortality distance for an open water shot (no confinement) for a variety of charge weights. Largemouth bass showed little response to repelling charges and none would have moved from the kill zone calculated for any explosive size. Only one of the flathead catfish and two of the channel catfish would have move to a safe distance for any blast. This means that only 11% of the fish used in the study would have survived the blasts.

These results call into question the true effectiveness of this minimization methodology; however, some argue that based on the monetary value of fish (American Fishery Society 1992 in Keevin *et al.* 1997) including high value commercial or recreational species like snook and tarpon found in southeast Florida inlets like Port Everglades, the low cost associated with repelling charge use would be offset if only a few fish were moved from the kill zone (Keevin *et al*. 1997).

Vibration and Pressure Monitoring

Vibration.

In an urban environment such as the Port, which is surrounded by commercial properties, utilities, and residential communities, protection of structures must be considered. Once the areas of the project requiring blasting have been identified, critical structures within the blast zones would be determined. Where vibration damage may occur, energy ratios and peak particle velocities shall be limited in accordance with state or county requirements, whichever is more stringent. Furthermore, vibration-monitoring devices will be installed to ensure that established vibration limits are not exceeded. If the energy ratio or peak particle velocity limits are exceeded, blasting will be stopped until the probable cause has been determined and corrective measures taken. Critical monitoring locations may include structures such as bulkheads, hazardous materials storage areas, and buried utilities.

Ground-borne vibration can be generated by a number of sources, including road and railways, construction activities such as piling, blasting and tunneling. Vibration can be defined as regularly repeated movement of a physical object about a fixed point. The parameter normally used to assess the ground vibration is the peak particle velocity (PPV) expressed in millimeters per second (mm/s). In order to completely define ground vibration, the amplitude and frequency of the motion are measured in the three orthogonal directions generally in terms of velocity which is considered to be the best descriptor for assessing human comfort and the potential damage response of structures. The vibration velocity signals are summed (in real time) and the maximum amplitude of this vector sum is defined as the Peak Vector Sum (PVS). Vibration can cause varying degrees of damage in buildings and affect vibration-sensitive machinery or equipment. Its effect on people may be to cause disturbance or annoyance or, at higher levels, to affect a person's ability to work.

Corps reviewed data from the two most recent blasting projects completed by the district: the deepening of San Juan Harbor in 2000 and of Miami Harbor in 2005. Both used confined underwater blasting. Both projects had significant structural resources located near the blast that were of concern (the San Juan site included the National Park Service's Castillo San Felipe del Morro, a 400+ year old fortress overlooking the harbor and 30 additional historic sites within boundaries of the National Monument). In Miami, the harbor is bounded on the north by the port facilities and on the south by Fisher Island, a residential island. In both cases, a network of monitoring locations was established by the blasting contractor to capture vibration associated with the detonation of each blast. Additionally, at El Morro, the contractor installed monitoring devices on each crack in the stucco that covers the structure's interior walls, and a photo was taken after installation to serve as a pre-construction baseline. During construction, the crack was monitored throughout the blasting project to ensure that crack's width or length had not increased (Figure 20).

At Miami the maximum PVS allowed for the project was 1.0 mm/s. The average maximum PVS for the Miami Harbor deepening in 2005 was 0.3828mm/s with a range of 0.0819mm/s - 1.08mm/s during the 40 blast detonations. During both projects, no adverse impacts were reported to any of the surrounding structures by either the vibration monitoring contractor, or the building's owners/trustees.

Air Pressure.
The Corps Safety and Health Requirements Manual (EM 385-1-1 3, September 1996) limits of "air blast pressure exerted on structures resulting from blasting shall not exceed 133 dB (0.013 psi)" and industry standard vibration limitations would be incorporated into the design process. A conservative regression analysis of similar projects may be used to develop the design and then continually updated with calibration of the environment. The contractor will also be required to abide by state and local blasting requirements in addition to the Corps Safety Manual previously referenced in this paragraph.

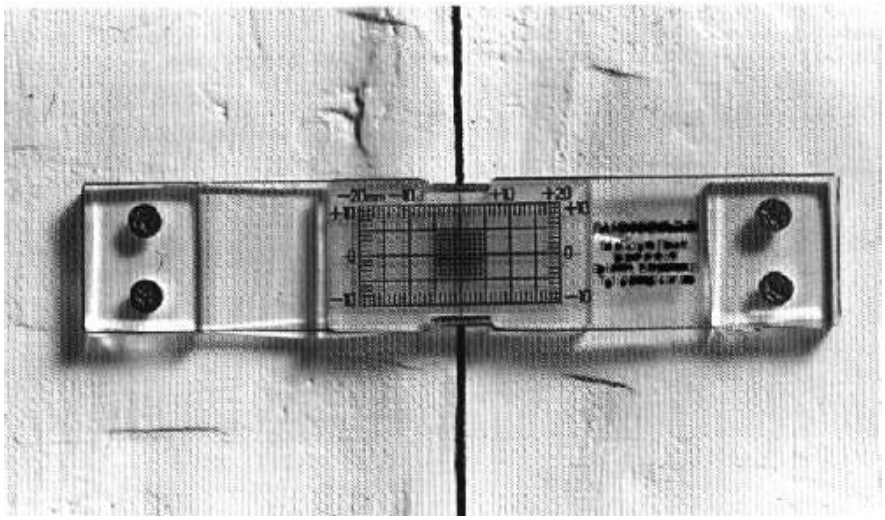


Figure 20 - Typical Crack Monitor Device

<u>Duration of Confined Blasting During Construction</u>
The duration of the blasting (pre-treatment) is dependent upon a number of factors including hardness of rock, how close the drill holes are placed, and the type of equipment that will be used to remove the pretreated rock. For comparison, the harbor deepening project at Miami Harbor in 2005-2006 estimated between 200-250 days of blasting with one-shot per day (a blast-day) to pre-treat the rock associated with that project. However, the contractor completed the project in 38 days with 40 blasts. The upcoming expansion at Miami Harbor scheduled to begin in spring of 2013 currently estimates 600 blast-days for the entire project footprint. However, the actual number of blast days may be reduced by the selected contractor, based on the previously mentioned factors. Using both Miami projects as a guide, and recognizing that 50% of the project footprint has been identified as possibly needing pre-treatment based on current information, Corps estimates approximately 900 blast-days for the Port

Everglades project, out of the total five years of uninterrupted construction, approximately 1,825 calendar days. This estimate is subject to change based on more detailed geotechnical analysis during the preconstruction, engineering and design (PE&D) phase of the project.

Adaptive Improvement of Blasting Specifications and Methods

Test Blast Program.

Prior to implementing a construction blasting program a test blast program will be completed. The test blast program will have all the same protection measures in place for protected species monitoring and protection as blasting for construction purposes. The purpose of the test blast program is to demonstrate and/or confirm the following:

- Drill Boat Capabilities and Production Rates
- Ideal Drill Pattern for Typical Boreholes
- Acceptable Rock Breakage for Excavation
- Tolerable Vibration Level Emitted
- Directional Vibration
- Calibration of the Environment

The test blast program begins with a single range of individually delayed holes and progresses up to the maximum production blast intended for use. The test blast program will take place in the project area and will count toward the pre-treatment of material, since the blasts of the test blast program will be cracking rock. Each test blast is designed to establish limits of vibration and air blast overpressure, with acceptable rock breakage for excavation. The final test event simulates the maximum explosive detonation as to size, overlying water depth, charge configuration, charge separation, initiation methods, and loading conditions anticipated for the typical production blast.

The results of the test blast program will be formatted in a regression analysis with other pertinent information and conclusions reached. This will be the basis for developing a completely engineered procedure for construction blasting plan. During the testing the following data will be used to develop a regression analysis:

- Distance
- Pounds Per Delay
- Peak Particle Velocities (TVL)
- Frequencies (TVL)
- Peak Vector Sum
- Air Blast, Overpressure

Fish Kill Monitoring.
In addition to monitoring for protected marine mammals, sawfish and reptiles in the area during blasting operations, Corps will work with the resource agencies to develop a monitoring plan for fish kills associated with each blasting event. This effort may be similar to the effort that was developed by FWC in association with the Port of Miami Phase II project, and is currently a requirement of the Miami Deepening project scheduled to start in the spring of 2013. This plan will be developed in detail during the PE&D portion of the project, but may include collection, enumeration and identification of dead and injured fish floating on the surface after each blast. In addition, blast data will be collected from the daily blasting reports provided after each shot by the blasting contractor, in addition to environmental data such as tidal currents (in-coming or out-going). Due to health and safety restrictions, all collections will be made from the surface only. No diving to recover fish carcasses is authorized.

Coordination.
As part of the development of the protected species protection and observation protocols, which will be incorporated into the plans and specifications for the project, Corps will continue to coordinate with the resource agencies (specifically BCEPD, NMFS, FWC, FWS and EPA) and NGOs to address concerns and potential impacts associated with the use of blasting as a construction technique.

Study Data.
In addition to coordination with the agencies and NGOs, findings from any new scientific studies regarding the effects of blasting (confined or unconfined) on species that may be in the area (marine mammals, sea turtles, fishes (both with a swim bladder and without) and reptiles will be incorporated into the design of the protection measures that will be employed in association with confined blasting activities in the port. Examples of these studies may include:

- "Caged Fish Study". As part of the August 1 & 2, 2006 After Action Review conducted for the Miami Harbor Phase II dredging project, which included blasting as a construction technique, Corps, in partnership with FWC, committed to conduct a study on the effects of blast pressures on finfishes with air bladders in close proximity to the blast. This study would attempt to answer the questions regarding proximity to the blast array, injury and death associated with confined blasting not resolved with research conducted with the Wilmington Harbor blasting conducted in 1999 (Moser 1998 and Moser 1999). This study is expected to be completed as part of the Miami Harbor 2013-2015 dredging project.
- Other blasting project monitoring reports for projects, both from inside and outside of Florida using confined underwater blasting as a construction technique completed prior to development of plans and specifications.

Conclusion.
Corps has concluded that confined blasting is the *least* environmentally impactful method for pre-treatment of hard, consolidated rock in the Port. Each blast will last no longer than 15 seconds in duration, and may even be as short as two seconds. Additionally, the blasts are confined in the rock substrate with stemming. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced significantly as compared to an unconfined blast (Nedwell and Thandavamoorthy 1992; Hempen *et al*. 2005; Hempen *et al*. 2007).

Protected Species Under NMFS Jurisdiction Included in this Assessment
The following endangered (E) and threatened (T) species under the jurisdiction of NMFS may occur in or near the action area:

Common Name	Scientific Name	Status
Marine Mammals		
Blue whale	*Balaenoptera musculus*	E
Fin whale	*Balaenoptera physalus*	E
Sei whale	*Balaenoptera borealis*	E
Humpback whale	*Megaptera novaeangliae*	E
Sperm whale	*Physeter macrocephalus*	E
North Atlantic Right whale	*Eubalaena glacialis*	E
Sea Turtles		
Loggerhead sea turtle	*Caretta caretta*	E/T
Hawksbill sea turtle	*Eretmochelys imbricate*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Green sea turtle	*Chelonia mydas*	E/T
Fish		
Smalltooth sawfish	*Pristis pectinata*	E
Plants		
Johnson's seagrass	*Halophila johnsonii*	T
Invertebrates		
Elkhorn coral	*Acropora palmata*	T
Staghorn coral	*Acropora cervicornis*	T

Critical Habitat
ESA-designated critical habitat for elkhorn and staghorn coral occurs within the action area.

The Corps has reviewed the biological, status, threats and distribution information presented in this assessment and believes that the following species will be in or near the action area and thus may be affected by the proposed project: four sea turtle species; Johnson's seagrass and smalltooth sawfish.

Marine Mammals

The full analysis of the life history of each of the six marine mammals in the impact area is provided in detail in the September 2004 Biological Assessment found in Appendix 2. The status of the six species has not changed since that analysis was conducted and it is incorporated by reference. These six species of endangered marine mammals may be found seasonally in the waters offshore southeastern Florida.

NMFS has previously consulted on effects of a large scale navigation expansion project (Miami Harbor) approximately 20 miles south of the Port Everglades project area for all six large whale species in 2003 and 2011. The same construction methodologies are being proposed for Port Everglades that were consulted on for Miami Harbor, and the same populations of the six large whale species were evaluated. Specifically NMFS said:

> "Blue, fin, sei, and sperm whales are predominantly found seaward of the continental shelf. Northern right whales and humpback whales are coastal animals and have been sighted in the nearshore environment in the Atlantic along the southeastern United States from November through March on their migration south. Right whales are rarely sighted south of northeastern Florida. None of these whale species are expected to be found in the shallow waters inshore of the outer reef. NOAA Fisheries believes that these whales could be affected by the use of explosives offshore of the outer reef; however, the COE has modified the proposed action such that explosives are not expected to be used seaward of the outer reef. NOAA Fisheries believes that this change in the proposed action, in combination with the above mentioned mitigation measures decreases the effects of the proposed action on listed whales to insignificant levels. If the COE decides to use explosives seaward of the outer reef they must reinitiate consultation as NOAA Fisheries believes that this may affect listed whale species." (NMFS, 2003a)
>
> "North Atlantic Right Whales and Humpback Whales
> North Atlantic right whales and humpback whales may be found in or near the action area. NMFS has analyzed the routes of potential effects on North Atlantic right whales and humpback whales from the proposed action and, based on our analysis, determined that potential effects are limited to the following: injury from potential interactions with construction (i.e., dredging) equipment (e.g., a dredge vessel striking a whale), injury from use of explosives, and temporary avoidance of the area during construction operations. The proposed project is not located in or near right whale calving areas. The COE will require the contractor to follow the safety conditions for blasting (noted in Section 3.1 above), therefore, NMFS concludes that the project's construction effects are discountable. In addition, the contractors will be required to abide by the NMFS' Vessel Strike Avoidance and Reporting guidelines. With implementation of these conservation measures, NMFS believes that the likelihood of right whales and humpback whales being adversely affected by the proposed action is discountable.
>
> Blue, Fin, Sei and Sperm Whales
> Blue, fin, sei, and sperm whales are predominantly found seaward of the continental shelf and are not expected to be found within the shallow waters inshore of the outer reef. Effects to whales include the risk of injury from construction, which will be discountable due to the species' mobility. Blue, fin, sei and sperm whales may be affected by being temporarily unable to use the site due to potential avoidance of construction activities and related noise, but these effects will be insignificant. Disturbance from construction activities and related noise will be intermittent

and only occur during the day for part of the construction period and will not appreciably interfere with use of the area by listed species." (NMFS, 2011)

Sea Turtles

A summary of the life history and species status for each of the five species of sea turtles that may occur on the beaches of, or offshore of, Broward County are found in the Sept 2004 Biological Assessment and are incorporated by reference.

Broward County is within the normal nesting range of three species of sea turtles: the threatened loggerhead (*Caretta caretta*), the endangered green turtle (*Chelonia mydas*), and the endangered leatherback (*Dermochelys coriacea*). The endangered hawksbill sea turtle (*Eretmochelys imbricata)* has also been recorded nesting in the County on rare occurrences (Table 2). The majority of sea turtle nesting activity in Broward County occurs during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis 1999). The waters and habitats offshore of Broward County are also used for foraging and shelter for the three species listed above and possibly the hawksbill turtle and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE 2000). Due to the heavily developed nature of the Broward County coastline, the relative location of Highway A1A to the beach, and extensive beach front lighting, all of which have the potential to negatively impact nesting sea turtles and their hatchlings, Broward County has relocated all discovered nests at Pompano Beach, Deerfield Beach, Hollywood-Hallandale, and Fort Lauderdale since the inception of its sea turtle conservation program in 1978 (Burney and Margolis, 1998). In 2005, the State of Florida changed its policy regarding relocation of nests, and decreasing the number of nests relocated in Broward County to approximately 65-70% of the deposited nests countywide and then to about 28-30% of the nests in 2006 and 2007 (Lou Fisher, pers. com 2007). Sea turtle nests located within the boundaries of JUL are not typically moved unless their location is in jeopardy from storm surge, tidal inundation, or erosion (S. Leve and E. Cowan, pers com, 2011). If nests are relocated, they are typically moved south to a natural area with slightly higher elevation.

Table 2 Sea Turtle Nesting in Broward County: Number of Nests by Year and Species

Year	Green	Loggerhead	Leatherback	Hawksbill
2010	268	2,283	14	0
2009	71	1,808	45	0
2008	276	1,929	14	0
2007	233	1,593	41	0
2006	138	1,740	15	0
2005	208	1,819	25	2
2004	153	1,826	4	0
2003	78	2,335	12	0
2002	216	2,070	18	0
2001	26	2,321	39	0
2000	255	2,674	13	0
1999	24	2,584	12	0
1998	200	2,643	14	0
1997	29	2,216	42	0
1996	130	2,902	2	0
1995	52	2,567	15	0
1994	123	2,180	9	1

FWRI 2011 [Hawksbill data currently being confirmed for 2006-2010]

Between 1991-2009, 28 stranded sea turtles have been reported within or near Port boundaries: 16 loggerhead turtles, six green turtles, four hawksbill turtles, and two unidentified species. Of these 28, 13 were documented as incidental captures. one green turtle was caught on hook and line at John U Lloyd Beach State Park, and 12 (10 loggerheads, one green turtle, and one unknown) were caught in the FP&L power plant at Port Everglades (A. Foley, FWRI, pers com, July 29, 2011). Specific location information, i.e., latitude/longitude, for 2010 and 2011 have not yet been entered into the FWC database, so it is unknown if any strandings for those years were associated with the project area.

Fish - Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*) has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish *P. perotteti* (west and south of Port Arthur, TX) (Adams and Wilson, 1995). Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months. It also was an occasional visitor to waters as far north as New York.

Smalltooth sawfish, *P. pectinata,* were once common in Florida as detailed by the Final Smalltooth Sawfish Recovery Plan (NMFS 2009a) and are very rarely reported in southeast Florida. Their core range extends along the Everglades coast from the Ten Thousand Islands to Florida Bay, with moderate occurrence in the Florida Keys and at the mouth of the Caloosahatchee River. Outside of these areas, sawfish are rarely encountered and appear to be relatively rare (Simpfendorfer 2006). It does not appear to be a coincidence that the core range of smalltooth sawfish corresponds to the section

of Florida with the smallest amount of coastal habitat modification. Corps requested sighting information from the FWC smalltooth sawfish sighting database on January 16, 2008 for the "area in and around Port Everglades, Broward County". In an email response dated January 16, 2008 FWC sawfish Biologist, Gregg Poulakis referred Corps to the FWC sawfish database previously provided to Corps in October 2007. A search of that database found a total of seven sightings of *P. pectinata* in Broward County between 1993 and 2007 ranging in size from 2.4-4.1 meters in length (FWC 2007). The locations of these sightings ranged from Pompano Beach through Lauderdale-By-the-Sea, including three sightings in the vicinity of the Port. In July 2011, Corps contacted FWC again, and was referred to NMFS-OPR, who has taken over management of the database. NMFS (via S. Norton, pers com) provided a figure of all of the smalltooth sawfish sightings throughout Broward County, which is shown below (Figure 21). NMFS provided data pertaining to a total of 15 individuals documented in Broward County between 2003-2011.

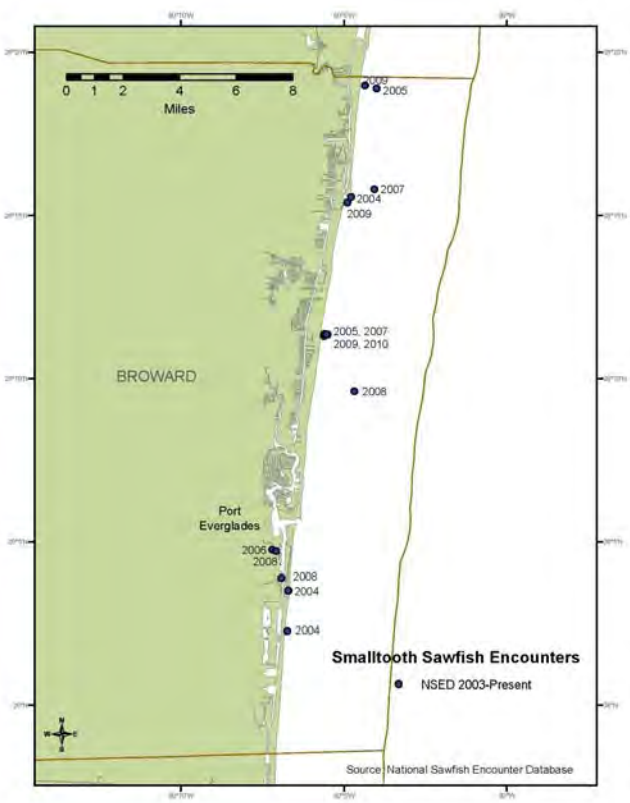


Figure 21 - Smalltooth sawfish observations, Broward County, Florida (2003-2011)

Possibly the most notable sighting of a *P. pectinata* in Broward County, in the vicinity of the Port took place at the Florida Power & Light (FP&L) Port Everglades power plant discharge canal on March 17, 2006 during an effort to capture an injured manatee in the canal (Figure 22). Based on data from FWC, the sawfish was approximately 10-12 feet

(120-144 inches) in length and was released from the manatee capture net without harm.

Figure 22 - Adult smalltooth sawfish incidentally captured in the FP&L power plant discharge canal

Habitat use by sawfish appears to be divided by animal size. Small sawfish (0-79 inches/0-200 cm) use shallow water areas as nursery areas often dominated by red mangrove habitats. The mangrove prop roots help serve as shelter against predation (NMFS 2009b and Simpfendorfer 2006). There is limited data available on habitat usage for large juvenile sawfish (>79 inches/201 cm). One tagged individual was recorded in water depths of less than 17 feet for 120-days (NMFS, 2006). Simpfendorfer found that a large percentage of animals greater than 300 cm (3 meters) in size were found in deeper water. Adult smalltooth sawfish use shallow coastal waters to deep shelf waters of up to 400 feet (NMFS 2009b). They may use navigation channels as a transit corridor between the shallow coastal and deeper water habitats. Mote Marine Laboratory (Simpfendorfer 2006) prepared a Habitat Suitability Index (HSI) for sawfish under contract to NOAA, for the entire state of Florida and found, that on a scale of 0-9 (with 9 being the best possible habitat for smalltooth sawfish), the water habitats in Broward county ranked between 2-3 on the HSI. This finding was based on the water depths adjacent to mangroves, distances to mangrove buffer and salinity. It should also be noted in that Broward County's tidal waterways are unique compared to other Florida coastal counties. Characterized as predominately linear, the marine waterways rarely exceed 1000 feet in width and most shorelines are stabilized with a seawall, rip-rap or other erosion control system (Broward County 2007). This determination by Simpfendorfer supports Corps's determination that the Port's existing habitats are not optimal for sawfish; the area is extremely limited for use by juveniles due to the lack of shallow water (less than one meter in depth) directly adjacent to large areas of mangroves. However, this does not mean that the areas near Port Everglades cannot support sawfish. This is also shown in the history of sawfish sightings in Broward County.

A review of the NOAA sawfish database provided one record of a sawfish smaller than two meters (168 cm), located offshore of Broward County near Pompano Beach, approximately 15 miles north of Port Everglades (Amanda Frick, NOAA, pers com, 25 July 2011). To date, no sawfish smaller than 2 meters (the size at which sawfish attain sexual maturity) has been documented within five miles of Port Everglades or within the boundaries of the Port.

NMFS released the final recovery plan for the smalltooth sawfish in January 2009 (NMFS, 2009), and designated critical habitat for the species in September 2009 (74 FR 45353).

Plants - Johnson's Seagrass

A detailed review of the biology and status of Johnson's seagrass is located in the September 2004 Biological Assessment and is incorporated by reference. *Halophila johnsonii* has the most limited geographic ranges of all seagrass species. It is known to occur only from 21.5 km north of Sebastian Inlet (i.e., near Palm Bay in Brevard County) south to northern Biscayne Bay (i.e., North Miami) on the east coast of Florida (Kenworthy 1997; Virnstein and Hall 2009). Although NMFS has listed *H. johnsonii* as a threatened species under Section 4 of the ESA, it has not promulgated a 4d rule under the Act, and as a result, there is no prohibition on take the *H. johnsonii*.

Seagrass habitat cover type, abundance, and density for the study area are described in the Environmental Baseline Surveys conducted in 1999, 2000, 2001, 2006 and 2009 (Figure 23). Additional surveys were carried out by Broward County in 2001 and 2004. The 1999 environmental baseline surveys for seagrasses occurred within the project area, which started approximately 1,200 feet north of the Port Inlet, then south along the IWW to approximately 1,000 feet south of the DCC juncture, and also along the DCC (DC&A 2001). In the 2000 survey, additional survey transects were located within the area 1,000 feet south of the DCC on the east side of the channel, and on the west side, from the DCC south to the Dania Beach Boulevard Bridge. Also, in order to field verify whether seagrass occurred in the OEC, as reported by the BCEPD staff (S. Higgins, Beach Erosion Administrator Broward County, pers com), an integrated video survey was performed within the OEC in 2001 (DC&A 2001). In 2006, thorough reconnaissance of the entire project area was completed, verifying that seagrasses were limited to the areas previously mapped in 1999 and 2000. After the reconnaissance effort, detailed seagrass surveys were conducted in the same project area as 1999 and 2000 field surveys (not including areas further south than approximately 1,000 feet south of the intersection of the DCC with the IWW (DC&A 2006)). In 2009, further thorough reconnaissance of the entire project area was completed, verifying that grasses remained in the previously mapped areas and had not established beds in new areas. After this reconnaissance effort, detailed seagrass surveys were conducted in the same project area as 2006 surveys (again, not including areas further south than approximately 1,000 feet south of the intersection of the DCC and the IWW) (DC&A 2009a; see Appendix D).

Several other seagrass surveys and anecdotal observations have occurred in the project area, including a Broward County seagrass survey in 2001, and a Broward County/FDEP QA/QC assessment for a previously conducted seagrass survey near the USN facility (the south side of the IEC) for a proposed Navy project in 2004. A permanent transect was established in April 2006 adjacent to the Coast Guard station to monitor annual changes in the documented *Halophila johnsonii* bed by Fish and Wildlife Research Institute (FWRI) (Jennifer Kunzelman, FWRI, pers comm, January 25, 2008). Also in 2008, seagrass surveys were conducted for Nova Southeastern University Oceanic Center's (NSUOC) boat basin and adjacent areas (Coastal Eco-Group 2008). Most recently in the summer of 2008, an interagency team conducted qualitative surveys within the project area. These studies have provided valuable supplemental information on seagrass populations changes and trends since 2001. In 2008 and 2009 Miller Legg conducted surveys for West Lake Park within the DCC portion of the project area. Due to the data collection methods, which may have included GPS point data in many cases, these data are not displayed in seagrass habitat maps, except for the 2009 dataset, which surveyed areas identified in the 2008 interagency survey effort.

Figure 23 - Transect coverage of all Corps seagrass surveys

Results from seagrass surveys conducted for the project (DC&A 1999; DC&A 2001; DC&A 2006; DC&A 2009) demonstrated that *H. johnsonii* occurs within the SAC (see Figures 24 and 25). *H. johnsonii was* documented by at least one survey in all assessment areas except OEC and IEC. In 2006, *H. johnsonii* was not observed in two assessment areas where it was previously observed, however it returned to these areas in 2009. The expansion and contraction of *H. johnsonii*, also referred to as “pulsating patches” may be a long-term survival strategy (Virnstein *et al*. 2009). The persistent presence of high-density elevated patches of *H. johnsonii* on flood tidal deltas near inlets suggests that it is capable of sediment stabilization (NMFS 2007).

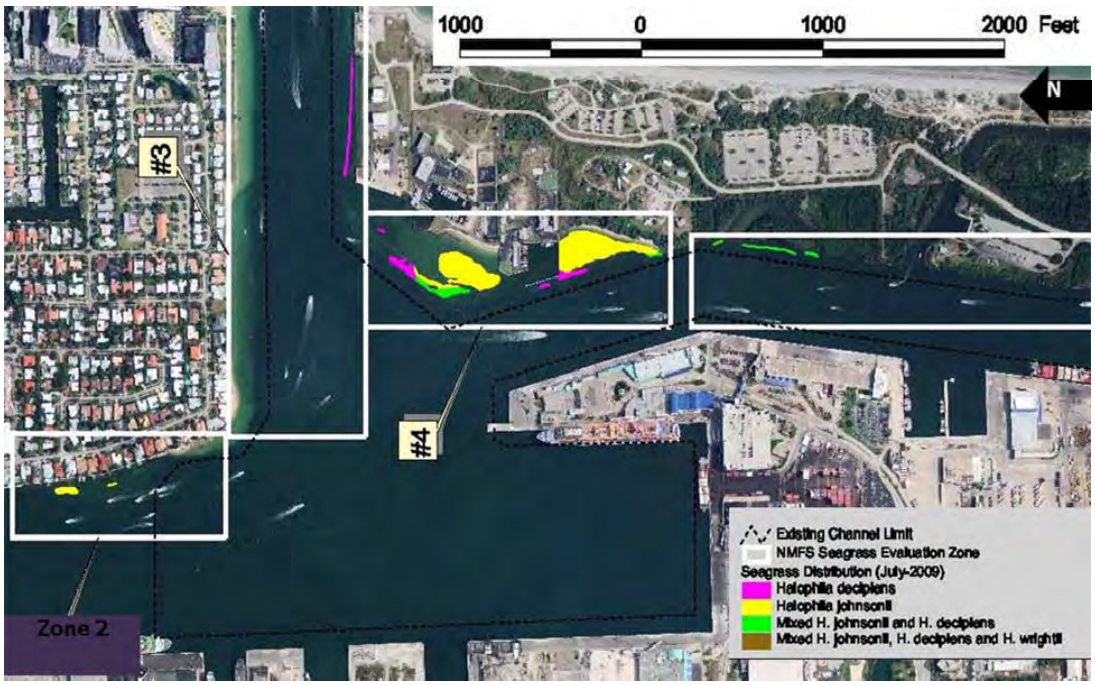


Figure 24 - Seagrass coverage in northern portion of project area

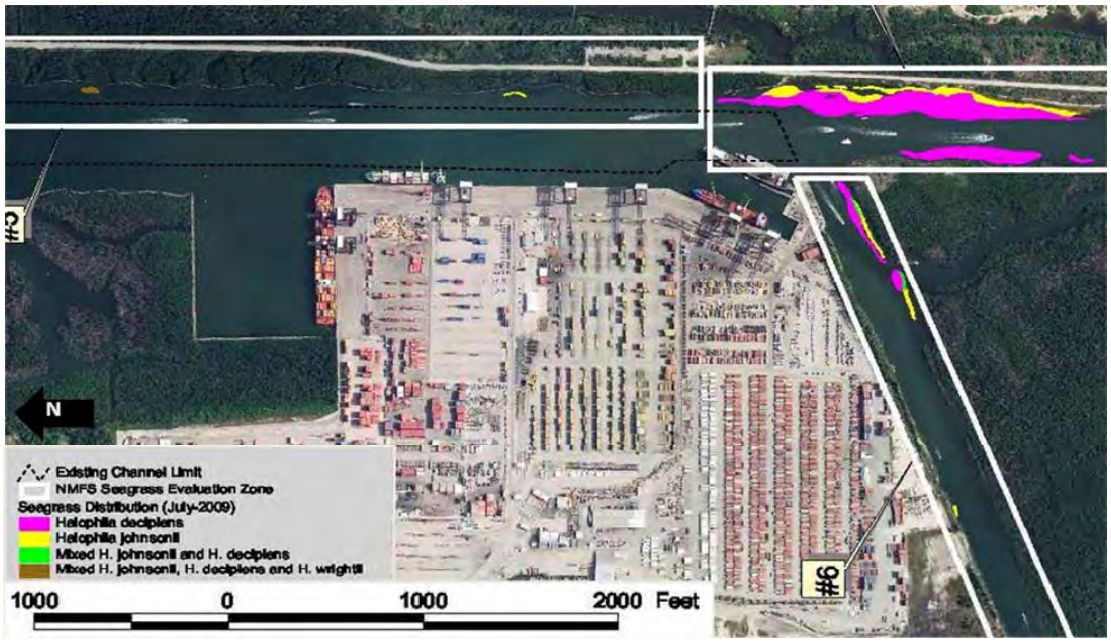


Figure 25 - Seagrass coverage in southern portion of project area

In Heidelbaugh (1999), *H. johnsonii* beds yielded a total of 126 species (69 epifauna and 57 infauna). Three hundred and twenty macrofaunal organisms were collected from *H. johnsonii* beds. NMFS has concluded that the conservation of *H. johnsonii* will not only maintain the diversity of the seagrass communities, but also the important biodiversity and biophysical characteristics of the entire ecosystem (NMFS 2007). Although *H. johnsonii* serves as hiding and resting area for many species, Gabiel and Hirons (2011), in a study specific to the project impact areas in the SAC, state "consumers in Port

Everglades are not feeding on seagrass" including some of the densest patches of *H. johnsonii* in the project area.

The total amount of *H. johnsonii* mapped in the project vicinity ranged between 1999-2009 from 4.81 acres to 5.40 acres with an average of 4.98 acres.

Table 3 - Mapped Johnson's seagrass in project vicinity

Bed Type (sp)	1999-2000 Acres	2006 Acres	2009 Acres	Average Acres coverage (minus DCC)
H. Johnsonii	2.85	2.80	4.68	3.44
Mixed *H. johnsonii/H. decipiens*	0.00	1.08	0.46	0.77
Mixed *H. johnsonii/H. decipiens/H. wrightii*	1.96	0.09	0.26	0.77
Totals	4.81	3.97	5.40	4.98

Critical Habitat

The northern and southern ranges of Johnson's seagrass are defined as Sebastian Inlet and central Biscayne Bay, respectively. These limits to the species' range have been designated as critical habitat for Johnson's seagrass. Within its range, Johnson's seagrass critical habitat designations have been designated for 10 areas: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. There is no designated critical habitat within the action area (NMFS, 2000).

Invertebrates - Staghorn and Elkhorn Corals

Staghorn (*Acropora cervicornis*) and elkhorn (*Acropora palmata*) corals were listed as threatened under the ESA on May 9, 2006, (71 FR 26852) based on a status review completed by NMFS in March 2005 (70 FR13151). NMFS published a "4D" rule for these *Acropora* species on October 29, 2008 (73 FR 64264) providing a list of activities that would result in "take" as defined by the ESA. NMFS published a final rule to designate critical habitat for these species on November 26, 2008 (73 FR 72210). NOAA has not yet prepared a recovery plan for either *Acropora* species. However a recovery plan development team completed a draft and provided this to NMFS for revisions and publication.

The Atlantic *Acropora* Status Review presents a summary of published literature and other currently available scientific information regarding the biology and status of both elkhorn and staghorn corals (http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/corals.pdf).

Based on the status review and final critical habitat designation, NMFS has determined that any hardground habitat located in Florida south of Boyton Inlet in Palm Beach County in waters less than 30 meters deep has the potential to support either of the *Acropora* species (NMFS 2005). The final critical habitat determination identifies that the primary constituent elements for the continued survival of acroporid species may be found in waters less than 30 meters in depth (NMFS 2007).

In October 2007, NMFS released the revised *Interim Acropora Survey Protocol for Section 7 Consultation*, a protocol for surveys to be conducted for projects within the known habitat of *Acropora* sp. Corps staff met with NMFS leadership in April 2008 to discuss the applicability of this interim protocol in high traffic federal navigation channels where human safety was a major concern. NMFS-OPR leadership agreed that a modified methodology for surveying for *Acropora* in 13 federal navigation channels within *Acropora* critical habitat was warranted. Working under this agreement, Corps developed a two-tiered survey approach. The two-tiered method includes integrated towed video survey, with a built in altimeter, that would allow the flyer and viewer to know the distance to the bottom, follow-up ground-truthing diver surveys, and diver surveys following the NMFS protocol.

Corps has conducted a total of four surveys (one specifically for Acropora in 2010) of the proposed project area between 2001-2010 (Figure 26), using a combination of towed video and divers, and has not documented the presence of either species in the project area.

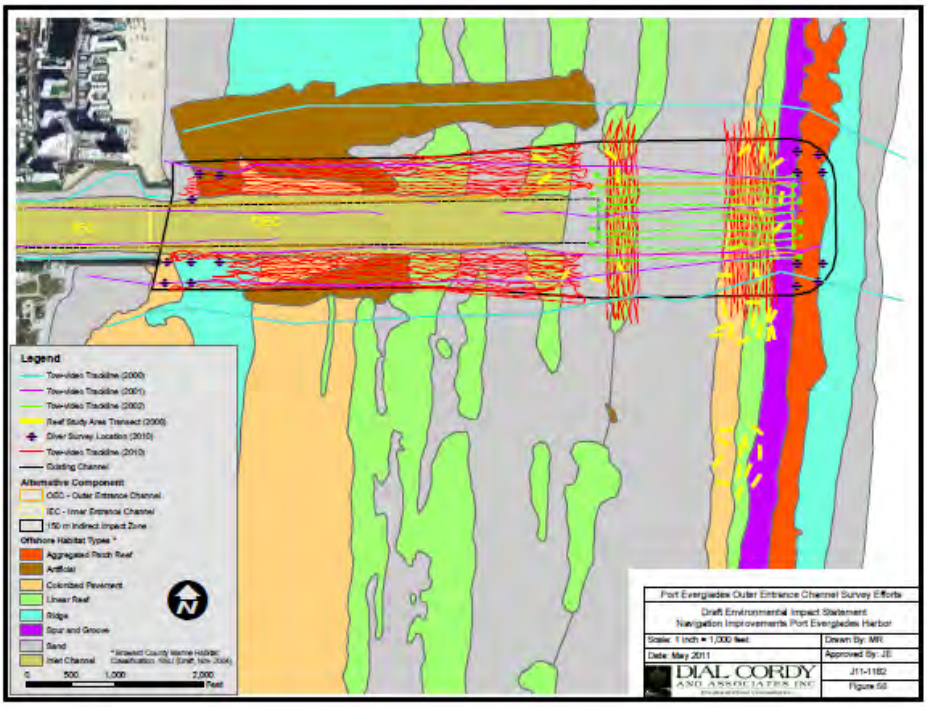


Figure 26 – Total Survey Coverage by Corps for Port Everglades 1999-2011

Towed video transects covered more than 40% of the entire direct and indirect impact area. This is significantly more area than would be covered if the diver-only protocol would have been employed to survey for *Acropora spp.* in the project area. Twenty-one dives were made to identify organisms that were designated as "potential" *Acropora* colonies in post-processed video. No *Acropora* colonies were documented within the direct or indirect impact areas of the Port Everglades expansion area during this survey. Full results of this survey are found in the "Port Everglades Feasibility Study *Acropora* Coral Survey Final Report October 2010" (Appendix 6). Additionally, the US Navy conducted a survey of coral species located within the South Florida Ocean Measurement Facility Restricted OPAREA located immediately south of the OEC (USN 2011/Appendix 5) (Figure 27).

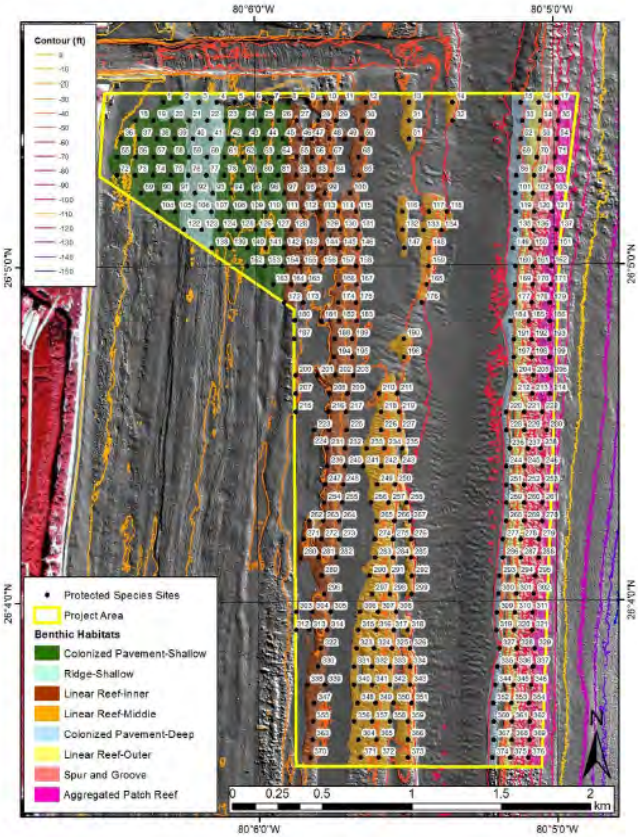


Figure 27 - US Navy Protected Coral Species Survey sample sites

A. cervicornis colonies are known to exist in the vicinity of Port Everglades, 2,780 feet (848m) to the south of the Port entrance channel, on the near shore hardbottom, and 1,400 feet (427m) north on the inner reef (Dial Cordy 2010, NOVA 2008). The Navy located *Acropora cervcornis* on the first, second and third reefs offshore of their facility located south of the OEC. *Acropora palmata* was not documented during the Navy survey. The closest documented *Acropora cerviconis* to the expansion project was located on the first reef, at the edge of the 150 meter (492 feet) buffer from the project footprint, approximately 500 feet south of the channel. This location is outside the indirect impact assessment area for the Port Everglades expansion project. Although the Navy survey did document *Acropora cervicornis* on the third reef, the closest documented colonies (1-5 colonies in density) were located more than a mile south of the 150-m project buffer (Figure 28). As of the writing of this document, no colonies of *A. palmata* have been documented within the vicinity of the existing channel. To-date, no *A. cervicornis* have been identified within the direct or indirect impact areas within the proposed Project area (Dial Cordy 2010, USN 2011).

Although *Acropora cervicornis* and *Acropora palmata* have not been located in the project footprint, or adjacent indirect impact zone, we recognize that this may change between the finalization of this consultation and initiation of construction dredging by the species migrating into the project footprint or that a colony less than 1-2 years old,

not visible to the eye during the surveys (NMFS 2005) matures and becomes visible to the naked eye. As we have previously committed to in our letter dated October 18, 2006 and our October 13, 2006 Effects Determination Memorandum, if any *Acropora cervicornis* or *Acropora palmata* are located prior to or during project construction, the Corps will implement the protective measures detailed in the Terms and Conditions of the Miami Harbor September 2011 Biological Opinion (F/SER/2011/00029) reinitate consultation with NMFS under the ESA.

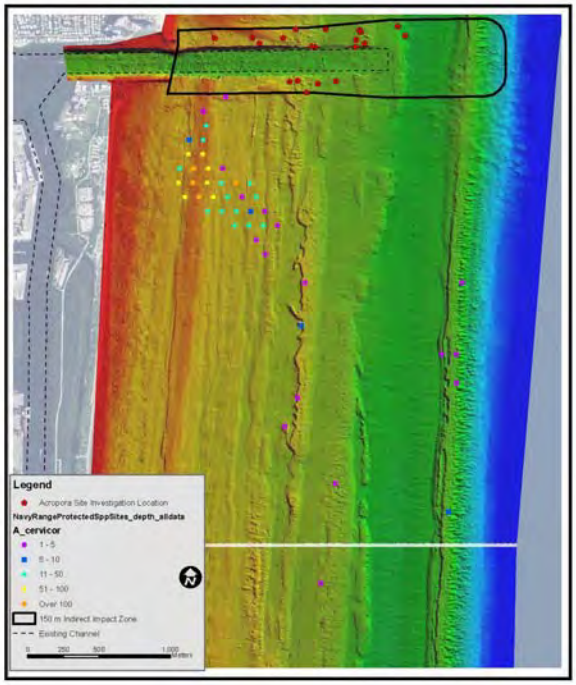


Figure 28 - Location of USN *A. cervicornis* colonies in comparison with Port Everglades Channel

Critical Habitat

On November 26, 2008, NMFS published a final rule in the Federal Register to designate critical habitat for Elkhorn and staghorn corals. Four specific areas were designated, including: the Florida unit (approximately 1,329 square miles of marine habitat); the Puerto Rico unit (approximately 1,383 square miles of marine habitat); the St. John/St. Thomas unit (approximately 121 square miles of marine habitat); and the St. Croix unit (approximately 126 square miles of marine habitat).

Designated critical habitat in the Florida Unit includes the Atlantic Ocean offshore of Broward County (Figure 29). Within these water depths, NMFS has defined that, ''substrate of suitable quality and availability'' is equivalent to consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover. (NMFS, 2008b). An area south of Port Everglades referred to as the "Dania RAA" was excluded from the DCH under 50 CFR §226.216(d). This area abuts the south side of the existing federal channel approximately 300 feet south of the channel, creating a 7.45 acre strip of DCH on the south side of the channel (Figure 30).

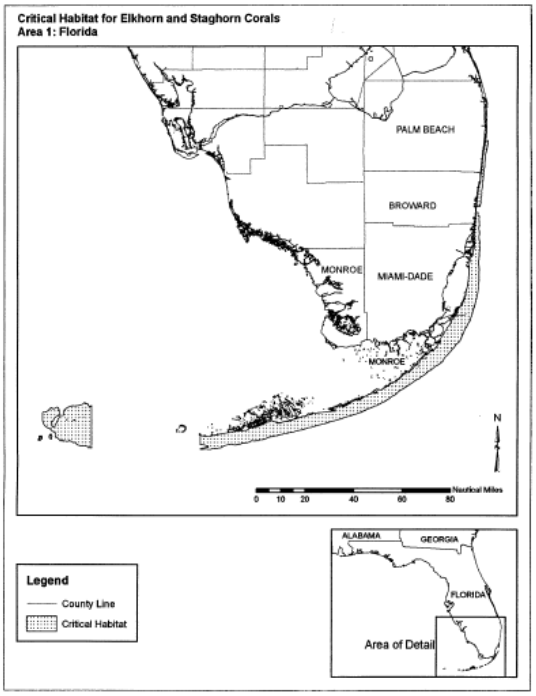


Figure 29 - Designated critical habitat for Elkhorn and staghorn corals in the Florida Area.

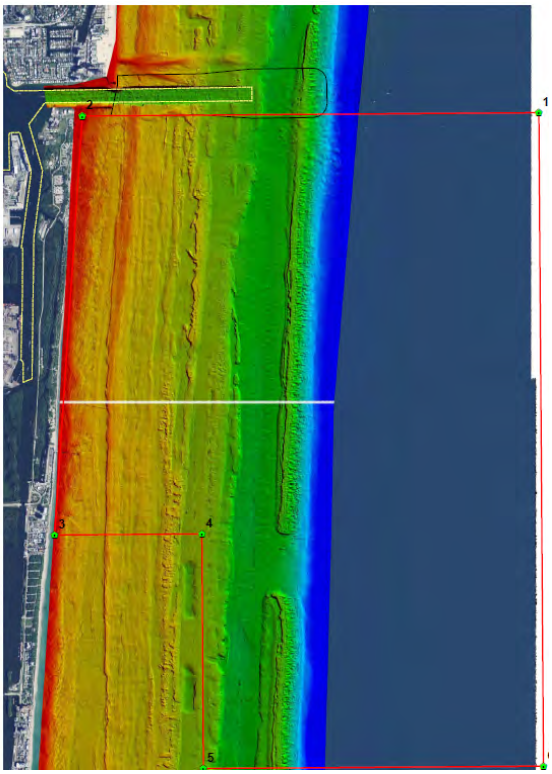


Figure 30 - Boundaries of Dania RAA in relation to Entrance Channel

Protective Measures to be taken in the Project Area as Part of the Proposed Action
Based on previous biological opinions issued by NMFS for adverse affects to listed *Acropora sp*., Johnson's seagrass, smalltooth sawfish and sea turtles associated with dredging and construction, the Corps plans to incorporate "terms and conditions" from these opinions into the plans and specifications for the Port Everglades project. These efforts will include:

1. Smalltooth Sawfish/Sea Turtles - Incorporation of the NMFS "Sea Turtle and Smalltooth Sawfish Construction Conditions" into the project plans and specifications:

a) The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b) The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c) Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d) All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

e) If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f) Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

g) Any special construction conditions, required of the project, outside these general conditions, if applicable, will be addressed in the primary consultation.

2. Acropora –

a) Transplantation of any Acroporid corals located during pre-construction surveys or during construction monitoring greater than 10 cm in size.
b) Turbidity monitoring during construction to meet the requirements in the Section 401 water quality certificate issued by the FLDEP.
c) Sedimentation monitoring during construction.
d) Maintaining a sufficient buffer from all mapped hardgrounds when placing rock for the reef mitigation creation site to ensure no damage occurs to those hardgrounds when placing the rock for artificial reef creation.

State of Florida

The State of Florida has numerous laws, regulations and programs aimed protecting corals and coral reef habitats, including those habitats that support Acroporid coral species. The Coral Reef Conservation Program (CRCP), as part of the Florida Department of Environmental Protection (FLDEP) coordinates research and monitoring, develops management strategies, and promotes partnerships to protect the coral reefs, hardbottom communities, and associated reef resources of southeast Florida. Through its role in supporting Florida's membership on the U.S. Coral Reef Task Force, and the U.S. All Islands Committee, the CRCP leads the implementation of the Southeast Florida Coral Reef Initiative and contributes to the National Action Plan to conserve coral reefs. The CRCP is also charged with coordinating response to vessel groundings and anchor damage incidents in southeast Florida, and developing strategies to prevent coral reef injuries. Florida Fish and Wildlife Conservation Commission's Wildlife Research Institute (FWRI) funds and conducts research activities on coral and hardbottom habitats throughout Florida, including those that support Acroporid corals and DCH.

Broward County

Broward County conducts numerous monitoring efforts throughout the county for all coral habitats, including Acroporid corals. They also deploy artificial reefs and maintain a mooring buoy program to establish a system of mooring buoys for recreational vessels to protect natural and artificial reefs from damage caused by boat anchors (http://www.broward.org/NATURALRESOURCES/BEACHANDMARINE/Pages/mooringbuoys.aspx). More than 120 buoys are available for use at various locations off Broward County. These sites include popular natural and artificial reef sites, including those habitats that may support Acroporid corals in Broward County. Broward County environmental staff also serves as the environmental assurance and compliance agent during county-sponsored in-water construction activities.

The Nature Conservancy

The Florida Reef Resilience Program brings scientists, reef managers and resource user groups together to develop strategies to improve the health of Florida's reefs and enhance the economic sustainability of reef-dependent commercial enterprises.

Scientific Research

NMFS provided an exception to the take prohibition for research and enhancement activities authorized by six (6) specific permit programs in the Acropora 4(d) Rule <http://sero.nmfs.noaa.gov/pr/pdf/AcroporaFinal4dRule.pdf> , they have not issued and permits under Section 10(a)(1) of the ESA to date (Jennifer Moore, pers.comm). Specifically for Broward County, any *Acropora* research would be permitted by the FWC. So long as a researcher holds a valid permit from FWC, no ESA sec 10 permit is required. NMFS may obtain a list of current permit holders from FWC as part of this consultation.

Other consultations of Federal actions in the action area to date

- None of the expansion projects authorized by Congress through 1968 were required to consult under the ESA. Port Everglades projects following implementation of the ESA are listed in the table below.

Date	Activity	Authorizing document/permit	Action	Volume of dredged material	Mitigation
1979-81	Port Expansion	H. Doc 93-144; 93rd Congress	Widening of entrance channel on a new alignment (shift centerline 75 ft north)	Not documented	Creating of Fishing Reef in SW Corning of "old" ODMDS in ~125 ft of water
1983	Berth 29 Bulkhead and Channel	USACE 81L-0624 FDER 060419139	Berth deepening and bulkhead construction	Dredge 311,000 cy material from unvegetated bottom	0.4 acres mangrove creation
1984	Pier 7 Channel Dredging	USACE 83D-2441 FDER 060257779	Channel deepening	Dredge 242,222 cy material from unvegetated bottom	None
1984	East Channel Dredging	USACE 84D-0385 FDER 060748269	Channel improvements	Dredge 46 acres unvegetated bottom, fill 4.73 acres of unvegetated bottom	None
1987	Construct Turning Notch	USACE 84R-4146 FDER 060924019	Port expansion	Removal of 18.27 acres of mangrove wetlands	Creation of 23 acres of mangroves, preservation of 48 acres of mangroves, creation of manatee refuge
1989	Construct Berth 33	USACE 84Y-4246 FDER 061407349	Port expansion	Removal of 2.0 acres of mangrove wetlands	Creation of 4.5 acres of mangroves
2004	Dredging of North Turning Basin		Operations and Maintenance Dredging	N/A	N/A
2005	Dredging of Entrance Channel		Operations and Maintenance Dredging – placement on JUL Beach as part of Broward SPP Seg III	Removed 40,523 cu yd of beach quality sand from inner entrance channel	N/A

2005-2006	Broward County Shore Protection Project, Segment 3	SAJ-1999-5545	Renourishment of Segment 3 of the Broward SPP from Beach fill extended from FDEP R-86 to R-92 within John U. Lloyd State Park, and R-99 to R-128 (Dade County line).	Burial of 7.6 acres of nearshore hardbottom (direct burial of 0.9 acres in John U. Lloyd State Park and 1.1 acres of worm rock habitat in Hollywood).	FDEP required the placement of 8.9 acres of mitigative artificial reef.

- The Corps and Broward County are currently in the planning process for a renourishment of Segment II of the Broward County Shore Protection Project located north of the port. ESA Consultation has not yet been initiated for that effort.
- Regulatory permits issued by the Jacksonville District's West Palm Beach Field Office under Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act are required to undergo consultation under Section 7 of the ESA. NMFS-PRD should have these consultations detailed in the PCTS tracking system for analysis.

Effects of the Action

Larger Vessels calling in the Future – All Species

Vessel Calls in a Without Project Condition

A major area of concern raised by resource managers is the increase in vessels expected to arrive as a result of the expansion of Port Everglades. The economic analysis of the project's without-project condition show as many as 8,984 vessels will be calling annually at Port Everglades, an increase from the pre-2009 baseline of more than 3,691 vessels (Table 4). This increase in vessel calls associated with the "Future without project" scenario/ No-Action Alternative will result in increased pressure on berth capacity as more ships arrive at the port and the port does not have more berthing capacity to absorb them. This will result in more ships waiting in the anchorage for berths to open and as a result may result in a greater likelihood of anchor damage or of a ship breaking free of the anchorage and grounding on the reefs shoreward of the anchorage. In a report about the usage of the Port Everglades Anchorage, Moffatt and Nichol (Moffat and Nichol 2006) documented that 50% of the grounding and anchorage damage was linked to vessels awaiting berths to open in Port Everglades. Although this report was specific to the old anchorage that was reconfigured to reduce impacts to the inshore reefs, as more vessels are crowded into the new anchorage, the potential for adverse impacts increases.

Table 4 - Baseline and Future Without Project Vessel Calls

Vessel Type	Baseline - Pre 2009			Future W/o Project 2009-2067				
	Baseline (High # Calls pre-2009)	Year	Passengers/tons	Future Calls w/o project	Projection Year	Passengers/tons	Change from base	Percentage change from base
Liquid bulk (minus Aframax)	467	2008		532	2066		65	12%
Aframax tanker	3	2008		3	2067		0	0%
Container								
PP2 = Post-Panamax 2 vessel size.	0	2008		103	2066		103	100%
PP1 = Post Panamax 1 vessel size.	23	2008		356	2066		333	94%
PEW= Panamax East West services.	117	2008		173	2066		56	32%
PNS = Panamax North South services.	190	2008		537	2066		347	65%
SP = Sub-Panamax size.	89	2008		187	2066		98	52%
Handy = Handysize.	491	2008		1388	2066		897	65%
Feedermax = Feedermax size.	235	2008		573	2066		338	59%
Feeder = Feeder size.	583	2008		1224	2066		641	52%
General Cargo	135	2006		176	2067		41	23%
RoRo	537	2006		1361	2067		824	61%
Cruise	2297	2004	4,075,406	2069	2067	6,879,729	-228	-11%
Dry Bulk	126	2006	2,954,310	302	2066	7,371,749	176	58%
	5293			8984			3691	

The Cruise industry has already launched two newer, larger classes of cruise ship since the economic and ship simulation analysis was completed by the Corps. When the Corps did the analysis for the project, the *Voyager of the Seas* (Voyager Class), launched in 1999, was the largest cruise ship in the world with a length of 1,020 ft, a beam (width) of 156 ft, a draft of 28 ft and a sail area (area above the water line) of 207 feet. In 2006, The *Freedom of the Seas* (Freedom Class) became the largest cruise ship in the world, with a length of 1,111 ft, a beam of 126 feet, a draft of 28 feet and a sail area of 209 feet. Currently, the *Oasis* and *Allure of Seas*, launched in December 2010 and October 2010, respectively, have a length of 1,187 feet, a beam of 154 feet, a draft of 31 feet and a sail area of 236 feet and are the largest cruise ships in the world. Both of these ships sail from Port Everglades.

Lastly, as larger ships call at Port Everglades, albeit light loaded and/or with higher sail area, they lack sufficient room in the outer entrance channel to respond to wind and varying current conditions in the channel, resulting in a higher risk of grounding on the reefs adjacent to the channel or scraping against the walls of the outer channel (allusion), impacting the resources that have colonized the walls since the channel was widened in 1980. This would also result in a higher likelihood of oil spills associated with vessels grounding (particularly petroleum vessels) and thus endanger human health and safety, in addition to the surrounding environment.

<u>Vessel Calls with Project Conditions</u>

Under the “with project” condition, the number of vessels calling at Port Everglades from all vessel classes is not expected to change significantly in association with the

additional depth. Growth projections showed increase use of the port with or without the deepening project, however, the amount of cargo and liquid bulk on the vessels is expected to increase as the vessels add more cargo in response to the additional water depth available for use, allowing for more efficient use of the vessels. The future without the project in 2067 estimates 8,984 vessel calls, an increase of 3,691 vessel calls into Port Everglades. With project vessel calls in 2067 are estimated to be 8,693, one call less than estimated without the project. Additionally, newer generations of cruise ships will add more passengers as the ships get larger. The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls, or possibly decreasing the number of vessel calls, which is consistent with national trends detailed in IWR 2012 and Figure 31. Table 5 provides a summary of historic and projected future vessel calls.

Table 1: Forecast East Coast Container Fleet 2012-2035

	2012	2015	2020	2025	2030	2035
0.1 - 1.3 k TEU	24	11				
1.3 - 2.9 k TEU	34	12	6	4	3	3
2.9 - 3.9 k TEU	28	12	10	4	4	2
3.9 - 5.2 k TEU	140	95	78	58	42	29
5.2 - 7.6 k TEU	86	114	153	156	159	168
7.6 - 12.0 k TEU	26	61	96	155	227	322
12.0 k TEU +		3	13	42	82	136

Note: post-Panamax vessel bands shaded in yellow. *Source: Maritime Strategies International, Limited*

This East Coast container fleet forecast shows the number of container vessels (by TEU range) being deployed on trade routes that include the U.S. East Coast ports. Vessels above 52k TEU are considered *post-Panamax* vessels.

Figure 31 - Shift from panamax to post-panamax ship class between 2012 and 2035 (IWR 2012)

Table 5 - Vessel Call Projects, Baseline, Future Without and Future With Project

With and Without Project Vessel Calls

		Baseline - Pre 2009			Future W/o Project 2009-2067					Future With Project 2009-2067					
Feasibility Study table	Vessel Type	Baseline (High # Calls pre-2009)	Year	Passengers/tons	Future Calls w/o project	Projection Year	Passengers/tons	Change from base	Percentage change from base	Future Calls w/ project	Projection Year	Passengers/tons	Change from base	Percentage change from base	Difference w vs wo project
4-33	Liquid bulk (minus Aframax)	467	2008		532	2066		65	12%	532	2066		65	12%	0
4-33	Aframax tanker	3	2008		3	2067		0	0%	2	2067		-1	-50%	-1
	Container														
7-1/8-11	PP2 = Post-Panamax 2 vessel size.	0	2008		103	2066		103	100%	103	2066		103	100%	0
7-1/8-9	PP1 = Post Panamax 1 vessel size.	23	2008		356	2066		333	94%	356	2066		333	94%	0
7-1/8-7	PEW= Panamax East West services.	117	2008		173	2066		56	32%	173	2066		56	32%	0
7-1	PNS = Panamax North South services.	190	2008		537	2066		347	65%	537	2066		347	65%	0
7-1	SP = Sub-Panamax size.	89	2008		187	2066		98	52%	187	2066		98	52%	0
7-1	Handy = Handysize.	491	2008		1388	2066		897	65%	1388	2066		897	65%	0
7-1	Feedermax = Feedermax size.	235	2008		573	2066		338	59%	573	2066		338	59%	0
7-1	Feeder = Feeder size.	583	2008		1224	2066		641	52%	1224	2066		641	52%	0
4-35	General Cargo	135	2008		176	2067		41	23%	176	2067		41	23%	0
4-36	RoRo	537	2008		1361	2067		824	61%	1361	2067		824	61%	0
4-37	Cruise	2297	2004	4,075,406	2069	2067	6,879,729	-228	-11%	2069	2067	6,879,729	-228	-11%	0
4-34	Dry Bulk	126	2006	2,954,310	302	2066	7,371,749	176	58%	302	2066	7,371,749	176	58%	0
		5293			8984			3691		8983			3690		

As a result of this analysis, there is no affect to any listed species under NMFS jurisdiction, associated with deepening of the harbor with regard to larger ship arrival as

the number and sizes of ships arriving after project implementation is expected to remain the same, or possibly decrease, due to the ability for ships to be fully loaded in the "with project" condition. The extension and deepening of the outer entrance channel is expected to improve safety and navigability, reducing the potential for ship groundings and subsequent oil spills, both of which would result in adverse impacts to all species under NMFS jurisdiction in the action area.

Johnson's Seagrass

Effects from Dredging.

Dredging would result in the permanent removal of up to approximately 3.57 acres of mixed or monoculture Johnson's seagrass where it occurs along the SAC and Widener based on the maximum coverage of Johnson's seagrass seen in the 1999-2009 seagrass surveys. Average cover of *H. johnsonii* during this same period of time was 2.71 acres. The impact is considered permanent because deepening of shallow-water habitats beyond 10 to 13 feet (3 to 4 meters) is likely to impede post-dredging recolonization of areas that currently support *H. johnsonii* (NMFS 2007, Kenworthy 2000, and Hammerstrom *et al*. 2006). This effect would be seen throughout the improved Widener and SAC, where water depths will be at to 50 feet MLLW plus 1 foot of required overdepth and 1 foot of allowable overdepth for a total dredge depth of up to 52 ft MLLW. Due to implementation of water-quality-protection Best Management Practices (BMPs) and turbidity monitoring required under FDEP permit, Corps does not anticipate indirect effects to seagrasses including Johnson's seagrass outside the impact footprint. Although seagrass habitat creation in Westlake Park as mitigation for unavoidable impacts, is being proposed, impacts to ESA species/resources cannot be mitigated, and there is no guarantee that *H. johnsonii* will colonize the mitigation area (as opposed to *H. decipiens* or *Halodule wrightii*). NMFS has listed *H. johnsonii* as a threatened species under Section 4 of the ESA, to date, it has not promulgated a 4d rule under the Act, and as a result, there is no prohibition on take of *H. johnsonii.* There is no critical habitat for *H. johnsonii* in the project area.

Smalltooth Sawfish

Effects from Dredging.

Although 16 sightings of sawfish have been made within the boundaries of Broward County, the likelihood of sawfish being in the project area is minimal, as the Port does not provide optimal habitat for sawfish (Simpendorfer 2006). The proposed deepening activities using a cutterhead, clamshell or hopper dredge are not expected to affect the sawfish (NMFS 2003b, as amended).

The assumptions and conclusions regarding cutterhead (pipeline) and mechanical (clamshell) dredges in the 1991, 1995 and 1997 South Atlantic Regional Biological Opinions (SARBO) and 2003 (as amended) Gulf Regional Biological Opinion (GRBO) (NMFS, 1991; NMFS 1995; NMFS 1997; and NMFS 2003) for sea turtles apply to sawfish as well. The 1991 SARBO states:

> "Clamshell dredges are the least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of such an occurrence are extremely low, although a take of a live turtle by a clamshell dredge has been documented at Canaveral. On the basis of the best available information, NMFS has determined that dredging with a clamshell dredge is unlikely to result in the take of sea turtles."

> "…pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely affect sea turtles."

The 2003 GRBO states…

> "In contrast to hopper dredges, pipeline dredges are relatively stationary, and therefore act on only small areas at any given time. In the 1980s, observer coverage was required by NOAA Fisheries at pipeline outflows during several dredging projects deploying pipeline dredges along the Atlantic coast. No turtles or turtle parts were observed in the outflow areas. Additionally, the COE's South Atlantic Division (SAD) office in Atlanta, Georgia, charged with overseeing the work of the individual COE Districts along the Eastern Seaboard from North Carolina through Florida, provided documentation of hundreds of hours of informal observation by COE inspectors during which no takes of listed species were observed. Additional monitoring by other agency personnel, conservation organizations, and the general public has never resulted in reports of turtle takes by pipeline dredges."

Corps concludes that if this statement holds true for species that are relatively abundant in South Florida like sea turtles, it should also hold true for a very rare species like sawfish.

In the 2003 GRBO, NMFS made the following determination

> "After consultation with individuals with many years in the business of providing qualified observers to the hopper dredge industry to monitor incoming dredged material for endangered species remains (C. Slay, Coastwise Consulting, pers. comm. August 18, 2003) and a review of the available scientific literature, NOAA Fisheries has determined that there has never been a reported take of a smalltooth sawfish by a hopper dredge, and such take is unlikely to occur because of smalltooth sawfishes affinity for shallow, estuarine systems."

The probability of a sawfish being taken by a cutterhead, mechanical or hopper dredge is so unlikely as to be discountable. To help minimize the potential for sawfish take, the Corps will incorporate the NMFS sawfish protection construction protocols into the plans and specifications. All depth alternatives would result in the same impact to smalltooth sawfish as discussed for the TSP.

Based on the information included in the recovery plan, the census information from FWC and NMFS and the proposed construction techniques, Corps determined that the expansion of Port Everglades using a cutterhead, clamshell or hopper dredge may affect, but is not likely to adversely affect the endangered smalltooth sawfish.

NMFS also came to this determination in the recently completed Biological Opinion for Miami Harbor (F/SER/2011/00029) stating:

> "NMFS has identified the following potential effects to smalltooth sawfish and has concluded that sawfish are not likely to be adversely affected by the proposed action. Effects on sawfish include the risk of injury from dredging activities, although there has never been a reported take of a smalitooth sawfish by any type of dredge. Smalltooth sawfish may be affected by being temporarily unable to use the site due to potential avoidance of construction activities and related noise, and physical exclusion from areas contained by turbidity curtains, but these effects will be insignificant. Disturbance from construction activities and related noise will be intermittent and only for part of the construction period; turbidity curtains will only enclose small areas at any one time in the project area, will be removed upon project completion, and will not appreciably interfere with use of the area by sawfish. Due to the species' mobility and the implementation of NMFS' Sea Turtle and Smalltooth Sawfish Construction Conditions, the risk of injury will be discountable."

Effects of Blasting.

Review of ichthyological information and test blast data indicates that fishes with swim bladders are more susceptible to damage from blasts, and some less-tolerant individuals may be killed within 140 feet of a confined blast (USACE 2000). Sawfishes, as chondrichthyans, do not have air bladders, and, therefore, they would be more tolerant of blast overpressures closer to the discharge, possibly even within 70 feet of a blast (Keevin and Hempen 1997). Based on this information, and the rarity of the species in the project footprint, the Corps believes that impacts to sawfish associated with blasting will be minor and discountable.

NMFS also came to this determination in the recently completed Biological Opinion for Miami Harbor (F/SER/2011/00029) stating "Therefore, NMFS believes that the effects on sawfish from blasting will be insignificant."

Indirect Effects on Habitat.

Although seagrass and other soft bottom habitats will be removed, Corps does not anticipate that the proposed project will have any adverse indirect effects on smalltooth sawfish in the vicinity of the action area. These habitats may be utilized by the species, however, loss of seagrass habitats is relatively small with respect to overall seagrass abundance throughout the area, and will be compensated through mitigative measures that have already begun to show increases in seagrass coverage in West Lake Park associated with the first phases of restoration efforts (Dylan Larson, pers comm., August 2011). Nearshore softbottom areas are also plentiful in and near the action area, and impacts to them would not limit resource use by sawfish, especially since population density of individuals in the area is extremely low. Construction of gaps in the rip-rap as part of the environmentally friendly bulkheads along the SAC and TN will ensure that juvenile sawfish, will have access to the existing mangroves on the western shoreline of JUL and the western side of the SAC some of which currently have no access due to the height of the rip-rap along the front of the mangroves, as well as any new mangroves that colonize the shoreline behind the EFBs, which would increase available mangrove habitat.

Sea Turtles

Since beaches of JUL provide important nesting areas for four sea turtle species and the offshore areas provide foraging ground for five listed sea turtle species, the project area comprises important resources for turtles. The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls, or even resulting in a decrease in overall vessel calls. Due to the widening and deepening components of the project, larger container, petroleum, bulk cargo and cruise vessels will call at Port Everglades and more tonnage will be carried per vessel call. The widened and deepened channels may provide sea turtles more room to maneuver around incoming and outgoing vessels throughout the action area, and avoid vessel strikes. Dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches.

Free-swimming turtles.

If a hopper dredge is utilized to clear shoaling material from the top of rock prior to dredging the rock within Port Everglades, Corps will comply will all terms and conditions for the use of hopper dredges in the Biological Opinion for this project to assure that incidental take of sea turtles are minimized during hopper dredging operations. A rigid-draghead designed to deflect sea turtles is required for all hopper-dredging projects throughout the year in South Florida, due to the year-round presence of sea turtles. The South Atlantic Regional Biological Opinion (NMFS 1997) mandates that year round, 100 percent observer coverage on the hopper dredge by NMFS-approved Endangered Species Observers is required for the Port Everglades project, if a hopper dredge is used during project construction. One-hundred percent inflow screening is required, and 100 percent overflow screening is recommended. If conditions prevent one hundred percent inflow screening, inflow screening can be reduced, but 100 percent outflow screening is required, and an explanation must be included in the preliminary dredging report. Preliminary dredging reports which summarize the results of the dredging and any sea turtle take must be submitted within 30 working days of completion of any given dredging project. Logs of any sea turtle injuries or deaths due to hopper dredging activities will be maintained, with immediate notification by the contractor to Corps-Jacksonville District, and NMFS. NMFS has previously determined (NMFS 1991, 1995, 1997 and 2003 as amended that pipeline and clamshell dredges are not likely to take sea turtles (NMFS, 1991):

> "Clamshell dredges are the least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of such an occurrence are extremely low, although a take of a live turtle by a clamshell dredge has been documented at Canaveral. On the basis of the best available information, NMFS has determined that dredging with a clamshell dredge is unlikely to result in the take of sea turtles."
>
> "…pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have approach the cutterhead and be caught

> in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely affect sea turtles."

A hopper dredge was previously used in the entrance channel and inner portions of the Port in 2005 for two separate dredging events. A total of 200 loads over a three-month period resulted in no documented lethal or injurious take of sea turtles during dredging operations. The following websites provide useful data:

- http://el.erdc.usace.army.mil/seaturtles/project.cfm?Id=442&Code=Project
- http://el.erdc.usace.army.mil/seaturtles/project.cfm?Id=403&Code=Project

As part of the standard plans and specifications for the project, Corps has agreed to implement the NMFS "Sea Turtle and Smalltooth Sawfish Construction Conditions," as detailed above in the section discussing sawfish. Additionally, the Corps will include all terms and conditions from the SARBO (1997) regarding vessel lighting and sea turtles, including the following:

> "From May 1 through October 31, sea turtles nesting and emergence season, all lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nm of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with U.S. Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches."

As part of this effort, the Corps conducts lighting surveys of the contractor's dredges when they arrive on site, and require the contractor to meet all USCG and/or OSHA requirements. This process will be adhered to for the Port Everglades project. As previously stated by USFWS in their Fish and Wildlife Coordination Act Report, the Port is an active facility, offshore lighting is not an unusual feature of the area, and should not appreciably change the ambient conditions for free-swimming turtles in the vicinity of the project. In addition, all construction/dredging vessels are required to adhere to best management practices, such as preventing lights from exposure to shore through use of shields. Therefore, no adverse indirect impacts to free swimming sea turtles due to lighting associated with dredging operations are anticipated for the proposed project.

The highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Port. It has been documented that the pressure and noise associated with unconfined blasting can physically damage sensory mechanisms and other physiological functions of individual sea turtles (Keevin and Hempen 1997). Impacts associated with blasting can be broken into two categories: direct impacts and indirect impacts.

Direct Impacts.
To-date, there has not been a single comprehensive study to determine the effects of underwater explosions on reptiles that defines the relationship between distance/pressure and mortality or damage (Keevin and Hempen 1997). However, there have been studies, which demonstrate that sea turtles are killed and injured by underwater explosions (Keevin and Hempen 1997). Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. Nervous system damage was cited as a possible impact to sea turtles caused by blasting (U.S. Department of Navy 1998 as cited in USACE 2000). Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtle shells would indeed afford such protection. Studies conducted by Klima *et al.* (1988) evaluated unconfined blasts of only approximately 42 pounds on sea turtles (four ridleys and four loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small-unconfined explosive weights, implies that the turtles in the Klima *et al.* (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, five of eight turtles were rendered unconscious at distances of 229 to 915 meters from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates. For CU blasting, these types of effects would not have occurred, due to the significantly reduced pressures associated with CU blasting. The proposed action will use CU blasts, which will significantly reduce the pressure wave strength and thus area around the discharge where injury or death may occur (Hempen *et al*. 2007). The Corps assumes that tolerance of turtles to blast overpressures is approximately equal to that of marine mammals (Department of the Navy 1998 in USACE 2000), *i.e.*, death would not occur to individuals farther than 400 feet from a confined blast (Konya 2001).

For assessing impacts of blasting operations on sea turtles, Corps relied on the previous analysis conducted by NMFS-OPR as part of their ESA consultations on the Miami Harbor GRR [NMFS Consult # F/SER/2002/01094] (NMFS 2003a); Miami Harbor Phase II project [NMFS Consult #I/SER/2002/00178] (NMFS 2002) as well as the results from the blasting conducted at Miami, where 16 sea turtles were recorded being in the action area during the 38-days when blasting occurred, without a single stranding of an injured or dead turtle being reported (Trish Adams, FWS pers.com, 2005; Wendy Teas, NMFS, pers.com 2005; Jordan *et al*. 2007). In both of the ESA Consultations for the two projects in Miami, with regard to impacts to sea turtles, NMFS found that, "NOAA Fisheries believes that the use of the mitigative measures above in combination with stemming the hole the explosives are placed in (which will greatly reduce the explosive energy released

into the water column) will reduce the proposed action's effects on sea turtles to insignificant levels." (NMFS 2003a and 2002).

Pressure data collected during the Miami Harbor project in 2005 by Corps geophysicists and biologists showed that using the four zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the exclusion zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen *et al*. 2007).

Indirect Effects due to Construction.
Indirect impacts on sea turtles due to dredging/blasting and construction activities in the project area include alteration of behavior. For example, daily movements of sea turtles may be impeded or altered. Based on the protective measures proposed for this project, in concert with the reduction in pressure from the blast due to the confinement of the pressure in the substrate, the impacts to sea turtles associated with blasting should be minimal.

Indirect Effects due to Removal of/Damage to Resting/Foraging Habitat.
Removal of approximately 16.64 acres of middle and outer reef associated with the project entrance channel expansion will remove foraging habitat for any of the five sea turtle species known to be in Broward County. Based on a GIS analysis of habitat types (Walker *et al.* 2007), the project will remove 0.08% of the middle reef (shallow colonized pavement & linear reef middle tract) and 0.54% of the outer reef (deep colonized pavement; linear reef outer tract; spur & groove reef) foraging habitat within Broward County by expansion of the outer entrance channel (Figure 32 and Table 6). Although Walker's minimum mapping unit was limited to the 1-acre level, and the project impacts are assessed at a more detailed level, a more detailed assessment of all the impact categories throughout all of Broward County is not likely to change the results significantly. The removal percentages would also decrease significantly if the calculations included existing middle and outer reef habitats in the adjacent counties of Miami-Dade and Palm Beach available for sea turtle foraging. Removal of this habitat, while small in the overall county-wide assessment of available foraging habitat, will permanently remove this habitat from the project area, and while mitigation is planned to be provided for the reef impacts, there is no guarantee that sea turtles in the project area will be able to utilize that mitigation as foraging habitat.

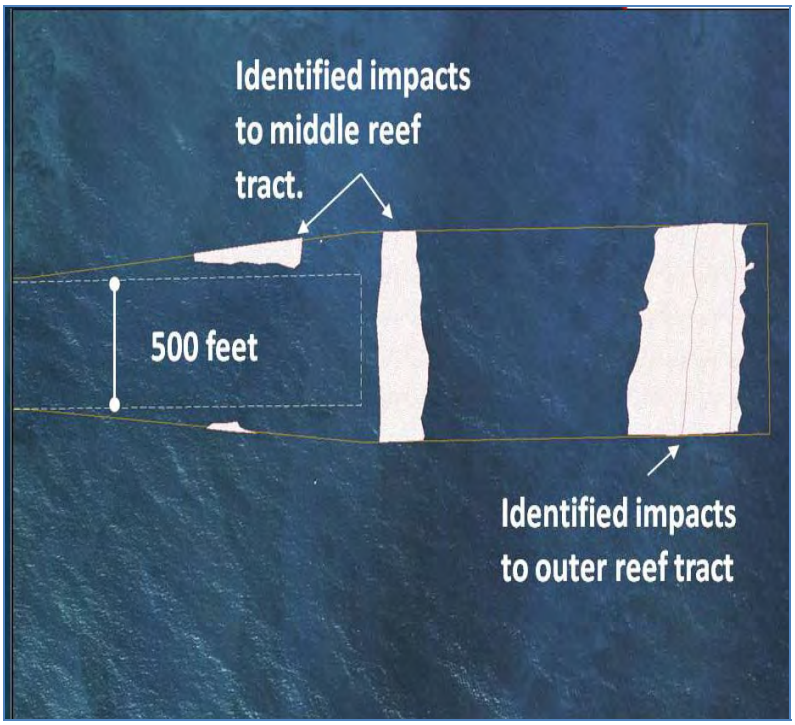


Figure 32 - Direct removal of sea turtle foraging habitat

Foraging habitats may also suffer some indirect effects, including temporary increases to turbidity and sedimentation on foraging habitat within the indirect impact zone for the project (the area within 150 meters surrounding the impact footprint). However, implementation of BMPs should reduce potential impacts, and they are not expected to be any greater than the effects of sedimentation and turbidity commonly experienced in this area due to the passage of storms (Pennekamp *et al.* 1996).

Table 6 - Relative Amount of Permanent Foraging Habitat Removal for Sea Turtles Due to Proposed Plan

Position and Habitat	Parameter	Coverage (ac)	Proportion (%)
Middle reef tract: shallow colonized pavement and linear reef habitats	Projected direct impact	5.56	
	Total available in Broward County	6,383	
	Relative impact		0.087
Outer reef tract: deep colonized pavement, linear reef, and spur and groove habitats	Projected direct impact	10.65	
	Total available in Broward County	1,958	
	Relative impact		0.54

Note: Acreage totals based on Walker *et al*. 2007 data

Direct Effects of each Construction Method on Acropora Critical Habitat

As previously stated, to date, colonies of *Acropora cervicornis* and *Acropora palmata* have not been located in either the direct or indirect impact areas of the project. Although *Acropora cervicornis* and *Acropora palmata* have not been located in the project footprint, or adjacent indirect impact zone, we recognize that this may change between the finalization of this consultation and initiation of construction dredging by the species migrating into the project footprint or that a colony less than 1-2 years old, not visible to the eye during the surveys (NMFS 2005) matures and becomes visible to the naked eye. As we have previously committed to in our letter dated October 18, 2006 and our October 13, 2006 Effects Determination Memorandum, if any *Acropora cervironis* or *Acropora palmata* are located prior to or during project construction, the Corps will implement the protective measures detailed in the Terms and Conditions of the Miami Harbor September 2011 Biological Opinion (F/SER/2011/00029) reinitiate consultation with NMFS under the ESA.

Dredging of the Channel Extension and Flare (All Dredge Types) - Direct Removal of Habitat by any Dredging Methodology

The most significant impact associated with dredging the entrance channel extension is the permanent removal of approximately 5.56 acres of the middle reef and approximately 10.65 acres of the outer reef to create the entrance channel flare as identified as a need for vessel safety. This flare is required due to the variable and unpredictable cross currents that are a result of eddies spinning off of the Gulf Stream located just offshore of the entrance channel as documented by Martinez-Pedraja, *et al.* (2004) and NOS (2010: Coast Pilot). Due to the increased size of the ships currently arriving at the port and the expected continuation of these larger ships to continue to arrive in the future, these cross currents can prove extremely unpredictable and may cause the ship to run aground on either side of the entrance channel. The Draft Feasibility Report for Port Everglades addresses existing issues with safe vessel navigation through the entrance channel due to unpredictable currents and documents. USCG casualty data dating from 1998- 2008 contained 55 casualties in and around Port Everglades due to vessel collisions, allisions or groundings. As a result of these groundings and ship simulations conducted by the Corps in support of the Feasibility study identifies extending the channel seaward 2,200 feet and creating an 800-ft wide mouth of the entrance channel to lessen the likelihood of vessel grounds as a result of these currents.

The DCH requires the presence of ‘‘substrate of suitable quality and availability’’ is equivalent to consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover as a “Primary Constituent Element” (PCE) that must be present for the physical area to be considered DCH. NMFS has not published a standard protocol for assessing the amount of “substrate of suitable quality and availability” to assess the presence of this PCE.

The proposed project's OEC component will permanently remove approximately 5.56 acres of the middle reef and approximately 10.65 acres of the outer reef to extend the entrance channel and create the flare. There are five hardbottom habitat types found in and adjacent to the existing federal channel and proposed extension and flare (based on Walker *et al.* 2007) that may be classified as designated critical habitat for acroporid species under the ESA:

- Shallow colonized pavement
- Deep colonized pavement
- Linear reef: middle tract
- Linear reef: outer tract
- Spur and groove reef: outer tract

The 5.56 acres of middle reef noted above equates to 0.0225 sq km of middle reef habitat and 10.65 acres of outer reef equates to 0.04310 sq km of outer reef habitat. The Florida unit of DCH is 3,442 sq km in size, adding the two impact figures together (0.0656 sq km) and dividing the impact area by the DCH area results in a determination that 0.00190587 % of DCH in the Florida unit will be permanently removed by the channel extension and widening (Table 7). This percentage assumes that 100% of the substrate is available for colonization, as NMFS defines it in the final rule designating critical habitat, ''substrate of suitable quality and availability'' meant consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover" (73 FR 72210 – 11/26/2008).

Table 7 - Direct Removal Impact of Designated Acropora Critical Habitat

Habitat type	Acreage/ km	%DCH of Florida unit removed by project – 100% clean substrate available	%DCH of Florida unit removed by project – % clean substrate survey results
Middle reef	5.56 ac (0.0225 sq km)	0.00065369%	0.00028762% (44% "available" substrate)
Outer Reef	10.65 ac (0.0431 sq km)	0.00125218%	0.00033809% (27% "available" substrate)
"Florida Unit" of DCH	3,442 sq km	0.00190587 % (0.0656 sq km)	0.00062571% (0.0215 sq km)

However, data show that there is 56% biotic coverage on middle reef (45% turf algae) and 73% biotic coverage on outer reef (55% turf algae) (DCA 2009) (Table 8).

Table 8- Percent cover of functional group categories as recorded in video belt transects at Port Everglades in 2006 (DCA, 2009)

Reef 2	***Zone 1***	***Zone 2***	***Zone 3***	***Avg***
Turf Algae	59.30	31.09	n/a	45.20
Sediment	16.92	38.60	n/a	27.76
Rubble	12.99	18.50	n/a	15.75
Reef 3	***Zone 1***	***Zone 2***	***Zone 3***	***Avg***
Turf Algae	60.93	52.37	50.56	54.62
Sediment	12.29	27.24	27.88	22.47
Rubble	6.37	2.15	4.34	4.29

This means that a maximum of 44% of the middle reef may be available for settlement of Acropid larvae and 27% of the outer reef may also be available. Calculating the percentages of available habitat, as defined by NMFS, 0.00062571% (0.0215 sq km) of the Florida unit of designated critical habitat available for colonization by Acropid larvae would be permanently removed by the project (Table 7).

Deepening of the entrance channel and dredging the flare is not expected to adversely impact any biological functions of acroporid corals (feeding, breeding, settling, etc). Concern has been expressed that deepening the existing channel and dredging the flare in the third reef may create a "sink" that fragments of acroporid corals could fall into and not escape, thus creating a physical blockage to fragments of acroporid corals moving north with the currents, thus hindering reproduction. The Corps has reviewed the available information on *Acropora sp*. coverage throughout south Florida, with specific attention paid to known colonies of *Acropora sp.* in the vicinity of deep water entrance channels.

The Corps has been unable to discover any research studies, monitoring reports or other publications that discuss this issue in any detail specific to *Acropora* species. There are 13 deepdraft navigation channels; three of which are currently slated to be deepened in the next 2-10 years; located within DCH, and this issue was not identified in the pending draft Recovery Plan for *Acropora* (in press) (that Corps reviewed as part of the recovery plan development team) as a potential hindrance to species recovery. The Corps was able to determine that there are two deepwater entrance channels within 25 miles of each other within DCH for acroporid corals: Miami Harbor and Port Everglades, both of which have been dredged to 45 feet. Miami was initially constructed late in 1905, and Port Everglades was originally constructed in 1927. Miami was deepened to its current depth with deepening resulting in all three offshore reefs being cut, in 1991 and Port Everglades was deepened to -45 feet and widened from 300 feet to 500 feet in 1981. *A. cervicornis* has been documented at Miami Harbor on the southern edge of the entrance channel and additional colonies have been documented on the northern side of the channel, within 200 feet of the channel edge, unlike Port Everglades where the closest documented colonies of *A. cervicornis* are more than 500 feet to the south of the

channel and 1,400 feet north of the channel by the Corps and USN surveys. Neither channel has *A. palmata* documented as being in close proximity. Since the early 1980s, *A. cervicornis* has been documented as expanding its range northward through Broward County and into Palm Beach County, into areas previously documented as being devoid of acroporid corals in the 1970s 1980s and even the 1990s and early 2000s, or where acroporid corals were documented as being rare (*A. cervicornis*) or absent (*A. palmata*) (Vargas-Angel *et al.* 2003; Goldberg 1973, Precht and Aronson 2004). There are several natural breaks in the 2nd and 3rd reefs located between the Miami and Port Everglades channels, including one in the third reef that is more than 1,000 meters wide located more than eight km south of Port Everglades and *Acropora cervicornis* has been located north of this natural break on the third reef. Since acroporid species reproduce predominately through fragmentation (NMFS, 2005) and there are natural breaks in the 2nd and 3rd reefs located between the Miami and Port Everglades entrance channel more than seven times wider than the cut proposed for the channel extension (500 feet/ 0.15 km), Corps concludes that these dredged channels, that are narrower in width than natural breaks in the reefs, have not previously hindered, nor will they hinder in the future after deepening, the continued ability of fragments of acroporid coral species to migrate northward and continue to expand the species range in southeast Florida, as habitat conditions warrant.

Hopper Dredging.

If sandy material is present in the outer entrance channel, the Corps may utilize a hopper dredge to remove the sand overburden. This material will be placed in the ODMDS. No direct impacts (breakage, removal or direct burial of *Acropora sp.*) are anticipated from hopper dredging activities associated with the sand removal operations, since the hopper dredge will not leave the channel and there is no known *Acropora sp.* in the Federal channel or on the channel walls. The hopper dredge locations will be monitored at all times via the DQM system, which includes a dredge and scow tracking function. If the dredge leaves the channel, the Corps will be able to determine when and where this occurred and the area can be surveyed for any potential damage or adverse effects. No direct impact to designated critical habitat located north or south of the entrance channel is expected to occur as a result of the use of a hopper dredge. The channel walls and bottom of the existing channel are not designated critical habitat (NMFS, 2008b) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c)(2).

Clamshell or Backhoe Dredging.

Clamshell dredging environmental impacts in unconsolidated sediment include resuspension of sediments when the clamshell drops onto the bottom and as material washes from the bucket as it rises through the water column. Operational controls such as reducing the bucket speed as it drops to the bottom and as it rises through the water column will reduce impacts, as will use of a closed bucket system.

Backhoe marine excavator dredging environmental impacts in unconsolidated sediment are similar to those of a clamshell dredge, as are the operation controls to reduce that impact. The key is slowing the movement of the bucket through the water. Environmental impacts are significantly less for a backhoe marine excavator dredge removing fractured (blasted) rock as the volume of fine grained sediment is significantly less in fractured rock than unconsolidated sediment and as a result the potential for sediment resuspension is reduced. The same operational controls can be applied to fractured rock as unconsolidated sediment, basically slowing the bucket's speed in the water.

The clamshell and backhoe dredges will "spud down" in the channel proper, and as such, have no direct impacts to hardbottom outside of the channel. No direct impact to designated critical habitat located north or south of the entrance channel is expected to occur by use of a clamshell or backhoe dredge. The channel walls and bottom of the existing channel are not designated critical habitat (NMFS, 2008b) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c)(2).

Cutterhead Dredging.
Environmental impacts from cutterhead dredges include localized suspended sediment along the bottom of the excavation site around the cutterhead and fine-grained sediment turbidity plumes from barge overflow or pipeline leaks. This can be reduced or eliminated by restricting the amount of overflow time, eliminating barge overflow, and performing regular inspections of the floating pipeline. Locating barges the furthest possible distance from resources can further reduce environmental impacts

Incidental Impacts due to Cutterhead Dredge Equipment.
Anchors are placed to both sides of the dredge to provide the ability to swing the cutterhead dredge. The anchors are placed using a crane on a workboat. If traditional cutterhead dredging is used with unrestricted anchor/cable placement as a construction method to deepen the entrance channel, additional direct impacts to both low relief and high relief hardbottom reefs would occur due to anchoring and cable systems for the cutterhead vessel. If the selected contractor uses the worst-case anchor-cable setup, the anchors will be placed at the apex of each triangle approximately 150 feet from the channel edge and a cable brought back to the dredge. This cable will move along the bottom as the dredge moves forward until it reaches the apex of the triangle. At that time, the anchor would be relocated and the process repeated. Figure 65 provides a worst-case scenario of potential hardbottom impacts with this construction method. The potential exists for up to approximately 17.13 acres of all reef habitat types (inner, middle and outer) as well as nearshore hardbottom and rubble zones to be impacted based on the maximum number of anchor positions with any impacts to hardbottom or coral habitats (A total of 69 anchor placement sites with 54 placed in coral/hardbottom environments), and footprint of cable movement (maximum 0.32-acre impact/anchor site) (Figure 33). The number of anchor sites and the distance of the

anchor from the channel edge, thus the length of cable, may increase or decrease, dependent upon what equipment type and size contractors propose.

Implementation of an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat will occur through the Request for Proposal (RFP) process and will include incentives to encourage potential contractors to avoid reef impacts. The evaluation criteria in the RFP will consider the technical aspects of the contractor's proposal as the most significant factor. As a result, the vessel operational and anchoring plan that best avoids or reduces impacts to reefs would receive the highest evaluation and the incentives that follow. Potential ideas provided by dredging companies and other consultants that would probably appear in contractor proposals for evaluation during the RFP process include:

- Use of surge buoys along the anchor cable to help lift it up off the reef areas during dredging operations to minimize the area impacted by the anchor cable; reviewing an assessment of the impacts associated with the 1991 deepening at Miami Harbor where anchors and cables were used in concert with surge buoys, the impact of placement and utilization of each anchor was 0.029 acres. If a contractor proposes a similar method as was used in 1991 during the RFP process, the impact per anchor site would be decreased by approximately 93 percent.
- Restricted anchor placement, which restricts placement of the anchors for the cutter-suction dredge to within the channel edge limits. That method reduces impacts but almost doubles dredging time since only half of the channel can effectively be dredged at a time.

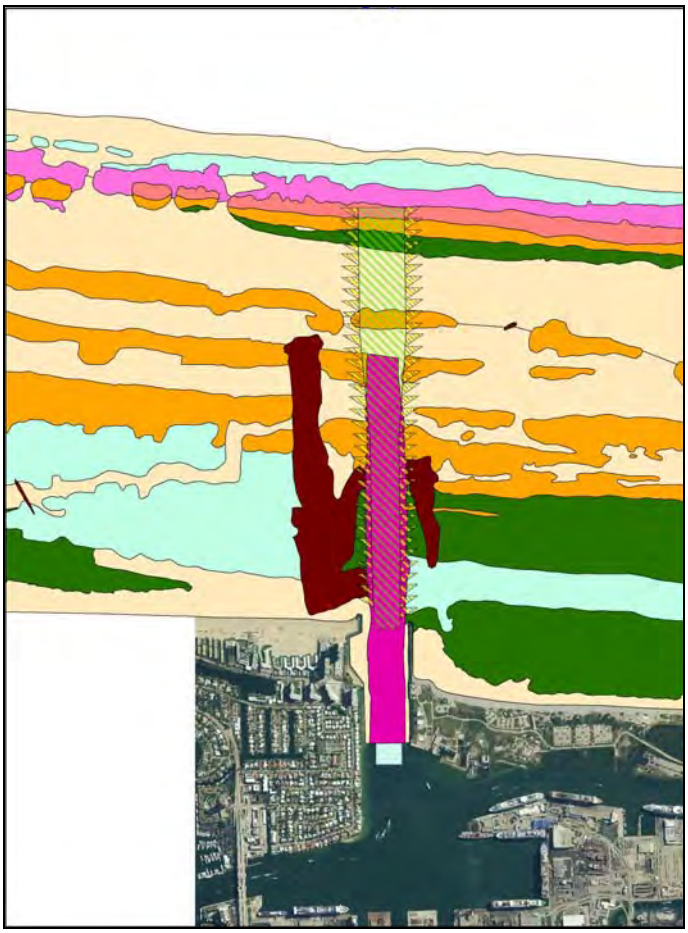


Figure 33 - Anchor/Cable Placement Area for Port Everglades - Traditional Cutterhead Dredge Placement Scheme

If the worst case anchor-cable setup is used by the selected contractor, the anchors will be placed at the apex of each triangle approximately 150 feet from the channel edge and a cable brought back to the dredge. This cable will move along the bottom as the dredge moves forward until it reaches the apex of the triangle. At that time, the anchor would be relocated and the process repeated.

After reviewing the monitoring reports from the 1980 channel deepening at Port Everglades where a traditional anchor/cable configuration was utilized with impact monitoring (CSA, 1981), the Corps determined that although the report states that no adverse impacts associated with the deployment of an anchor/cable configuration were documented, impacts may occur. A review of an Habitat Equivalency Analysis (HEA) conducted for the Hillsboro Inlet navigation district associated with injury to offshore hardground by "cables dragging across or near the reef surface by a barge during… dredging operations" demonstrates the potential for detachment and abrasive injuries to hard corals, octocorals and sponges. To be conservative, the Corps believes that the unrestricted placement of anchor/cables may result in similar impacts (NCRI, 2003). During the damage assessment phase of the HEA, NCRI documented that 2.24% of hard

corals in the impact area were injured, 7.7% of octocorals and 34% of barrel sponges. Assuming that *A. cerivcornis* had been located in preconstruction surveys, and relocated any *A. cerivcornis* from the project area, the remaining smaller *A. cerivcornis* colonies would be adversely affected. The Corps has applied the percentage of hard coral impacts from the NCRI, (2003) assessment to any remaining *A. cerivcornis* still in the project area after transplantation is complete. This means that 2.24% of the remaining *A. cervicornis* could be injured by the use of unrestricted anchor/cable placement and for the purposes of this consultation should be considered lethally taken. The movement across the reef by the cable is a onetime event and has no adverse effect on designated critical habitat as it does not remove or alter the physical structure of the substrate, it only impacts the organisms attached to the substrate.

Effects of Rock Pre-treatment/ Confined Underwater Blasting.

A literature review of the effects of open-water blasts on invertebrates (including corals and *Millepora sp*.) by Keevin and Hempen (1997) states the following:

> "The results of all the studies reviewed indicate that invertebrates are insensitive to pressure related damage from underwater explosions. This may be due to the fact that all the invertebrate species tested lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates. Underwater explosion produce a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs. In fish, the swimbladder, a gas-containing organ, is the most frequently damaged organ (Christian 1973; Faulk and Lawrence 1973; Kearns and Boyd 1965; Linton *et al*. 1985a; Yelverton *et al*. 1975). It is subject to rapid contraction and overextension in response to the explosive shock waveform (Wiley *et al*. 1981). Species lacking swimbladders or with small swimbladders are highly resistant to explosive pressures (Aplin 1947; Fitch and Young 1948; Goertner 1994). For example, Wiley *et al*. (1981) and Goertner *et al*. (1994) noted that hogchokers (*Trinectes maculatus*), which lack swimbladders, were extremely tolerant of underwater explosions, and greatly exceeded the tolerance of any species with swimbladders that they had tested. Goertner *et al*. (1994) found that hogchokers were not killed beyond a distance of 1-m from a 4.5 kg charge of pentolite.
>
> "Gas-containing organs have also been implicated as a causative factor of internal damage and mortality in other vertebrate species exposed to underwater explosions. Sailors exposed to depth charges and torpedo explosions, while escaping their sinking ships during World War II, suffered damage to gas-containing organs (Cameron *et al*. 1944; Ecklund 1943; Gage 1945; Palma and Uldall 1943; Yaguda 1945). The lungs, stomach, and intestines, all gas-containing organs, were ruptured or hemorrhaged, while other organs were relatively unaffected. Similar results have been observed in underwater explosion tests with other mammalian species (Richmond *et al*. 1973)."

Based on the fact that acroporid corals are invertebrates, and lack gas containing organs like swim bladders, lungs, etc., and that no acroporid corals have been documented in the project footprint, the Corps concluded that pre-treatment of hard rock in the outer entrance channel with confined blasting would not have any impact on acroporid corals. NMFS concurred with this determination in the September 2011 Biological Opinion issued for the expansion of Miami Harbor where *A. cerivcornis* has been documented directly adjacent to the channel.

Additionally, the Corps will be conducting sedimentation and turbidity monitoring in the project area, adjacent to the blast sites that will detect any potential effects of blasting on small acroporid colonies discovered during pre-construction surveys, yet not transplanted out of the project area before construction due to size. This data will be recorded and could be utilized by NMFS and the Corps for future consultations where pre-treatment of hard rock is needed throughout the range of acroporid corals.

Indirect Impacts to Critical Habitat

Although there is published literature concerning the effects of sedimentation and turbidity on coral reefs throughout the world, there is a paucity of peer reviewed published data specific to the recent dredging events that have taken place in southeast Florida. There are numerous published papers specific to Caribbean coral reefs that in context can be applied to corals in Florida (Rogers 1983; Rogers 1990; Dodge and Vaisnys 1977, Bak 1978), however, peer-reviewed literature specific to monitoring of dredging projects in south Florida is very limited. Corps reviewed four monitoring reports and two peer reviewed studies from recent projects in documented *Acropora* habitat between 1980 – 2007 where sedimentation and turbidity data were collected not only at sites adjacent to the channels or borrow sites, but also from background sites so that potential indirect impacts associated with dredging could be detected in addition to background impacts from natural events.

The four projects that were reviewed were: (1) Port Everglades entrance channel widening and deepening project conducted in 1980-1981; (2) Broward County Shore Protection Project conducted in 2005; (3) Key West Harbor O&M dredging 2004-2006 and (4) Key West Harbor O&M dredging 2007 (Jordan *et al*. 2010; Gilliam *et al*. 2006; Fisher *et al.* 2008; CSA 2007; CSA 2007a and CSA 1981). These projects utilized cutterhead, hopper, and clamshell dredges (or a combination thereof) for their operations.

From a turbidity and/or sedimentation standpoint, a hopper dredge has the highest likelihood of adverse effect due to the overflow of water being returned from the hopper to the surrounding environment. With this overflow, “fines” (usually clays or silts which are light enough not to have settled out in the hopper) are returned to the water during dredging operations. The clamshell or bucket dredge ranks second since the material may or may not be enclosed in a bucket, and if it is not enclosed, material may escape that bucket into the surrounding environment. The dredging method with the lowest level of associated sedimentation or turbidity is the cutterhead dredge. This dredge has suction that removes the sediment, transports it to the surface where it is either pumped into the receiving disposal site, or placed in a scow for transport to a disposal site. The Key West O&M projects in 2004-2006 and 2007 utilized both a clamshell dredge and a hopper dredge. The Broward County Shore Protection Project utilized a hopper dredge and the Port Everglades expansion project in 1980 utilized a cutterhead dredge. Understanding which types of equipment were utilized allows for a

comparison across projects of results regarding turbidity and/or sedimentation monitoring.

A review of these four projects found that using BMPs for turbidity and sedimentation control (e.g. ceasing dredging when turbidity levels exceed permitted standards) are protective of the coral and hardground environments surrounding South Florida sand borrow sites and navigation channels. Impacts associated with storms can have sedimentation rates in excess of 400 times those seen with a dredging project. The following information is provided from the Key West Harbor O&M project. (CSA 2007):

> "Average daily sedimentation rates at the monitoring sites fluctuated based on weather conditions and ambient suspended sediment load in the surrounding waters. This was especially evident during periods of winter cold-front activity during November 2005 and January 2006, with associated rough seas and high turbidity. During these periods, average daily sedimentation rates were more than twice as high as during the previous November and January, and up to 25 times above levels observed during June 2004 at several sites. The passage of hurricanes during August and September of 2004 and July, September, and October of 2005 provided the most dramatic increase in levels of sediment re-suspension (Figures 3.23 to 3.25 [Figures 32]). Average daily sedimentation rates at several of the Hawk Channel seagrass sites and the bank reef sites were up to 400 times higher than levels noted during June 2004. Following Hurricane Dennis in July 2005, nearly every sediment trap site had at least a ten-fold increase in the average daily sedimentation rate compared to the previous month.
>
> "Site BP-41, a bank reef monitoring site adjacent to the Main Ship Channel, had an average daily sediment deposition rate of 18 mg/cm^2/day for August 2005, while in the following month when Hurricanes Katrina and Rita impacted the area, the average daily sediment deposition rate recorded in the traps increased to 1,219 mg/cm^2/day, 67 times the previous month's level. For Site SP-37, a seagrass site located adjacent to the Main Ship Channel, there was an increase in average daily sediment deposition rate during this same period from 14.4 mg/cm^2/day up to 3,529.7 mg/cm^2/day, 245 times the August levels."

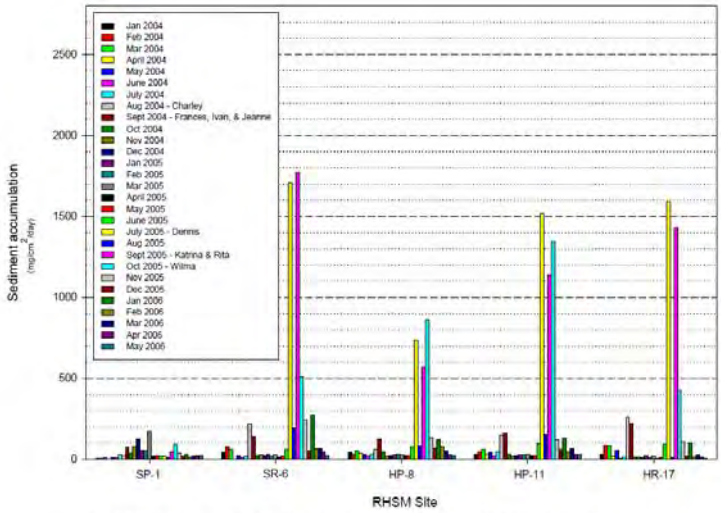


Figure 34 Key West RHSM Sites SP-1 to HR-17 sediment trap data (January 2004 - May 2006)

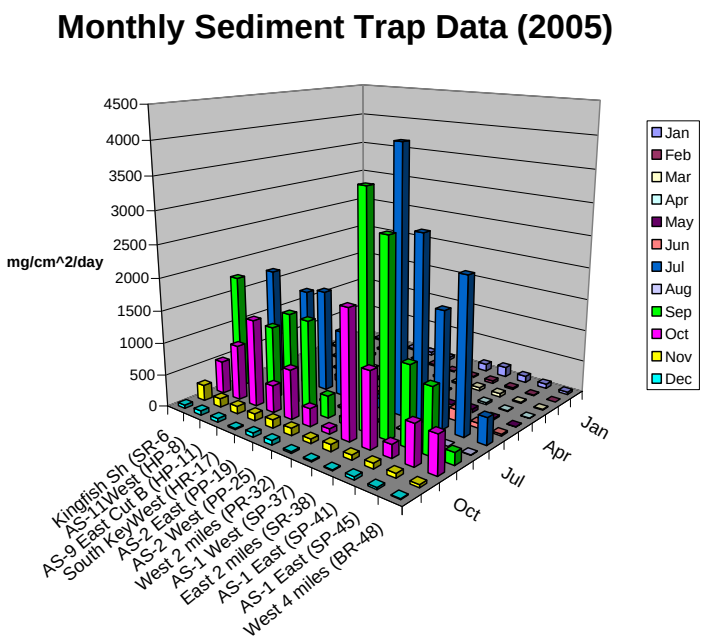


Figure 35 - Monthly Sediment Trap Data - Key West O&M 2005

Additionally, Gilliam *et al. (*2006) and Fisher *et al.* (2008), found there to be no detectable impacts to corals living on the hardgrounds adjacent to the borrow areas utilized for the Broward County shore protect project. While the Key West and Broward County projects were required by regulatory permit to maintain a lower turbidity threshold (15 NTUs), a review of the monitoring from the Port Everglades channel widening and deepening from 1980-1981 continues this trend in showing little to no effect of dredging operations on corals adjacent to dredging areas (CSA, 1981). The Port Everglades deepening project in 1980-1981 was not bound by any state or federal agency issued turbidity level that required the dredge to cease operations. The Corps did monitor turbidity and sedimentation levels throughout the dredging operations, which is most similar in nature to the dredging currently proposed, and the final report for the Port Everglades deepening conducted states, "Due to the powerful suction ability of the dredge, only a small fraction of the dredged material entered the water column. No significant increase in turbidity levels was detected during daily monitoring of the dredging operations by U.S. Army Corps of Engineers environmental contractor." (CSA 1981).

The examples of the adverse effects of turbidity or sedimentation on coral species often cited by resource managers are commonly projects in third world countries without the strict water quality protections that are in place in the U.S. (Bak 1978); or are studies where the material used to simulate dredged material is not the same sediment size or mineral composition of the material proposed to be dredged (Telesniki and Goldberg

1995) and thus are not a good substitute for the effects of projects bound by the water quality restrictions required by the State of Florida under the Clean Water Act. These restrictions are protective of water quality by limiting turbidity; they are also protective of coral species, including *Acropora sp.* and its designated critical habitat, located near dredging operations where material is being removed from the bottom by a dredge. Dredging projects take place in a spatially and temporally finite area and thus impacts associated with them, if present, should be detectable within this same finite footprint. A review of these four projects, three of them in the very recent past, demonstrates that no adverse effects of dredging were detectable (or in the case of Broward county were detectable as monitoring continues) (Gilliam *et al.* 2006; Fisher *et al.* 2008; Jordan *et al.* 2010; CSA 2007; CSA 2007a; CSA 1981).

Of the four projects, only the Key West O&M project documented any acroporid corals adjacent to dredging areas, which may be attributable the lack of focus on *Acropora* on the other (and, indeed, most) projects prior to the listing of the two species under the ESA. Between the two dredging projects in Key West, *A. cervicornis* was documented along the east side of the Key West entrance channel near station BP-41. The 2007 dredging event took approximately four months between May and August. These colonies did not show any impacts different than control corals (CSA 2007) and none of the recorded changes were attributed to the dredging.

To protect hardgrounds in project areas including those that support *A. cervicornis*, the Corps requires turbidity monitoring with all of its projects. It is a standard practice for the Corps to monitor sedimentation associated with dredging projects where corals and coral habitats are adjacent to the project area. This has been standard practice for more than 30 years (CSA 1981; CSA 2007; CSA 2007a).

In the 2009 biological opinion for dredging associated with sand mining dated October 21, 2009 (Consultation # F/SER/2009/00879), NMFS reviewed effects of sedimentation associated with *A. cervicornis*. NMFS states:

> "Additionally, Rogers (1983) tested sedimentation rates on *A. cervicornis*, among other coral species, and determined that daily doses of sediment at a rate of 200 mg/cm2/day had no effect (Rogers 1990)."

Given the strong similarities between the proposed action and the Key West and Port Everglades projects previously reviewed, we believe it is reasonable to assume the impacts documented at the Key West and Port Everglades sites will be similar to those likely to occur during the proposed action. Adverse affects from sedimentation are also less likely to occur in the presence of strong oceanographic currents (Rogers 1990) because sediments are swept off corals. This phenomenon was also observed at the Port Everglades project in 1980. The influence of the relatively strong Gulf Stream in the action area is also likely to reduce any adverse affects from sedimentation.

Concern has been raised that the Corps is utilizing data from a project (Key West) that had restrictions on the maximum allowable NTUs (15) that are lower than those that will be required for Port Everglades (29 NTU). The specific concern is that higher turbidity values allow for higher sedimentation rates on adjacent habitats, however, the scientific literature does not support this concern. There is no direct correlation between turbidity and sedimentation rates, or between turbidity and total suspended solids that can be uniformly applied across differing projects (Davies-Colley and Smith, 2001; Clarke and Wilber, 2008). The effects of sedimentation are a dose-response relationship, and the results of that relationship specific to dredging projects in SE Florida has been reported here – both at the 15 NTU and 29 NTU levels, and for both levels, the effects of sedimentation, with proper *in situ* monitoring, showed no adverse effect on coral species in general (Port Everglades and Broward County), and specifically *Acropora sp*. (Key West) near dredging projects. The Port Everglades expansion project (like Key West and Miami) will include sedimentation monitoring as a project component. The substrates being dredged are composed of limestone (calcium carbonate) rock, and as cited by NMFS in 2011, Torres (2001) found

> "In sites with higher carbonate percentages and corresponding low percentages of terrigenous sediments, growth rates were higher. This suggests that resuspension of sediments and sediment production within the reef environment does not necessarily have a negative impact on coral growth while sediments from terrestrial sources increase the probability that coral growth will decrease, possibly because terrigenous sediments do not contain minerals that corals need to grow."

Since the rates of sedimentation observed during the Key West and Port Everglades deepening monitoring were within the bounds of sedimentation documented to be occurring naturally, and those were far less than this 200 mg/cm2/day threshold set by Rogers (1983) cited by NMFS (2009) as a daily dose threshold, we believe adverse effects to *A. cervicornis* and designated critical habitat from increased sedimentation will be insignificant. This determination is consistent with NMFS' previous findings in NMFS biological opinions (2009, 2011) where in both cases NMFS determined the effects of sedimentation on critical habitat to be temporary in nature.

<u>Dredged Material Disposal Impacts</u>. Potential barge environmental impacts could occur as the barge is loaded if material is allowed to spill over the sides and during transport if the barge leaks material. Operational controls eliminate spilling material during loading by monitoring the dredge operator to make sure that the dredge bucket swings completely over the barge prior to opening the bucket. Requiring barges in good repair with new seals minimizes leaking during transport. Hauling rock is often damaging to transport barges, so intermediate inspection and repairs may be required during the project to maintain the barges in good working condition. Seals may require replacement. Proper use of the ODMDS minimizes the environmental impacts during disposal. The barges will be required to use positioning equipment to place dredged material within the designated ODMDS and inspectors may be required to monitor disposal activity. The Corps's required monitoring of vessels in ullage and location ensure that the dredged material is being disposed of in the approved location. Disposal

of dredged material will have no impact on *Acropora sp*. corals or DCH. The ODMDS is not within the boundaries of DCH as the site is located offshore of Fort Lauderdale, beyond the edge of the continental shelf in greater than 500 feet of water.

Sedimentation and Turbidity Monitoring. Monitoring of the Port Everglades expansion project will take place on numerous levels including physical monitoring of scow and dredge location relative to reefs and other mapped resources and turbidity and sedimentation monitoring during construction. Monitoring protocols will adapt aspects from other monitoring projects previously referenced, including Key West O&M (CSA 2007; CSA 2007a); Broward County SPP (Gilliam *et al*. 2006 and Fisher *et al.* 2008) and Miami Harbor that is scheduled to begin construction in 2013. Corps will develop detailed monitoring plans prior to construction with the contractor and local sponsor, as well as the federal, state and local resource agencies, and expects NMFS-OPR staff to participate in the development of those plans.

Effects on Designated Critical Habitat by Disposal Activities

As previously detailed, the ODMDS is beyond the 30 meter contour. If the Corps opts to build an artificial reef site as compensatory mitigation for unavoidable impacts of the project on the 2nd and 3rd reef this reef would be potentially be built in the sand trough located between the 2nd and 3rd reef. The mitigation will be constructed with either rock mined from the entrance channel, or native limestone purchased from a quarry. Based on HEA, a total of 37.5 acres of artificial reef would be required to offset unavoidable impacts associated with the TSP. At this time, the Corps is planning on constructing artificial reef for this mitigation, however, Broward County has recently request the Corps review additional mitigation options in lieu of reef construction. The Corps is considering the options presented by the County. Per the final mitigation plan included in the FEIS:

> Two types of mitigation reefs will be constructed: High Relief, High Complexity (HRHC) reefs (exceeding three feet of vertical relief) and Low Relief, Low Complexity (LRLC) reefs (approximately three feet of relief), based on data collected in 2006 (DC&A 2009). The HRHC reefs are intended to mitigate for impacts to high relief habitat (i.e., linear or spur-and-groove reefs) and the LRLC reefs are intended to mitigate for impacts to lower relief reef (i.e., pavement or channel wall) and hardbottoms outside of the project footprint (i.e., in the indirect effect area). The two reef types will be deployed in acreages proportional to direct impacts expected to each type of natural reef habitat. The ratio of HRHC to LRLC is 60%/40%.
>
> Limestone rock excavated from the STB, MTB, IEC, and the OEC may be used in reef construction and, if necessary, supplemented with quarried limestone. Hence, rock excavation will commence inside the harbor to create habitats at selected mitigation sites, and then proceed to dredging the entrance channel; i.e., dredging and reef installation will occur simultaneously. The construction contractor will be allowed the option of purchasing quarried native limestone in lieu of quarrying the material from within the project boundaries. HRHC reefs will consist of limestone rock boulders from 1.0 to 10.0 ton each, having a minimum density of 140 pounds per cubic foot. The material will be deployed in shore-parallel strips 50-100 feet wide to mimic the orientation of typical natural reefs. This reef design will have a vertical relief of 3-6 feet and boulders will be partially stacked to provide the maximum structural complexity and to provide

> refugia for cryptic and reclusive species. As interstitial sand patches associated with reef habitat are thought to be important in the ecological function of the reef habitat, the reef footprint will contain approximately 20 percent open sand surface. Temporary buoys delineating the deployment strip will mark areas for deployment. Corner buoys for the sites shall be placed using DGPS with sub-meter accuracy. Natural limestone provides an ideal substrate for the establishment of a reef community. An additional advantage of limestone rock boulders is aesthetic. Once colonized by the reef community, the reef is almost indistinguishable from a natural reef, enhancing its value as a recreational resource. HDHC reefs are intended to provide persistent habitat with higher complexity and habitat diversity than typical natural nearshore hardbottom reefs. It may also be desirable to include prefabricated structures such as Reef Balls™ in the HRHC reef arrays. These modules, which provide a high degree of complexity and void space, are widely used in artificial reef construction and have proven stable in shallow water applications.

This is the same type of artificial reef that is being constructed as part of the Miami Harbor expansion that NMFS reviewed under the September 2011 Biological Opinion. Construction of these mitigation reefs can also serve as potential habitat for Acroporid corals to settle onto, since they will be bare limestone, although they would not be considered DCH per 50 CFR 226.216(c)(2). Additionally, the site could be used in the future by Broward County, or other permitted organizations to transplant corals from other impactive projects. During construction, a buffer between the selected sites and any adjacent hardground habitats will be maintained at all times to ensure no adverse impacts associated with mitigation construction. Monitoring of the mitigation reefs will consist of both physical and biological components.

As the artificial reef site would be placed on sandy substrate, the Corps believes that such a site would lack the exposed rock or hardbottom necessary to find that the placement areas contain the PCE for Acroporid coral critical habitat as detailed in the final rule (NMFS, 2008b). Additionally the monitoring of the surrounding hardbottom habitats will ensure no adverse effects occur during construction.

Effects of Transplantation

Although no *Acropora* sp. have located in the project direct or indirect footprint, the Corps can conceptually estimate impacts to *Acropora*, should it be located after this consultation is complete, either before or during construction. Prior to initiation of any dredging activities, the Corps will require the contractor to perform a baseline survey of the project area and should they locate an Acropora in the project direct or indirect footprint, they will be required to relocate any *Acropora sp.* colonies greater than 10cm located within 150 meters of the outer entrance channel in accordance with Appendix A of "*Acropora cervicornis* Transplantation Protocols for Miami Harbor Expansion Project" Endangered Species Act - Section 7 Consultation Biological Opinion for Dredging and expansion of Miami Harbor, Miami-Dade County, Florida (Consultation Number F/SER/2011/00029) (NMFS 2011).

This transplantation effort would be consistent with reasonable and prudent measures included in recent biological opinions for beach nourishment and harbor deepening

activities (NMFS 2009; NMFS 2011) where *A. cervicornis* was in the action area and is expected to reduce the effect of the anticipated take. Collection of small *A. cervicornis* fragments (i.e., approximately 3-cm fragments) from each transplanted coral would be required to help achieve recovery goals for the species. The fragments will be grown in nurseries by either Broward County or another permitted nursery, increasing population sizes and protecting genetic diversity. These fragments will be collected via careful breaking of the branch tips of the coral colonies using pliers or other small hand tools, or will be fragments of opportunity created during transplantation. The collections will be made by coral experts and trained professionals. Even though these actions involve directed take of *A. cervicornis*, they constitute a legitimate take reduction method (and NMFS has previously included this as a Reasonable and Prudent Measure) because it reduces the level of potential lethal take of *A. cervicornis* during the deepening of the entrance channel by cutterhead dredge, and allows the colonies to be collected and relocated out of the impact area where they will have a high likelihood of continued survival. The Consultation Handbook (USFWS and NMFS 1998) expressly authorizes such directed take as an RPM (see page 4-53). Therefore, NMFS should evaluate the expected level of *A. cervicornis* take through transplantation, so that these levels can be included in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

NMFS has previously stated:

> "…that the collection of small tissue samples from A. cervicornis colonies will result in temporary effects on coral colonies. The collection of approximately 3-cm-long branch tip tissue samples from single staghorn coral colonies will result in a small reduction of coral colony biomass; however, this effect is expected to be temporary with recovery through tissue replacement and/or coral colony growth. Acropora cervicornis' dominant mode of reproduction is through asexual fragmentation (see Section 3.2 for further discussion). In the congener Acropora palmata, lesions at the point of fragment detachment have been shown to begin regeneration within two weeks (Lirman 2000) of fragmentation, with regeneration rates being positively correlated with decreasing size of lesion and proximity to growing tip. The size of the lesion created in this project will be a function of the diameter of the branch being clipped. The diameter of staghorn coral branches ranges from 0.25 to 1.5 cm. Lirman (2000) showed that a 3-cm2 lesion regenerated completely within 100 days. Given that the rate of recovery is an exponential decay, it is expected that lesions 0.25 to 1.5 cm in diameter (less than 2.25 cm2) will recover much faster than in Lirman's experiment.
>
> Furthermore, the proposed collection of tissue samples from A. cervicornis colonies will occur at the outermost portion of the branch tip of the coral colony. Soong and Lang (1992) observed that, in A. cervicornis, large polyps and basal tissues located 1.0 to 4.5 cm from the colony base were infertile, and larger eggs were located in the mid-region of colony branches. Gonads located within 2 to 6 cm of the colony's branch tips always had smaller eggs than those in the mid-region (Soong and Lang 1992). Larger colonies (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). Thus, the effect of this activity on coral colony reproduction is insignificant. Given that the collected tissue samples are small in size (~3 cm) relative to coral colony size, that the effects of collecting such fragments are temporary, that fragmentation is a natural reproductive mode, and that these fragments will be collected from the outermost portion of the coral branch tip where smaller eggs are found, it is not likely that

survival or reproductive output of staghorn coral colonies will be measurably reduced by the proposed action.

Coral transplantation can successfully relocate colonies that would likely suffer injury or morality if not moved. Provided that colonies are handled with skill, are reattached properly, and the environmental factors at the reattachment site are conducive to their growth (e.g. water quality, substrate type, etc.), many different species of coral have been shown to survive transplantation well (Maragos 1974, Birkeland et al. 1979, Harriott and Fisk 1988, Hudson and Diaz 1988, Guzman 1991, Kaly 1995, Berker and Mueller 1999, Tomlinson and Pratt 1999, Hudson 2000, Lindahl 2003, NCRI 2004). Herlan and Lirman (2008) documented a 17.3 percent mortality rate in Acropora coral fragments after transplantation to a coral nursery in Biscayne National Park. The authors stated the mortality rate might have been increased due to stress caused by relatively high water temperatures during fragmentation not necessarily the process itself. This observation has been supported by other nursery managers who report post-relocation coral fragment mortality rates closer to 1 percent (NMFS, 2009). Transplantation of coral colonies less than 10 cm in size is not feasible because detaching such small colonies would likely result in breakage. Survivability of transplanted coral colonies less than 10 cm in size is also very low due to injury and the decrease in the overall surface area of living tissue, which reduces the colony's resilience to stress." (NMFS, 2009).

We believe that unless Acroporid corals are relocated from the impact area, if they were found to be present, up to 50% could be injurious taken or lethally taken due to the impacts of anchor/cable usage associated with cutterhead dredging. These effects are detailed further in the BA under the heading "Dredging - Deepening Entrance Channel Utilizing Cutterhead Dredge". We believe coral transplantation will be highly successful and relocating these corals outside the entrance channel is appropriate to minimize the impact of this take. Similar habitat, influenced by the same environmental conditions currently affecting these colonies, exists both north and south of the entrance channel beyond the 150-m indirect impact zone, and has been documented to support *A. cerviconis* (USN, 2011; Gilliam et al, 2011). Because suitable transplantation habitat is nearby and proper handling techniques are available and will be required (see Appendix A of Miami Harbor Biological Opinion), we have confidence that transplantation survival rates similar to those noted by NMFS in the 2009 biological opinion will be likely in this case. NMFS has previously stated a maximum estimated coral fragment mortality rate of 17% (NMFS, 2009), although this may be artificially high, brought on more by unusual environmental conditions than actual transplantation. To be conservative, we use a 17% mortality rate in our estimates, but believe actual mortality may be lower. Therefore, we anticipate 100 percent success in reattachment and an 83% survival rate of transplanted colonies. These same estimates were previously utilized by NMFS (2009).

Summary Effects Determination

The Corps has determined that the proposed expansion of Port Everglades may adversely affect listed and proposed species within the action area and requests initiation of formal consultation with NMFS.

SUMMARY OF EFFECT DETERMINATIONS

Project effect determination summary for sea turtle *sp*., Johnson's seagrass, Acroporid *sp*., large whales, and smalltooth sawfish (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLAA – orange), May Affect Likely to Adversely Affect (MALAA – yellow), and Not Likely to Adversely Modify (NLAM – orange)

Proposed Activity	Effect Determination													
	Sea Turtle					Johnson's seagrass	Acroporid Sp.	Large Whales						Smalltooth Sawfish
	Leatherback	*Loggerhead*	*Green*	*Kemp's Ridley*	*Hawksbill*			*NARW*	*Humpback*	*Sperm*	*Blue*	*Sei*	*Fin*	
Hydraulic Hopper limited to the channel bottom	NE	MALAA	MALAA	MALAA	MALAA	MALAA	NE	NE	NE	NE	NE	NE	NE	NE
Hydraulic Cutterhead w/unrestricted anchor/cable placement	NE	MANLAA	MANLAA	MANLAA	MANLAA	MALAA	MANLAA	NE	NE	NE	NE	NE	NE	NE
Mechanical Dredge (clamshell or back-hoe)	NE	MANLAA	MANLAA	MANLAA	MANLAA	MALAA	MANLAA	NE	NE	NE	NE	NE	NE	NE
Pre-Treatment with blasting	NE	MANLAA	MANLAA	MANLAA	MANLAA	NE	MANLAA	NE	NE	NE	NE	NE	NE	NE
Disposal - ODMDS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Disposal – Reef Mitigation	NE	NE	NE	NE	NE	NE	MANLAA	NE	NE	NE	NE	NE	NE	NE
Transplantation of Acropora sp.	NE	NE	NE	NE	NE	NE	MALAA	NE	NE	NE	NE	NE	NE	NE
Critical Habitat	NLAM	NE	NLAM	NE	NLAM	NLAM	NLAM	NLAM	NE	NE	NE	NE	NE	NLAM

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ESA Consultation History – Port Everglades Feasibility Study
Consultation # F/SER/2002/00626

- September 8, 2001 – Request for Species List from Corps to NMFS-SERO
- March 25, 2002 – Biological Assessment from Corps to NMFS-SERO
- June 24, 2002 – Corps contacts NMFS to verify package has arrived and check on 30-day letter. Email from E. Hawk that package arrived, assigned log #F/SER/2002/00626 and assigned to Bob Hoffman. No 30-day letter ever received from NMFS.
- 2003 - Due to changes in the ship simulations for the project and potential change in impacts, Ms. Terri Jordan contacted Mr. Hoffman and asked him to set the BA aside, as a revision would be coming once the new ship simulations were complete.
- September 12, 2004-Letter from James Duck to Ms. Georgia Cranmore. Recommended Plan and included Corps' Biological Assessment.
- September 17, 2004 – Revised Biological Assessment from Corps to NMFS–SERO.
- November 17, 2004 – Corps calls to check on 30-day complete letter from NMFS. Resent consultation documents via mail and email to Mr. Hoffman since NMFS unable to locate package. Package has been reassigned to Mr. Juan Levesque.
- November 17, 2004 – Email from Mr. Levesque that package is complete. No additional information required.
- No 30-day letter received.
- No requests for additional information made.
- March 9, 2005 – Ms. Jordan emails Mr. Levesque asking for status check, since NMFS database does not show any movement on project. Mr. Lévesque responses that Mr. David Bernhart had reviewed Biological opinion and his comments are being responded to and package is headed to Office of General Counsel for review and clearance.
- May 9, 2005 – proposed listing of *Acropora palmata* and *A. cervicornis* as threatened under the ESA (70 FR 24359).

- Late May 2005 - After the listing, Ms. Jordan contacted Mr. Levesque by phone to discuss the new *Acropora* proposal and how it should be handled since the consultation was not yet complete. The Corps and NMFS agreed to incorporate existing surveys of the project area, including the baseline survey and the survey from the Broward County Shore Protection Project Resource GIS system (a series of 9 CDs with GIS data on them with mapped resources in Broward County – A copy of these CDs had been provided to NMFS as part of the ESA consultation for the Broward County shore protection project and represents the most detailed assessment of reef resources in Broward County). The Corps and NMFS agreed that no additional species specific surveys would be completed due to sufficient information already being available and a lack of funding (about 2 million dollars) to complete a survey of the action area specifically for these species.
- June 23, 2005 – the Corps emailed a determination that the Port Everglades feasibility study, may affect, but was not likely to adversely affect listed Acroporid corals near Port Everglades.
- July 7, 2005 – an email was received from Mr. Levesque that stated that the opinion “had gone to GC today”.
- July 27, 2005 – another email stating the opinion was still in review in the office of General Counsel.
- December 6, 2005 – email sent to Mr. Levesque and Mr. Bernhart requesting a status check on the biological opinion. No response received to this email. It is the Corps’ understanding that Mr. Levesque had been deployed to assist with hurricane Katrina recovery in October 2005 and that had delayed his working on the project.
- The next communication from NMFS came on March 28, 2006. Mr. Levesque asked for information on material disposal locations. The Corps provided additional details and a graphic showing the areas via email dated March 29, 2006 as this information was included in the baseline report sent in November 2004 as part of consultation package.
- May 9, 2006 – listing of *A. palmata* and *A. cervicornis* as threatened under the ESA (71 FR 26852)
- May 17, 2006 – informed that Mr. Levesque is leaving NMFS, no information available on who will be taking over file or on the status of the file that was last

noted as “in the office of General Counsel”. Numerous email and phone requests for information made to Bob Hoffman and Eric Hawk.

- June 2, 2006 – Informed by phone that Ms. Audra Livergood, NMFS Miami office will be completing the consultation.
- June 14, 2006 – Corps makes formal request for a timeline for the completion of the consultation to Mr. Bob Hoffman. Timeline not provided.
- June 21, 2006 – Met in person with Ms. Livergood at the Mineral Management Service’s Information Transfer meeting in Melbourne, Florida to discuss the biological opinion and its status. Made sure Ms. Livergood had all existing survey information in the file and clarified that the Port Everglades Reef survey that had been started in May 2006 would provide additional information on the species composition at the end of the entrance channel where the project proposes to extend the channel through the third reef. This would be considered additional information for the file – in addition to the Broward and baseline surveys previously discussed. Also discussed the northern right whale finding for the opinion and the history of northern right whales transiting through the project area.
- June 23, 2006 – After conversation with Ms. Livergood in Melbourne, email received agreeing to modify conference opinion request of June 23, 2005 to consultation request for the Acroporid corals due to delays by NMFS in completing consultation.
- July 6, 2006 – Copy of draft Port Everglades Reef Report sent to all resource agencies by email (A. Livergood included).
- July 25, 2006 – Port Everglades Reef Report results presentation meeting, Port Everglades. Written comments requested to be to Corps by August 7, 2006.
- August 11, 2006 – Email draft comments from Ms. Livergood on report recommending “an active and quantitative survey designed specifically to identify and quantify the presence and abundance of /A. palmata/ and /A. cervicornis/ should be conducted for the proposed impact areas and control sites. We request that the survey design and methodology be submitted to NMFS PRD for review and comment prior to conducting the survey.”

- August 11, 2006 – after receipt of the comments, Ms. Jordan contacted Ms. Livergood and discussed that while an additional survey would be nice to have, it was not feasible due to budget and schedule. Ms. Livergood offered to have NMFS review a database of known locations of Acroporid corals that has been developed as part of the listing process to see additional coral locations, not presented by the Broward County survey, baseline reports or the new Reef Survey.
- August 13, 2006 – Email from Ms. Livergood stating "I spoke to Jennifer Moore, and she said that NMFS cannot share the data yet that has been compiled for the Acropora GIS database. However, she suggested that I request a shapefile of the action area from you, and she can create a map with the Acropora data they have in-house. Would you mind sending me a shapefile of the action area for Port Everglades?"
- August 18, 2006-Letter from Mr. Bernhart- *Port Everglades Reef Mapping and Assessment, 06 July 2006 Preliminary Draft*. "NMFS PRD believes study is flawed".
- August 30, 2006 – Email to Ms. Livergood with action area. This later proved to be the original survey area provided to the Corps' baseline report contractor and covered a much larger area than the action being consulted on.
- September 7, 2006 – Email from Ms. Livergood with map of known *Acropora* colonies in the action area as provided on August 30, 2006. At this time, Corps realized that graphic of refined action area needed to be sent since the original covered much more area than the true action area.
- September 21, 2006 – Phone call between Ms. Jordan and Ms. Livergood – Re: Revised action area for Port Everglades
- September 21, 2006 – Email from Ms. Livergood requesting justification for change in action area.
- September 21, 2006 – Email to Ms. Livergood clarifying why the need for the change in action area.
- September 22, 2006 – Email to Ms. Livergood with new graphic showing revised action area.
- September 25, 2006 – Email from Ms. Livergood requesting shapefile of revised action area be sent to her and NMFS-St. Petersburg for database review.

- September 26, 2006 – Email to Ms. Livergood and Amanda Flick with shapefile of the revised action areas.
- October 12, 2006 – Updated seagrass report emailed to Ms. Livergood
- Oct 13, 2006 – Although effects determination provided earlier as part of request for consultation sent to Mr. Levesque for Acroporid dated June 2005 – at NMFS' request, the Corps prepared memo for the record with an effects determination for Acroporid corals. Memo sent by email.
- Oct. 18, 2006-Letter to Mr. Bernhart (NMFS) from Mrs. Marie Burns. Response to belief that "study is flawed".
- Mar 26, 2008-Letter from Mr. Bernhart to Mrs. Burns reiterating recommendations from August 18, 2006 letter. Concerned *cervicornis* may occur closer than 3,500 feet to the entrance channel.
- Apr 28, 2008- The Corps met with NMFS leadership and staff in St. Petersburg to discuss the project timeline, *Acropora* survey methodology and a path forward for the project. Determination was made that navigation channels in Designated Critical Habitat required alternative survey methodology, and Corps would work with NMFS SEFSC researchers to develop this methodology.
- Dec 2009-*Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel Final Draft. Prepared by Dial Cordy and Associates Inc. for CORPS Jacksonville District.* Document finalized.
- Summer 2010 – Acropora survey with new navigation channel protocol conducted at Port Everglades.
- Oct 2010- *Acropora Coral Survey Final Report*. Prepared by Dial Cordy and Associates Inc. for CORPS Jacksonville District
- October 12, 2011 - Review of video and results of Survey completed with Robert Hoffman, Chief, ESA consultation branch, NMFS-SERO-PRD. Mr. Hoffman expressed satisfaction with methodology utilized and results of survey.
- August 2, 2011 – NMFS informs Corps of Navy *Acropora* survey that detected *Acropora* on Reef 3 and requests that CORPS hold off submittal of ESA consultation package until Navy report is complete. Corps requests copy of report from Navy when they are able to release report.

- Dec 2011-*Benthic Habitat Characterization for the South Florida Ocean Management Facility: Protected Stony Coral Species Assessment*. Prepared by Gilliam & Walker for Seaward Services completed for US Navy.
- February 13, 2012 – Corps receives Navy *Acropora* Survey.
- May 1, 2012 – Corps Environmental Branch leadership meets with NMFS PRD and HCD leadership to discuss ongoing projects and communication. Included in those discussions, NMFS-PRD leadership asks Corps to compile a complete package for the ESA consultation for Port Everglades and resubmit all materials in that complete package.
- May – August 2012 – Corps revised package, prepared new documentation and completed package for submittal to NMFS for continued consultation.
- August 20, 2012 – Corps informed that consultation has been reassigned to a new NMFS biologist – Kelly Logan.
- September 5, 2012 – Corp’s Supplemental Consultation package complete, letter to David Bernhart transmitting package signed by Jason Spinning.

Sept 17, 2004

Planning Division
Environmental Branch

Ms. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Dear Mr. Bernhart:

This request for consultation replaces the original request for this project submitted to your office March 25, 2002 for the port Everglades Feasibility Study.

The U.S. Army Corps of Engineers (Corps), Jacksonville District proposes to conduct a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. An evaluation of benefits, costs, and environmental impacts determines Federal interest. This Feasibility Study was authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan main elements include: widening and deepening the Outer Entrance Channel to –56 feet (-54 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), deepening the Inner Entrance Channel and Main Turning Basin to –51 feet (-49 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), widening and deepening the Southport Access Channel to –51 feet (-49 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), widening of the DCC to 310 feet and deepening the Dania Cutoff Canal to –34 feet (-32 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), constructing a Turning Basin at the intersection of the Dania Cutoff Canal and the Southport Access Channel at –34 feet (-32 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), deepening a portion of the South Turning Basin to –46 feet (-44 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), and widening and deepening the Turning Notch to –51 feet (-49 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth). Other significant construction items include relocation of the U.S. Coast Guard (USCG) Basin easterly within essentially

USCG property, port facility construction, and environmental mitigation.

Enclosed please find the Corps' biological assessment of the effects of the proposed project on listed species in the action area. A copy of the Baseline Assessment prepared for this proposed project has been sent to your office previously by email to Mr. Robert Hoffman.

We request initiation of consultation under section 7 of the Endangered Species Act concerning the effects of the proposed activities on the smalltooth sawfish, green, hawksbill, Kemp's ridley, leatherback and loggerhead sea turtles, humpback and sperm whales and Johnson's seagrass.

If you have any questions, please contact Ms. Terri Jordan at 904-232-1817 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Jordan/CESAJ-PD-EA/3453/
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Scarborough/CESAJ-DP-C
Strain/CESAJ-PD-P
Duck/CESAJ-PD

L: group/pde/jordan/Version 2 Sect 7 cover letter NMFS

BIOLOGICAL ASSESSMENT
PORT EVERGLADES NAVIGATION PROJECT
BROWARD COUNTY, FLORIDA

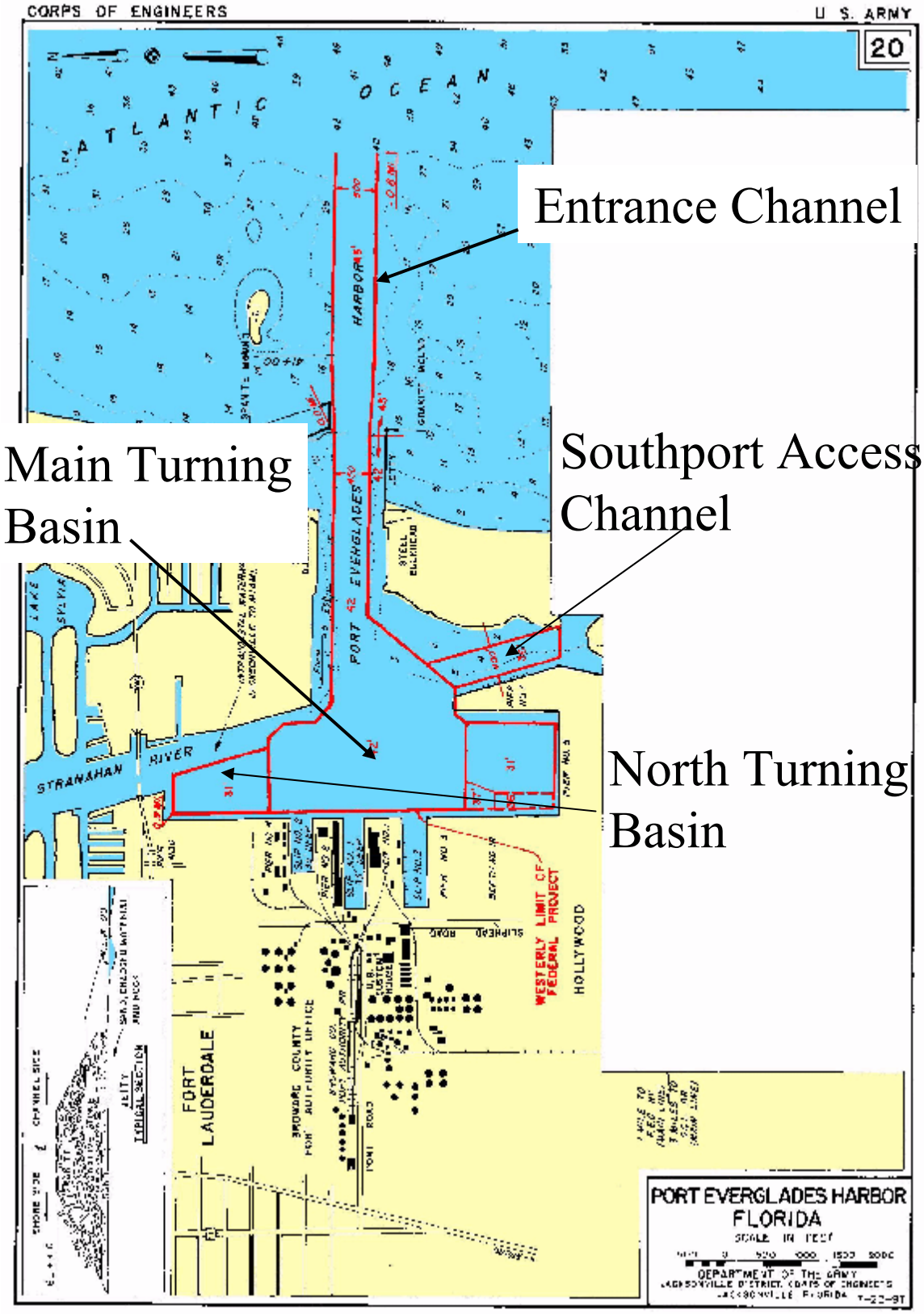
Description of the Proposed Action

The U.S. Army Corps of Engineers (Corps) proposes to expand and deepen Port Everglades Harbor. A detailed description of the proposed project and all alternatives considered under the Feasibility Study are evaluated in the pending Draft Environmental Impact Statement. Broward County Port Department requested that the Corps study the feasibility of widening and deepening most of the major channels and basins within Port Everglades. Four major improvement goals were identified. 1) Improve transit in the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and Southport Access Channel (SAC) to accommodate liquid bulk, cruise, and container vessels; 2) Develop the Dania Cutoff Canal (DCC) to accommodate mid-size vessels; 3) Deepen the North Turning Basin to accommodate Panamax size container ships; and 4) Improve turning and berthing in the Turning Notch (Figure 1).

The purpose of the proposed action is to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment. The proposed action resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the port. This economic analysis has shown that improvements to most of the major Federal and non-Federal channels and basins are required to achieve efficient transit of the existing fleet, and to accommodate the future fleet. Substantial liquid bulk cargo cost savings can be achieved by deepening the OEC, IEC, and MTB. Widening of the OEC flare will allow safer transit for all the larger commercial vessels that experience sometimes troublesome cross currents at the channel entrance. Removal of the Widener Shoal and widening of the SAC allows for more efficient and safer transits of containerized cargo vessels past the Knuckles restriction where new generation cruise vessels are expected to be berthed. Lengthening and deepening of the TN will provide turning possibilities for larger vessels and will provide critical berthing for containerized cargo vessels. Deepening of the STB will allow for more efficient use Berths 16-18 by allowing Panamax vessel calls. Finally, widening and deepening of the DCC (in addition to a turning basin located adjacent to the SAC) will allow for relocation of smaller and midsize container, roll on/roll off (ro/ro) vessels, and general cargo traffic, thereby reducing congestion in the areas serviced by larger vessels.

The Corps expects the construction to be performed using a variety of methods including blasting and dredging with a cutterhead, clamshell, hopper or other type of dredge. Any blasting that will occur within the project will be confined blasting. Confined blasting is defined as a blast where the explosives had been placed in a hole bored into the rock substrate and capped with 3-4 feet of crushed rock known as “stemming”. Stemming forces the explosive blast downward into the rock instead of allowing the blast to expand into the water column.

Fig 1 – Port Everglades Federal Navigation Project



Action Area

The Port Everglades Harbor is the second largest seaport located on the east coast of Florida. The Harbor lies adjacent to cities of Dania and Fort Lauderdale (Broward County), with immediate access to the Atlantic Ocean and the Intracoastal Waterway. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. Figure 2 shows major features located within and surrounding the project site.

Protected Species Included in this Assessment

The Corps has determined the that the following listed species under NMFS jurisdiction occur in the action area: green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Johnson's seagrass (*Halophila johnsonii*), blue (*Balenoptera musculus*), humpback, (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), fin (*Balenoptera physalus*) and sperm (*Physeter macrocephalus*) whales and smalltooth sawfish (*Pristis pectinata*). The Corps has relied heavily upon the Surtass LFA Biological Opinion that was completed by NMFS on May 31, 2002 for biological information concerning the biology, life history and status for the large whale species discussed in this assessment. This document was accessed from the NMFS website at:
http://www.nmfs.noaa.gov/prot_res/readingrm/ESAsec7/7pr_surtass-2020529.pdf.

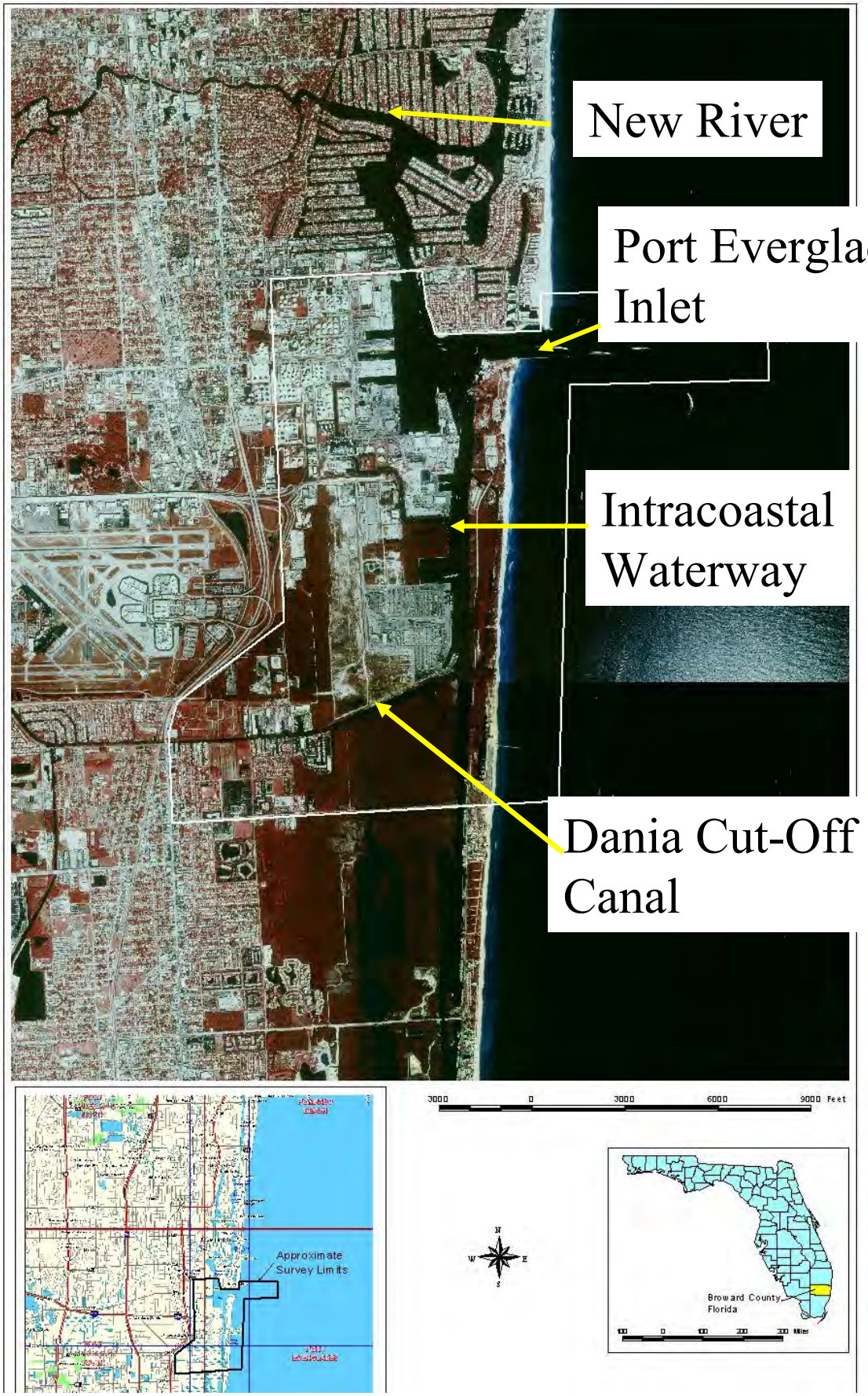
The Corps has reviewed the biological, status, threats and distribution information presented in this assessment and believes that the following species will be in or near the action area and thus may be affected by the proposed project: the five sea turtle species; humpback and sperm whales, Johnson's seagrass and smalltooth sawfish.

Six species of endangered marine mammals may be found seasonally in the waters offshore southeastern Florida. The Corps believes that only the sperm and humpback whales may be adversely affected by activities associated with the proposed action. These effects would be a result of acoustic harassment.

The blue, fin, northern right and sei whales are not discussed in detail because they are unlikely to be within the vicinity of the project. Additional information on blue, fin and sei whales can be found in Waring *et al*. (1999). Due to the rarity of sightings of these four whale species near the project area, the Corps believes that any effects to them by the project are discountable. Discountable effects under Section 7 of the ESA are those "extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur."

The endangered Florida manatee (*Trichecus manatus*) and the American crocodile (*Crocodylus acutus*) also occur with the action area and the Corps has initiated consultation with the U.S. Fish and Wildlife Service concerning the effects of the proposed action on these species.

Fig 2 – Location Map and Plan View



Status and Distribution of the Species

Green Turtle (*Chelonia mydas*)

Distribution. Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean, but are considered rare north of Cape Hatteras (Wynne and Schwartz, 1999). Several major nesting assemblages have been identified and studied in the western Atlantic (Peters 1954; Carr and Ogren, 1960; Carr *et al.*, 1978). Most green turtle nesting in the continental United States occurs on the Atlantic Coast of Florida (Ehrhart 1979). Green turtles are the largest of the hard-shelled sea turtles. Adult male green turtles are smaller than adult females whose lengths range from 92 to 110 cm (36 to 43 in.) and weights range from 119 to 182 kg (200 to 300 lbs). Their heads are small compared to other sea turtles and the biting edge of their lower jaws is serrated.

Green turtles have a more tropical distribution than loggerhead turtles; they are generally found in waters between the northern and southern 20°C isotherms (Hirth 1971). Green turtles, like most other sea turtles, are distributed more widely in the summer when warmer water temperatures allow them to migrate north along the Atlantic coast of North America. In the summer, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and continental North America from Texas to Massachusetts. Immature greens can be distributed in estuarine and coastal waters from Long Island Sound, Chesapeake Bay, and the North Carolina sounds south throughout the tropics (Musick and Limpus, 1997). In the United States, green turtles nest primarily along the Atlantic Coast of Florida, the U.S. Virgin Islands, and Puerto Rico. In the winter, as water temperatures decline, green turtles that are found north of Florida begin to migrate south into subtropical and tropical water.

Status and Population Trends. The green turtle was protected under the ESA in 1978; breeding populations off the coast of Florida and the Pacific coast of Mexico are listed as endangered, all other populations are listed as threatened. Recent population estimates for the western Atlantic area are not available. However, there is evidence that green turtle nesting has been on the increase during the past decade. Recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Certain Florida nesting beaches where most green turtle nesting activity occurs have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989. A nesting summary for the county in which the proposed project resides is found in Table 1.

Table 1: Summary of Green Turtle (*Chelonia mydas*) Nesting in Broward County, 1988-2003

Year	Beach Length (km)	Number of Nests	Number of Non-Nesting Emergences	Date of First Nest	Date of Last Nest
1988	38.4	35	25	5/27/88	6/29/88
1989	42.1	30	24	6/2/89	8/17/89
1990	38.3	106	82	5/13/90	9/12/90
1991	38.6	11	25	6/12/91	9/4/91
1992	41.3	132	205	6/6/92	9/5/92

1993	42.5	31	25	6/30/93	9/3/93
1994	42.5	123	189	6/2/94	9/10/94
1995	37.4	52	97	5/12/95	9/13/95
1996	42.5	130	188	5/31/96	9/11/96
1997	42.5	29	48	5/24/97	9/10/97
1998	42.5	200	265	5/30/98	9/6/98
1999	38.6	24	32	5/24/99	9/3/99
2000	38.6	255	394	5/17/00	9/3/00
2001	38.6	26	48	3/16/01	8/4/01
2002	38.6	216	342	5/16/02	9/26/02
2003	28.6	78	49	5/30/03	9/28/03

Source: Florida Marine Research Institute. 2004

Natural History. While nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging grounds. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida, the northwestern coast of the Yucatan Peninsula, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Post-pelagic green turtles feed primarily on sea grasses and benthic algae but also consume jellyfish, salps, and sponges. In the western Atlantic region, the summer developmental habitat encompasses estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds, and south throughout the tropics (Musick and Limpus, 1997). Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to southern waters in autumn, or face the risk of cold stunning.

Threats. The greatest threat to this species is the loss of its nesting habitat. Throughout the tropical and subtropical distribution of this species, beaches are eroded, armored, renourished, or converted for residential or commercial purposes. Green turtles are also threatened by fibropapilloma disease; incidental takes in commercial or recreational fishing gear; and poaching (although poaching is infrequent in the United States). Green turtles are harvested in some nations for food, leather, and jewelry. Green turtles are also threatened by natural causes including hurricanes; predation by fire ants, raccoons, and opossums; and poaching of eggs and nesting females.

Anthropogenic impacts to the green turtle population are similar to those for other sea turtle species. Sea sampling coverage in the pelagic driftnet, pelagic longline, scallop dredge, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. In addition, the NMFS/Northeast Fisheries Science Center (NEFSC) is conducting a review of bycatch levels and patterns in all fisheries in the western Atlantic for which observer data is available. Bycatch estimates will be made for all fisheries for which sample sizes are sufficiently large to permit reasonable statistical analysis. This will be compiled into an assessment report. Until that analysis is completed, the only information on the magnitude of takes available for fisheries in the action area are unextrapolated numbers of observed takes from

the sea sampling data. Preliminary sea sampling data summary (1994-1998) shows the following total take of green turtles: one (anchored gillnet), two (pelagic driftnet), and two (pelagic longline). Stranding reports indicate that between 200-300 green turtles strand annually from a variety of causes (Sea Turtle Stranding and Salvage Network, unpublished data). As with the other species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality.

Critical Habitat. In 1998, NMFS designated the waters surrounding the islands of Culebra, Puerto Rico as critical habitat for the green turtle. This area supports major seagrass beds and reefs that provide forage and shelter habitat. The action area does not comprise critical habitat for green turtles.

Loggerhead Turtle

Distribution. Loggerhead turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerheads concentrate their nesting in the north and south temperate zones and subtropics, but generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (NRC 1990). The largest known nesting aggregation of loggerhead turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani, 1982). In the western Atlantic, most loggerhead turtles nest from North Carolina to Florida and along the gulf coast of Florida. The best scientific and commercial data available on the genetics of loggerhead turtles suggests there are four major subpopulations of loggerheads in the northwest Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); and (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990) (approximately 1,000 nests in 1998, according to TEWG, 2000). This biological assessment will focus on the northwest Atlantic subpopulations of loggerhead turtles, which occur in the action area. A nesting summary for the county in which the action is proposed is included in Table 2.

Table 2: Summary of Loggerhead (*Caretta caretta*) Nesting in Broward County, 1988-2003

Year	Beach Length (km)	Number of Nests	Number of Non-Nesting Emergences	Date of First Nest	Date of Last Nest
1988	38.4	1349	2509	5/1/88	8/28/88
1989	42.1	1791	1547	4/20/89	9/8/89
1990	38.3	2283	1928	4/22/90	9/12/90
1991	38.6	2033	1923	4/23/91	9/3/91
1992	41.3	2230	1978	4/23/92	9/2/92
1993	42.5	2267	2071	4/29/93	9/15/93
1994	42.5	2180	2306	4/23/94	9/4/94
1995	37.9	2567	2330	4/25/95	9/12/95
1996	38.6	2902	3235	4/23/96	9/7/96
1997	38.6	2216	2382	4/18/97	9/8/97
1998	38.6	2643	4065	4/23/98	9/13/98
1999	38.6	2584	3025	4/18/99	8/29/99
2000	38.6	2674	3121	4/18/00	9/9/00
2001	38.6	2321	2327	4/20/01	8/28/01
2002	38.6	2070	2361	4/12/02	9/10/02
2003	38.6	2335	2746	4/17/03	8/28/03

source: Florida Marine Research Institute. 2004

Although NMFS and FWS have not completed the administrative processes necessary to formally recognize populations or subpopulations of loggerhead turtles, these sea turtles are generally grouped by nesting locations. Based on the most recent reviews of the best scientific and commercial data on the population genetics of loggerhead sea turtles and analyses of their population trends (TEWG, 1998; TEWG 2000), NMFS and FWS treat these loggerhead turtle nesting aggregations as distinct subpopulations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will focus on the four nesting aggregations of loggerhead turtles identified in the preceding paragraph (which occur in the action area) and treat them as subpopulations for the purposes of this analysis. Natal homing to the nesting beach provides the genetic barrier between these subpopulations, preventing recolonization from turtles from other nesting beaches. The importance of maintaining these subpopulations in the wild is shown by the many examples of extirpated nesting assemblages in the world. In addition, recent fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco *et al.* 2000) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but generally are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal *et al.* 1983: *in* NMFS SEFSC 2001).

The loggerhead turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern nesting subpopulation produces about 9% of the loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia: between 25 and 59 percent of the loggerhead turtles in this area are from the northern subpopulation (NMFS SEFSC 2001; Bass *et al*., 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears 1994, Sears *et al.,* 1995). In the Carolinas, the northern subpopulation is estimated to make up from 25% to 28% of the loggerheads (NMFS SEFSC 2001; Bass *et al.* 1998, 1999). About ten percent of the loggerhead turtles in foraging

areas off the Atlantic coast of central Florida are from the northern subpopulation (Witzell *et al*., in prep). In the Gulf of Mexico, most of the loggerhead turtles in foraging areas will be from the South Florida subpopulation, although the northern subpopulation may represent about 10% of the loggerhead sea turtles in the Gulf (Bass pers. comm). In the Mediterranean Sea, about 45 - 47 percent of the pelagic loggerheads are from the South Florida subpopulation and about two percent are from the northern subpopulation, while only about 51% originated from Mediterranean nesting beaches (Laurent *et al.*, 1998). In the vicinity of the Azores and Madiera Archipelagoes, about 19% of the pelagic loggerheads are from the northern subpopulation, about 71% are from the South Florida subpopulation, and about 11% are from the Yucatán subpopulation (Bolten *et al*., 1998).

Natural History. Loggerhead turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years. Turtles in this life history stage are called "pelagic immatures" and are best known from the eastern Atlantic near the Azores and Madeira and have been reported from the Mediterranean as well as the eastern Caribbean (Bjorndal *et al*., in press). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm SCL they recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immatures have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico (R. Márquez-M., pers. comm.). Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder *et al.*, 1998) along the south and western coasts of Florida as compared with the rest of the coast, but it is not known whether the larger animals actually are more abundant in these areas or just more abundant within the area relative to the smaller turtles. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly *et al.,* 1995; Keinath, 1993; Morreale and Standora, 1999; Shoop and Kenney, 1992), and migrate northward in spring. Given an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer and Limpus, 1998), the benthic immature stage must be at least 10-25 years long. NMFS SEFSC 2001 analyses conclude that juvenile stages have the highest elasticity and maintaining or decreasing current sources of mortality in those stages will have the greatest impact on maintaining or increasing population growth rates.

Like other sea turtles, the movements of loggerheads are influenced by water temperature. Since they are limited by water temperatures, sea turtles do not usually appear on the summer foraging grounds until June, but are found in Virginia as early as April. The large majority leaves the Gulf of Maine by mid-September but may remain in these areas until as late as November and December. Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz, 1999). Under certain conditions they may also scavenge fish, particularly if they are easy to catch (e.g., caught in nets) (NMFS and USFWS, 1991).

Adult female loggerheads in the western Atlantic come ashore to nest primarily from North Carolina southward to Florida. Additional nesting assemblages occur in the Florida Panhandle and on the Yucatán Peninsula. Non-nesting, adult female loggerheads are reported throughout

the U.S. and Caribbean Sea; however, little is known about the distribution of adult males who are seasonally abundant near nesting beaches during the nesting season. Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Threats. Loggerhead sea turtles face a number of human-related threats in the marine environment, including oil and gas exploration, development, and transportation; marine pollution; trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries (see below); underwater explosions; dredging, offshore artificial lighting; power plant entrapment; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching.

Although loggerhead turtles are most vulnerable to pelagic longlines during their pelagic, immature life history stage, there is some evidence that benthic immatures may also be captured, injured, or killed by pelagic fishery operations. Recent studies have suggested that not all loggerhead turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic immatures, followed by permanent settlement into benthic environments. Some may not totally circumnavigate the North Atlantic. In addition, some of these turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or they may move back and forth between pelagic and coastal habitats (Witzell in prep.). Any loggerhead turtles that follow this developmental model would be adversely affected by shark gill nets and shark bottom longlines set in coastal waters, in addition to pelagic longlines.

On their nesting beaches in the U.S., loggerhead turtles are threatened with beach erosion, armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; predation by fire ants, raccoons, armadillos, opossums; and poaching. Elimination/control of these threats are especially important because, from a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of this species: it is second in size only to the nesting aggregations in the Arabian Sea off Oman and represents about 35 and 40 percent of the nests of this species. The status of the Oman nesting beaches has not been evaluated recently, but they are located in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), the resulting risk facing this nesting aggregation and these nesting beaches is cause for considerable concern (Meylan *et al*., 1995).

Loggerhead turtles also face numerous threats from weather and coastal processes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and loggerhead turtle nesting season (March to November); hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton *et al*., 1992). On Fisher Island near Miami, Florida, 69% of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern subpopulation were destroyed by hurricanes, which made landfall in North Carolina in the mid to late 1990's. Sand accretion and rainfall that result from these storms can appreciably

reduce hatchling success. The recent landfall of Hurricane Charley on Florida's southwest coast and the impending landfall of Hurricane Frances will also have adverse effects on nest success. These natural phenomena probably have significant, adverse effects on the size of specific year classes; particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

Status and Population Trends. The loggerhead turtle was listed as threatened under the ESA on July 28, 1978. The most recent work updating what is known regarding status and trends of loggerhead sea turtles is contained in NMFS SEFSC 2001. The recovery plan for this species (NMFS and USFWS 1991) state that southeastern U.S. loggerheads can be considered for delisting if, over a period of 25 years, adult female populations in Florida are increasing and there is a return to pre-listing annual nest numbers totaling 12,800 for North Carolina, South Carolina, and Georgia combined. This equates to approximately 3,100 nesting females per year at 4.1 nests per female per season. NMFS SEFSC 2001 concludes, "…nesting trends indicate that the numbers of females associated with the South Florida subpopulation are increasing. Likewise, nesting trend analyses indicate potentially increasing nest numbers in the northern subpopulation" (TEWG 2000). However, NMFS SEFSC 2001 also cautions that given the uncertainties in survival rates (of the different life stages, particularly the pelagic immature stage), and the stochastic nature of populations, population trajectories should not be used now to quantitatively assess when the northern subpopulation may achieve 3,100 nesting females.

Several published reports have presented the problems facing long-lived species that delay sexual maturity in a world replete with threats from a modern, human population (Crouse *et al.,* 1987, Crowder *et al.,* 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high, annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general tenet of population ecology originated in studies of sea turtles (Crouse *et al.,* 1987, Crowder *et al.,* 1994, Crouse 1999). Heppell *et al.* (in prep.) specifically showed that the growth of the loggerhead sea turtle population was particularly sensitive to changes in the annual survival of both juvenile and adult sea turtles and that the adverse effects of the pelagic longline fishery on loggerheads from the pelagic immature phase appeared critical to the survival and recovery of the species. Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles would adversely affect large segments of the total loggerhead sea turtle population.

The four major subpopulations of loggerhead sea turtles in the northwest Atlantic, northern, south Florida, Florida panhandle, and Yucatán are all subject to fluctuations in the number of young produced annually because of natural phenomena like hurricanes as well as human-related activities. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merrit Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection and probably cause fluctuations in sea turtle nesting success. Sea turtles nesting in the southern and central counties of Florida can be affected by beach armoring, beach renourishment, beach cleaning, artificial lighting, predation, and poaching (NMFS & FWS 1991).

As discussed previously, the survival of juvenile loggerhead sea turtles is threatened by a completely different set of threats from human activity once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North Atlantic over several years (Carr 1987, Bjorndal 1994). During that period, they are exposed to a series of long-line fisheries that include an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar *et al*., 1995, Bolten *et al.,* 1994, Crouse 1999). Based on their proportional distribution, the capture of immature loggerhead sea turtles in long-line fleets in the Azores and Madiera Archipelagoes and the Mediterranean Sea will have a significant, adverse effect on the annual survival rates of juvenile loggerhead sea turtles from the western Atlantic subpopulations, with a disproportionately large effect on the northern subpopulation that may be significant at the population level.

In waters off coastal U.S., a suite of fisheries in Federal and State waters threatens the survival of juvenile loggerhead sea turtles. Loggerhead turtles are captured, injured, or killed in shrimp fisheries off the Atlantic coast; along the southeastern Atlantic coast, loggerhead turtle populations are declining where shrimp fishing is intense off the nesting beaches (NRC 1990). Conversely these nesting populations do not appear to be declining where nearshore shrimping effort is low or absent. The management of shrimp harvest in the Gulf of Mexico demonstrates the correlation between shrimp trawling and impacts to sea turtles. Waters out to 200nm are closed to shrimp fishing off of Texas each year for approximately a three-month period (mid-May through mid-July) to allow shrimp to migrate out of estuarine waters; sea turtle strandings decline dramatically during this period (NMFS, STSSN unpublished data). Loggerhead sea turtles are captured in fixed pound-net gear in the Long Island Sound, in pound-net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, in gill net fisheries in the mid-Atlantic and elsewhere, in fisheries for monkfish and for spiny dogfish, and in northeast sink gillnet fisheries (see further discussion in the *Environmental Baseline* of this Opinion). Witzell (1999) compiled data on capture rates of loggerhead and leatherback turtles in U.S. longline fisheries in the Caribbean and northwest Atlantic; the cumulative takes of these fisheries approach those of the U.S. shrimp fishing fleet (Crouse 1999, NRC 1990).

Based on the data available, it is not possible to estimate the size of the loggerhead population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989-1998 represent the best dataset available to index the population size of loggerhead turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates. Given this, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,016-89,034 annually, representing, on average, an adult female population of 44,780 [(nests/4.1) * 2.5]. On average, 90.7% of the nests were from the South Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle subpopulation. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to what subpopulation they belong. Based on the above, there are only an estimated 3,800 nesting females in the northern loggerhead subpopulation. The status of this population, based on number of loggerhead nests, has been classified as stable or declining

(TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate, using genetics data from Texas, South Carolina, and North Carolina in combination with juvenile sex ratios from those states, that the northern subpopulation produces 65% males, while the Florida subpopulation is estimated to produce 80% females (NMFS SEFSC 2001, Part I).

Critical Habitat. No critical habitat has been designated for loggerhead turtles.

Leatherback Turtle (Dermochelys coriacea)

Distribution. The leatherback is the largest living turtle. Leatherback sea turtles are widely distributed throughout the oceans of the world, and are found throughout waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972).

Leatherback turtles undertake the longest migrations of any other sea turtle and exhibit the broadest thermal tolerances (NMFS and USFWS 1998). Leatherback turtles are able to inhabit intensely cold waters for a prolonged period of time because leatherbacks are able to maintain body temperatures several degrees above ambient temperatures. Leatherback turtles are typically associated with continental shelf habitats and pelagic environments, and are sighted regularly in offshore waters (>328 ft). Leatherback turtles regularly occur in deep waters (>328 ft), and an aerial survey study in the north Atlantic Ocean sighted leatherback turtles in water depths ranging from 3 to 13,618 ft, with a median sighting depth of 131.6 ft (CeTAP 1982). This same study found leatherbacks in waters ranging from 7 to 27.2°C.

Natural History. Although leatherbacks are a long lived species (> 30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported as about 13-14 years for females, and an estimated minimum age at sexual maturity of 5-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996).

Leatherback sea turtles are predominantly distributed pelagically where they feed on jellyfish such as *Stomolophus, Chryaora,* and *Aurelia* (Rebel 1974). Leatherbacks are deep divers, with recorded dives to depths in excess of 1000 m, but they may come into shallow waters if there is an abundance of jellyfish nearshore. They also occur annually in places such as Cape Cod and Narragansett bays during certain times of the year, particularly the fall.

Status and Threats. The leatherback was listed as endangered on June 2, 1970 and a recovery plan was issued in 1998. Leatherback turtles are included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which effectively bans trade.

Globally, leatherback turtle populations have been decimated worldwide. The global leatherback turtle population was estimated to number approximately 115,000 adult females in 1980 (Pritchard 1982), but only 34,500 in 1995 (Spotila *et al*. 1996). The decline can be attributed to many factors including fisheries as well as intense exploitation of the eggs (Ross 1979). On some beaches nearly 100% of the eggs laid have been harvested (Eckert 1996). Eckert (1996) and Spotila *et al*. (1996) record that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries.

The status of the Atlantic population is not clear. In 1996, it was reported to be stable, at best (Spotila 1996), but numbers in the Western Atlantic at that writing were reported to be on the order of 18,800 nesting females. According to Spotila (pers. com.), the Western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the Eastern Atlantic (i.e. off Africa, numbering ~ 4,700) have remained consistent with numbers reported by Spotila *et al*. in 1996. Between 1989 and 1995, marked leatherback returns to the nesting beach at St. Croix averaged only 48.5%, but that the overall nesting population grew (McDonald, et. al 1993). This is in contrast to a Pacific nesting beach at Playa Grande, Costa Rica, where only 11.9% of turtles tagged in 1993-94 and 19.0% of turtles tagged in 1994-95 returned to nest over the next five years. Characterizations of this population suggest that it has a very low likelihood of survival and recovery in the wild under current conditions.

Spotila *et al*. (1996) describe a hypothetical life table model based on estimated ages of sexual maturity at both ends of the species= natural range (5 and 15 years). The model concluded that leatherbacks maturing in 5 years would exhibit much greater population fluctuations in response to external factors than would turtles that mature in 15 years. Furthermore, the simulations indicated that leatherbacks could maintain a stable population only if both juvenile and adult survivorship remained high, and that if other life history stages (i.e. egg, hatchling, and juvenile) remained static, stable leatherback populations could not withstand an increase in adult mortality above natural background levels without decreasing.

The primary threats to leatherback turtles are entanglement in fishing gear (e.g., gillnets, longlines, lobster pots, weirs), boat collisions, and ingestion of marine debris (NMFS and USFWS 1997). The foremost threat is the number of leatherback turtles killed or injured in fisheries. Spotila (2000) states that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls and gillnets) in the Pacific during the 1990s is 1,500 animals. He estimates that this represented about a 23% mortality rate (or 33% if most mortality was focused on the East Pacific population). As noted above, leatherbacks normally live at least 30 years, usually maturing at about 12-13 years. Such long-lived species cannot withstand such high rates of anthropogenic mortality.

Table 3: Summary of Leatherback (*Dermochelys coriacea*) Nesting in Broward County, 1988-2003

Year	Beach Length (km)	Number of Nests	Number of Non-Nesting Emergences	Date of First Nest	Date of Last Nest
1988	38.4	4	0	5/12/88	6/1/88
1989	42.1	4	2	4/24/89	5/19/89
1990	38.3	1	2	5/9/90	5/9/90
1991	38.6	4	1	4/1/91	5/28/91
1992	41.3	7	6	4/15/92	6/16/92
1993	42.5	17	4	4/6/93	6/19/93
1994	42.5	9	0	3/24/94	5/28/94
1995	37.9	15	5	3/16/95	6/29/95
1996	38.6	2	0	5/8/96	6/3/96
1997	38.6	41	10	2/28/97	6/19/97
1998	38.6	14	8	4/26/98	6/11/98
1999	38.6	12	2	3/11/99	5/26/99

2000	38.6	13	4	5/5/00	6/3/00
2001	38.6	39	7	4/20/01	8/21/01
2002	38.6	18	7	3/2/02	6/22/02
2003	38.6	12	3	3/19/03	5/10/03

source: Florida Marine Research Institute. 2004

Critical Habitat. NMFS and FWS designated certain areas of the US Virgin Islands as critical habitat for the leatherback turtle. The action area does not comprise designated critical habitat for the species.

Hawksbill Turtle

Distribution. Hawksbill turtles occur in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Recognized subspecies occupy the Atlantic Ocean (ssp. *imbricata*) and the Pacific Ocean (ssp. *squamata*). Richardson *et al*. (1989) estimated that the Caribbean and Atlantic portions of the U.S. support a minimum of 650 hawksbill turtle nests each year. In the United States, hawksbill turtles have been recorded in all states along the Gulf of Mexico and along the Atlantic coast from Florida to Massachusetts. United States populations nest primarily in the U.S. Virgin Islands and Puerto Rico, but occasionally on the Atlantic coast of Florida. Two hawksbill turtle carcasses have been found in the vicinity of the action area (Wendy Teas, pers com, 2002, NMFS - SEFSC Miami Laboratory).

Natural History. Hawksbill turtles use different habitats for different stages in their life cycles. Post-hatchling hawksbill turtles remain in pelagic environments to take shelter in weedlines that accumulate at convergence points. Juvenile hawksbill turtles (those with carapace lengths of 20-25 cm) re-enter coastal waters where they become residents of coral reefs, which provide sponges for food and ledges, and caves for shelter. Hawksbill turtles are also found around rocky outcrops, high-energy shoals, and mangrove-fringed bays and estuaries (particularly in areas where coral reefs do not occur). Hawksbill turtles remain in coastal waters when they become subadults and adults.

Status and Threats. The hawksbill turtle was listed as an endangered species on June 2, 1970 (35 FR 8491). Populations are threatened by significant modifications of its coastal habitat throughout its range. The National Research Council (1990), and NMFS/FWS (1993) have published general overviews of the effects of habitat alteration on hawksbill turtles. In the U.S. Virgin Islands, problems such as egg poaching, domestic animals, beach driving, litter, and recreational use of beaches have presented problems for nesting hawksbill turtles. In addition, beachfront lights appear to pose a serious problem for hatchling hawksbill (and other) turtles in the U.S. Virgin Islands. At sea, activities that damage coral reefs and other habitats that are important to the hawksbill turtle threaten the continued existence of this species. Hawksbill turtles are also threatened by stochastic events (e.g., hurricanes); predation by fire ants, raccoons and opossums; and by poaching of eggs and nesting females by humans.

Critical Habitat. In 1998, NMFS designated the waters surrounding Mona and Monito Islands, Puerto Rico as critical habitat for the hawksbill turtle. The action area does not comprise designated critical habitat for the species.

Kemp's Ridley Sea Turtle

Status and Population Trends. Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. The Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempi*) (USFWS and NMFS 1992) contains a description of the natural history, taxonomy, and distribution of the Kemp's ridley turtle. Kemp's ridleys nest in daytime aggregations known as *arribadas*. The primary arribada in the Gulf of Mexico is at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970's, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and there is cautious optimism that the population is now increasing.

After unprecedented numbers of Kemp's ridley carcasses were reported from Texas and Louisiana beaches during periods of high levels of shrimping effort, NMFS established a team of population biologists, sea turtle scientists, and managers, known as the Turtle Expert Working Group (TEWG) to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in some years have increased at rates higher than the rate of increase in the Kemp's population (TEWG 1998).

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service (FWS) and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of turtle excluder devices (TEDs). Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1,940 nests in 1995 and about 3,400 nests in 1999.

The TEWG (1998) was unable to estimate the total population size and current mortality rates for the Kemp's ridley population. However, the TEWG listed a number of preliminary conclusions. The TEWG indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production

and the use of TEDs. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This trajectory of adult abundance tracks with trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The TEWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The population model in the TEWG projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. It determined that the data reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the Atlantic.

The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular inter-nesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

Hurricane Gilbert expanded the area surveyed for ridley nests in Mexico in 1990 due to destruction of the primary nesting beach. The TEWG (1998) assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

Natural History. Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Post-pelagic ridleys feed primarily on crabs, consuming a variety of species, including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal, 1997). Juvenile ridleys migrate south as water temperatures cool in fall, and are predominantly found in shallow coastal embayments along the Gulf Coast during fall and winter months. Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 centimeters in carapace length, and weighing less than 20 kilograms (Klinger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June, and migrating to more southerly waters from September to November (Keinath *et al.*, 1987; Musick and Limpus, 1997). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas

supporting submerged aquatic vegetation (Lutcavage and Musick, 1985; Bellmund *et al.*, 1987; Keinath *et al.*, 1987; Musick and Limpus, 1997). The juvenile population in Chesapeake Bay is estimated to be 211 to 1,083 turtles (Musick and Limpus, 1997).

Research being conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, Galveston NMFS Laboratory staff tracked 50 of these turtles using satellite and radio telemetry. The tracking study was designed to characterize sea turtle habitat and to identify small and large-scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

Threats. Observations in the northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. As with loggerheads, a large number of Kemp's ridleys are taken in the southeast shrimp fishery each year. Kemp's ridleys were also affected by the apparent large-mesh gillnet interaction that occurred in spring off of North Carolina. A total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 277 loggerhead carcasses were found. This is expected to be a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all carcasses washed ashore. Stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters as well (TEWG 1998). While many of the stranded turtles observed in recent years in Texas and Louisiana have been incidentally taken in the shrimp fishery, other sources of mortality, such as those observed in the northeastern and southeastern Atlantic zones, exist in these waters.

Critical Habitat. No critical habitat has been designated for the Kemp's ridley turtle.

Smalltooth Sawfish

All modern sawfish belong to the Suborder Pristoidea, Family Pristidae, and Genus *Pristis*. Although they are rays, sawfish appear to be more shark-like than ray-like, with only the trunk and especially the head ventrally flattened. The snout of all sawfish is extended as a long narrow flattened rostral blade with a series of transverse teeth along either edge, hence the vernacular name. Species in the genus *Pristis* are separable into two groups according to whether the caudal fin has a distinct lower lobe or not. The smalltooth sawfish, *Pristis pectinata*, is the sole known representative on the western side of the Atlantic of the group lacking a defined lower caudal lobe (NMFS, 2000).

Distribution. The smalltooth sawfish has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish (west and south of Port Arthur, TX) (Adams and Wilson, 1995). It also was an occasional visitor to waters as far north as New York. As with all sawfishes, it is euryhaline, occurring in fresh water, nearshore estuaries and in coastal waters to depths of 25 meters.

Pristis pectinata is the largest of the sawfishes, reported to reach 760 cm while more commonly growing to 550 cm (Last and Stevens 1994). Bigelow and Schroeder (1953) reported litter size of 15-20 embryos. Overall, life history parameters for this species are largely unknown.

In the United States, smalltooth sawfish are generally a shallow water fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. Records indicate that smalltooth sawfish have been found in the lower reaches of the St. Johns River and the Indian River lagoonal system. Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months.

Updated collection records from the Florida Museum of Natural History of the University of Florida include 13 records of *P. pectinata* from 1912 to 1998 (with one record not dated). Nine of these specimens were recorded from the Gulf of Mexico off Florida, three came from the Atlantic side of Florida, and one animal was caught in Pacific waters off Ecuador. Three additional records of smalltooth sawfish from the Atlantic coast of Florida have yet to be cataloged in this collection: one specimen is from 1979; the second is not dated (the Museum received both these fish from the Harbor Branch Oceanographic Institute); a third specimen was landed May 22, 1998 from the Indian River (Burgess, pers. comm.). There are eight reports of smalltooth sawfish along the Florida east coast in the 1990's, most from coastal rather than lagoonal areas.

General Human-related impacts. The principal habitats for smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving upriver in freshwater (Bigelow and Schroeder, 1953). The continued urbanization of the southeastern coastal states has resulted in substantial loss of coastal habitat through such activities as agricultural and urban development; commercial activities; dredge and fill operations; boating; erosion and diversions of freshwater run-off (SAFMC, 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity to shallow, estuarine systems. With the K-selected life history strategy of smalltooth sawfish, including slow growth, late maturation, and low fecundity, long-term commitments to habitat protection are necessary for the eventual recovery of the species.

A complete review of the factors contributing to the decline of the smalltooth sawfish can be found in the "Status Review of Smalltooth Sawfish (*Pristis pectinata*)", (NMFS, 2000) and will not be repeated in detail here.

Status and Trends. The smalltooth sawfish was added to the list of species as candidates under the ESA in 1991, removed in 1997, and placed back on the list again in 1999. In November 1999, NMFS received a petition from the Center of Marine Conservation requesting that this species be listed as endangered under the ESA. NMFS completed a status review for smalltooth sawfish in December 2000, and published a proposed rule to list this the U.S. population of this species as endangered under the ESA on April 16, 2001. On April 1, 2003, the National Marine Fisheries Service (NOAA Fisheries) announced its final determination to list smalltooth sawfish as an endangered species under the Endangered Species Act (ESA).

According to NMFS (2000) "The U.S. DPS of smalltooth sawfish has experienced a ninety

percent curtailment of its range and severe declines in abundance. Agriculture, urban development, commercial activities, channel dredging, boating activities, and the diversion of freshwater run-off have resulted in the destruction and modification of smalltooth habitat throughout the southeastern U.S. Although habitat degradation is not likely the primary reason for the decline of smalltooth sawfish abundance and their contracted distribution, it has likely been a contributing factor. Over 50% of the U.S. human population lives within fifty miles of the ocean or Great Lakes. Migration to the coastlines for home, livelihood or recreation is predicted to increase by the year 2010 (National Ocean Service, 2000). Increases in coastal human populations will likely result in additional losses of marine habitats and increased pollution, further threatening the survival of smalltooth sawfish."

Simpfendorfer (2000) used a demographic approach to estimate intrinsic rate of natural increase and population doubling time. Since there are very limited life history data for smalltooth sawfish, much of the data (e.g. reproductive periodicity, longevity and age-at-maturity) were inferred from the more well-known largetooth sawfish. The litter size of smalltooth sawfish in the literature is given as 15 – 20 and Simpfendorfer used a mean of 17.5. However, the data on which this litter size is based are somewhat dubious. To account for uncertainty in the life-history parameters several different scenarios were tested, covering longevities from 30 to 70 years and ages-at-maturity from 10 to 27 years. The results indicated that the intrinsic rate of population increase ranged from 0.08/year to 0.13/ year, and population-doubling times ranged from 5.4 years to 8.5 years. These models assume the literature value for litter size is correct; doubling times would be longer if litter sizes are more in the range observed for largetooth sawfish (1 to 13, with a mean of 7.3). Simpfendorfer concluded:

> The estimated population doubling times for smalltooth sawfish indicate that the recovery times for this population will be very long. There are no data available on the size of the remaining populations, but anecdotal information indicates that smalltooth sawfish survive today in small fragmented areas where the impact of humans, particularly from net fishing, has been less severe. Fragmenting of the population will increase the time that it takes for recovery since the demographic models used in the study above assume a single inter-breeding population. The genetic effects of recovery from very small population sizes may also impact conservation efforts. It is likely that even if an effective conservation plan can be introduced in the near future, recovery to a level where the risk of extinction is low will take decades, while recovery to pre-European settlement levels would probably take several centuries.

Johnson's Seagrass

Species Description. Johnson's seagrass was listed as threatened under the ESA on September 14, 1998 based on the results of fieldwork and a status review initiated in 1990 and is the first marine plant ever listed. Kenworthy (1993, 1997, 1999) discusses the results of the field studies and summarizes an extensive literature review and associated interviews regarding the status of Johnson's seagrass.

The species has only been found growing along approximately 200 km of coastline in southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited

geographic distribution of any seagrass in the world.

Johnson's seagrass occurs in dynamic and disjunct patches throughout its range. Growth appears to be rapid and leaf pairs have short life spans while horizontally spreading from dense apical meristems (Kenworthy 1997). Kenworthy suggested that horizontal spreading rapid growth pattern and a high biomass turnover could explain the dynamic patches observed in distribution studies. New information reviewed in Kenworthy (1999, 1997) confirms *H. johnsonii's* limited geographic distribution in patchy and vertically disjunct areas between Sebastian Inlet and northern Biscayne Bay. Surveys conducted by NMFS and Florida staff in Biscayne Bay, Florida Bay, the Florida Keys, outer Florida Bay, Puerto Rico, and the Virgin Islands provided no verifiable sightings of Johnson's seagrass outside of the range already reported.

Extent of critical habitat. The northern and southern ranges of Johnson's seagrass are defined as Sebastian Inlet and central Biscayne Bay, respectively. These limits to the species' range have been designated as critical habitat for Johnson's seagrass. Within its range, Johnson's seagrass critical habitat designations have been designated for 10 areas: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. There is no designated critical habitat within the action area.

Life History

Reproductive strategy

The species is perennial and may spread even during winter months under favorable conditions (Virnstein *et al.* 1997). Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found; however, dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds either in the field or under laboratory conditions (Jewett-Smith *et al.* 1997). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting that the species does not reproduce sexually or that the male flowers are difficult to observer or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean, suggesting that inlet conditions are qualitatively better for flowering than conditions further inshore (Kenworthy pers. comm. 1998). It is possible that male flowers, if they exist, occur near inlets as well. Maintenance of good water quality around inlets may be essential for promoting flowering in the Johnson's seagrass population.

Niche

The essential features of habitat appear to be adequate water quality, salinity, water clarity and stable sediments free from physical disturbance. Important habitat characteristics include shallow intertidal as well as deeper subtidal zones (2-5 m). Water transparency appears to be critical for Johnson's seagrass, limiting its distribution at depth to areas of suitable optical water quality (Kenworthy 1997). In areas in which long-term poor water and sediment quality have existed until recently, such as Lake Worth Lagoon, *H. johnsonii* appears to occur in relatively

higher abundance perhaps due to the previous inability of the larger species to thrive. These studies support unconfirmed previous observations that suspended solids and tannin, which reduce light penetration and water clarity, may be important factors limiting seagrass distribution. Good water clarity is essential for *Halophila johnsonii* growth in deeper waters.

Johnson's seagrass occurs over varied depths, environmental conditions, salinities, and water quality. In tidal channels *H. johnsonii* is found in coarse sand substrates, although it has been found growing on sandy shoals, in soft mud near canals and rivers where salinity many fluctuate widely (Virnstein *et al.* 1997). Virnstein has called Johnson's seagrass a "perennial opportunistic species." Within his study areas in the Indian River Lagoon, *H. johnsonii* was found by itself, with other seagrass species, in the intertidal, and (more commonly) at the deep edge of some transects in water depths of up to 180 cm. *H. johnsonii* was found shallowly rooted on sandy shoals, in soft mud, near the mouths of canals, rivers and in shallow and deep water (Virnstein *et al.* 1997). Additionally, recent studies have documented large patches of Johnson's seagrass on flood deltas just inside Sebastian Inlet, as well as far from the influence of inlets (reported at the workshop discussed in Kenworthy, 1997). These sites encompass a wide variety of salinities, water quality, and substrates.

Competitors:
Halophila johnsonii appears to be outcompeted in ideal seagrass habitats where environmental conditions permit the larger species to thrive (Virnstein *et al.* 1997, Kenworthy 1997).

Population Dynamics
Population stability
A factor leading to the listing of *H. johnsonii* is its rareness within its extremely restricted geographic range. Johnson's seagrass is characterized by small size (it is the smallest of all of the seagrasses found within its range, averaging about 3 cm in height), fragile rhizome structure and associated high turnover rate, and is apparently reliant on vegetative means to reproduce, grow and migrate across the sea bottom. These factors make Johnson's seagrass extremely vulnerable to human or environmental impacts by reducing its capacity to repopulate an area once removed. The species and its habitat are impacted by human-related activities throughout the length its range, including bridge construction and dredging, and the species' threatened status produces new and unique challenges for the management of shallow submerged lands. Vessel traffic resulting in propeller and anchor damage, maintenance dredging, dock and marine construction, water pollution, and land use practices could require special management within critical habitat.

Population (genetic) variability:
The Boca Raton and Boynton Beach sites proposed for critical habitat designation have populations that are distinguished by a higher index of genetic variation than any of the central and northern populations examined to date (Kenworthy, 1999). These two sites represent a genetically semi-isolated group that could be the reservoir of a large part of the overall genetic variation found in the species. Information is still lacking on the geographic extent of this genetic variability.

Status and Distribution. Kenworthy (1997, 1999) summarized the newest information on

Johnson's seagrass biology, distribution, and abundance and confirmed the limited range and rareness of this species within its range. Additionally, the apparent restriction of propagation through vegetative means suggests that colonization between broadly disjunct areas is likely difficult, suggesting that the species is vulnerable to becoming endangered if it is removed from large areas within its range by natural or anthropogenic means. Human impacts to Johnson's seagrass and its habitat include: (1) Vessel traffic and the resulting propeller dredging and anchor mooring; (2) dredging; (3) dock and marina construction and shading from these structures; (4) water pollution; and (5) land use practices including shoreline development, agriculture, and aquaculture.

Activities associated with recreational boat traffic account for the majority of human use associated with the proposed critical habitat areas. The destruction of the benthic community due to boating activities, propeller dredging, anchor mooring, and dock and marina construction was observed at all sites during a study by NMFS from 1990 to 1992. These activities severely disrupt the benthic habitat, breaching root systems, severing rhizomes, and significantly reducing the viability of the seagrass community. Propeller dredging and anchor mooring in shallow areas are a major disturbance to even the most robust seagrasses. This destruction is expected to worsen with the predicted increase in boating activity. Trampling of seagrass beds, a secondary effect of recreational boating, also disturbs seagrass habitat. Populations of Johnson's seagrass inhabiting shallow water and water close to inlets, where vessel traffic is concentrated, will be most affected.

The constant sedimentation patterns in and around inlets require frequent maintenance dredging, which could either directly remove essential seagrass habitat or indirectly affect it by redistributing sediments, burying plants and destabilizing the bottom structure. Altering benthic topography or burying the plants may remove them from the photic zone. Permitted dredging of channels, basins, and other in- and on-water construction projects cause loss of Johnson's seagrass and its habitat through direct removal of the plant, fragmentation of habitat, and shading. Docking facilities that, upon meeting certain provisions, are exempt from state permitting also contribute to loss of Johnson's seagrass through construction impacts and shading. Fixed add-ons to exempt docks (such as finger piers, floating docks, or boat lifts) have recently been documented as an additional source of seagrass loss due to shading (Smith and Mezich, 1999).

Decreased water transparency caused by suspended sediments, water color, and chlorophylls could have significant detrimental effects on the distribution and abundance of the deeper water populations of Johnson's seagrass. A distribution survey in Hobe and Jupiter Sounds indicates that the abundance of this seagrass diminishes in the more turbid interior portion of the lagoon where reduced light limits photosynthesis.

Other areas of concern include seagrass beds located in proximity to rivers and canal mouths where low salinity, highly colored water is discharged. Freshwater discharge into areas adjacent to seagrass beds may provoke physiological stress upon the plants by reducing the salinity levels. Additionally, colored waters released into these areas reduce the amount of sunlight available for photosynthesis by rapidly attenuating shorter wavelengths of Photosynthetically Active Radiation.

Continuing and increasing degradation of water quality due to increased land use and water management threatens the welfare of seagrass communities. Nutrient overenrichment caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural land run-off stimulates increased algal growth that may smother Johnson's seagrass, shade rooted vegetation, and diminish the oxygen content of the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities.

A wide range of activities funded, authorized or carried out by Federal agencies may affect the essential habitat requirements of Johnson's seagrass. These include authorization by the COE for beach nourishment, dredging, and related activities including construction of docks and marinas; bridge construction projects funded by the Federal Highway Administration; actions by the U.S. Environmental Protection Agency and the COE to manage freshwater discharges into waterways; regulation of vessel traffic by the U.S. Coast Guard; management of national refuges and protected species by the U.S. Fish and Wildlife Service; management of vessel traffic (and other activities) by the U.S. Navy; authorization of state coastal zone management plans by NOAA's National Ocean Service, and management of commercial fishing and protected species by NMFS.

Rangewide trend:
Lamentably, there is currently insufficient information to clearly determine trends in the Johnson's seagrass population, which was described in 1980 and has only been extensively studied during the 1990s. Generally, seagrasses within the range of Johnson's seagrass have declined in some areas and increased in others. Where multiyear mapping studies have been conducted within the Indian River Lagoon, recent increases in Johnson's seagrass have been noted but may be attributed in part to the recent increase in search effort and increased familiarity with this species (Virnstein *et al.* 1997). The authors conclude that from 1994 through 1997, no strong seasonal distribution or increases or decreases in abundance or range can be discerned.

Humpback Whale (Balaenoptera physalus)
Species description and distribution. Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. Humpback whales feed on krill and small schooling fish on their summer grounds. The whales occupy tropical areas during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, when they are feeding, primarily on small schooling fish and krill (Caldwell and Caldwell 1983).

In the Atlantic Ocean, humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Six separate feeding areas are utilized in northern waters after their return. This area will not be affected because it is within the biologically important area defined by the 200-m (656-ft) isobath on the North American east coast. Humpback whales also use the mid-Atlantic as a migratory pathway and apparently as a feeding area, at least for juveniles. Since 1989, observations of juvenile humpbacks in that area have been increasing during the winter months, peaking January through March (Swingle *et al.*

1993). Biologists theorize that non-reproductive animals may be establishing a winter-feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. They feed on a number of species of small schooling fishes, particularly sand lance and Atlantic herring, by targeting fish schools and filtering large amounts of water for the associated prey. Humpback whales have also been observed feeding on krill.

Life History. Humpback whale reproductive activities occur primarily in winter. They become sexually mature at age four to six. Annual pregnancy rates have been estimated at about 0.40-0.42 (NMFS unpublished and Nishiwaki 1959). Cows will nurse their calves for up to 12 months. The age distribution of the humpback whale population is unknown, but the portion of calves in various populations has been estimated at about 4B12% (Chittleborough 1965, Whitehead 1982, Bauer 1986, Herman *et al.* 1980, and Clapham and Mayo 1987).

The information available does not identify natural causes of death among humpback whales or their number and frequency over time, but potential causes of natural mortality are believed to include parasites, disease, predation (killer whales, false killer whales, and sharks), biotoxins, and entrapment in ice.

Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes, euphausiids, and other large zooplankton. Fish prey in the North Pacific include herring, anchovy, capelin, pollack, Atka mackerel, eulachon, sand lance, pollack, Pacific cod, saffron cod, arctic cod, juvenile salmon, and rockfish. In the waters west of the Attu Islands and south of Amchitka Island, Atka mackerel were preferred prey of humpback whales (Nemoto 1957). Invertebrate prey includes euphausiids, mysids, amphipods, shrimps, and copepods.

Diving and social behavior. In Hawaiian waters, humpback whales remain almost exclusively within the 1820 m isobath and usually within 182 m. Maximum diving depths are approximately 150 m (492 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton *et al.* 1997). They may remain submerged for up to 21 min (Dolphin 1987). Dives on feeding grounds ranged from 2.1-5.1 min in the north Atlantic (Goodyear unpubl. manus.). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California humpback whale dive times averaged 3.5 min (Strong 1989). Because most humpback prey is likely found above 300 m depths most humpback dives are probably relatively shallow.

Clapham (1986) reviewed the social behavior of humpback whales. They form small stable groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long periods of times. There is good evidence of some territoriality on feeding grounds (Clapham 1994, 1996), and on wintering ground (Tyack 1981). On the breeding grounds males sing long complex songs directed towards females, other males or both. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham 1996). Intermale competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds that may be as high as 2.4:1.

Vocalizations and hearing. Humpbacks produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne 1970; Winn *et al.* 1970a; Thompson *et al.* 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson *et al.* 1979). The songs appear to have an effective range of approximately six to 12 miles (10 to 20 km). Animals in mating groups produce a variety of sounds (Tyack 1981; Tyack and Whitehead 1983, Silber 1986). Sounds are produced less frequently on the summer feeding grounds. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 sec and source levels of 175-192 dB (Thompson *et al.* 1986). These sounds are attractive and appear to rally animals to the feeding activity (D=Vincent *et al.* 1985; Sharpe and Dill 1997). In summary, humpback whales produce at least three kinds of sounds: 1) complex songs with components ranging from at least 20Hz B 4 kHz with estimated source levels from 144 B 174 dB, which are mostly sung by males on the breeding grounds (Payne 1970; Winn *et al.* 1970a; Richardson *et al.* 1995); 2) social sounds in the breeding areas that extend from 50Hz B more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and 3) Feeding area vocalizations that are less frequent, but tend to be 20Hz B 2 kHz with estimated sources levels in excess of 175 dB re 1 µPa-m (Thompson *et al.* 1986; Richardson *et al.* 1995). Sounds often associated with possible aggressive behavior by males (Tyack 1983; Silber 1986) are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz. These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983). A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale above. Humpback whales respond to low frequency sound. Humpback whales have been known to react to low frequency industrial noises at estimated received levels of 115 B 124 dB (Malme *et al.* 1985), and to conspecific calls at received levels as low as 102dB (Frankel *et al.* 1995). Humpback whales apparently reacted to 3.1 B 3.6 kHz sonar by changing behavior (Maybaum 1990 1993). Malme *et al.* (1985) found no clear response to playbacks of drill ship and oil production platform noises at received levels up to 116dB re 1 µPa. Studies of reactions to airgun noises were inconclusive (Malme *et al.* 1985). Humpback whales on the breeding grounds did not stop singing in response to underwater explosions (Payne and McVay 1971). Humpback whales on feeding grounds did not alter short-term behavior or distribution in response to explosions with received levels of about 150dB re 1 µPa/Hz at 350Hz (Lien *et al.* 1993; Todd *et al.* 1996). However, at least two individuals were likely killed by the high intensity, impulsed blasts and had extensive mechanical injuries in their ears (Ketten *et al.* 1993; Todd *et al.* 1996). The explosions may also have increased the number of humpback whales entangled in fishing nets (Todd *et al.* 1996). Frankel and Clark (1998) showed that breeding humpbacks showed only a slight statistical reaction to playback of 60 B 90 Hz bounds with a received level of up to 190 dB. While these studies have shown short-term behavioral reactions to boat traffic and playbacks of industrial noise, the potential for habituation, and thus the long term effects of these disturbances are not known.

Status and Trends. Humpback whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for the species.

New information has become available on the status and trends of the humpback whale population in the North Atlantic (NMFS, 2001). Although current and maximum net productivity

rates are unknown at this time, the population is apparently increasing. It has not yet been determined whether this increase is uniform across all six feeding stocks (Waring *et al. in prep.*). Katona and Beard (1990) estimated the rate of increase at 9.0 percent, while Barlow and Clapham (1997) reported a 6.5 percent rate for the Gulf of Maine using data through 1991. The rate reported by Barlow and Clapham (1997) may roughly approximate the rate of increase for the portion of the population within the action area. The best estimate of abundance for the North Atlantic humpback whale population is 10,600 animals (CV=0.067; Smith *et al.* 1999), while the minimum population estimate used for NMFS management purposes is 10,019 animals (CV = 0.067; Waring *et al. in prep.*). The Northeast Fisheries Science Center is considering recommending that NMFS identify the Gulf of Maine feeding stock as the management stock for this population in U.S. waters. A population estimate for the Gulf of Maine portion of the population is not available.

Threats. In the 1990s, no more than 3 humpback whales were killed annually in U.S. waters by commercial fishing operations in the Atlantic and Pacific Oceans. Between 1990 and 1997, no humpback whale deaths have been attributed to interactions with groundfish trawl, longline and pot fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska (Hill and DeMaster 1999). Humpback whales have been injured or killed elsewhere along the mainland U.S. and Hawaii (Barlow *et al.* 1997). In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill *et al.* 1997). In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone.

Humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989, Clapham *et al.* 1993, Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman *et al.* 1980, Watkins *et al.* 1981, Krieger and Wing 1986). Several investigators have suggested that noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979b, Dean *et al.* 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.* 1993; Wiley *et al.* 1995).

Many humpback whales are killed by ship strikes along both coasts of the U.S. On the Atlantic coast, 6 out of 20 humpback whales stranded along the mid-Atlantic coast showed signs of major ship strike injuries (Wiley *et al.* 1995). Almost no information is available on the number of humpback whales killed or seriously injured by ship strikes outside of U.S. waters.

Sperm Whale (Physeter macrocephalus)

Species description and distribution. Sperm whales are distributed in the entire world's oceans. Sperm whales have a strong preference for the 3,280 ft (1,000 m) depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 300 m (984 ft), while Watkins (1977) and Reeves and Whitehead (1997) reported that they are usually not found in waters less than 3,281 ft (1,000m) deep. While deep water is their typical habitat, sperm whales have been observed near Long Island, NY, in waters of 41-55 m (135-180 ft) (Scott and Sadove

1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). They can dive to depths of at least 2000 m (6562 ft), and may remain submerged for an hour or more (Watkins *et al.* 1993). Sperm whales feed primarily on buoyant, relatively slow-moving squid (Clark *et al.* 1993), but may also eat a variety of fish, including salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*) (Caldwell and Caldwell 1983).

In the Atlantic Ocean, NMFS' most recent stock assessment report notes that sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. There is also a very large population of sperm whales found in the Gulf of Mexico near the Mississippi River delta.

Life History. Female sperm whales take about 9 years to become sexually mature (Kasuya 1991, as cited in Perry *et al.* 1999). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for 2 - 3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980, as cited in Perry *et al.* 1999). Sperm whales are known for their deep foraging dives (in excess of 3 km). They feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollack, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales taken in the Gulf of Alaska in the 1960s had fed primarily on fish. Daily food consumption rates for sperm whales ranges from 2 - 4% of their total body weight (Lockyer 1976b, Kawakami 1980). Potential sources of natural mortality in sperm whales include killer whales and papilloma virus (Lambertson *et al.* 1987).

Diving and social behavior. Sperm whales are likely the deepest and longest diving mammals. Typical foraging dives last 40 min and descend to about 400m followed by approximately 8 min of resting at the surface (Gordon 1987; Papastavrou et al. 1989). However, dives of over 2 hr and as deep as 3,000 m have been recorded (Clarke 1976; Watkins et al. 1985). Descent rates recorded from echosounders were approximately 1.7m/sec and nearly vertical (Goold and Jones 1995). There are no data on diurnal differences in dive depths in sperm whales. However, like most diving vertebrates for which there is data (e.g. rorqual whales, fur seals, chinstrap penguins), sperm whales probably make relatively shallow dives at night when organisms from the ocean's deep scattering layers move toward the ocean's surface.

The groups of closely related females and their offspring develop dialects specific to the group (Weilgart and Whitehead 1997) and females other than birth mothers will guard young at the surface (Whitehead 1996b) and will nurse young calves (Reeves and Whitehead 1997).

Vocalizations and hearing. Sperm whales produce loud broadband clicks from about 0.1 to 20 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). These have source levels estimated at 171 dB re 1 μPa (Levenson 1974). Current evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce these vocalizations (Norris and Harvey 1972; Cranford 1992; but see Clarke 1979). This suggests that the production of these loud low frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well studied (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). Long series of monotonous regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Distinctive, short, patterned series of clicks, called codas, are associated with social behavior and intragroup interactions; they are thought to facilitate intra-specific communication, perhaps to maintain social cohesion with the group (Weilgart and Whitehead 1993).

A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale above. The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins *et al.* 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Sperm whales have moved out of areas after the start of air gun seismic testing (Davis *et al.* 1995). Seismic air guns produce loud, broadband, impulsive noise (source levels are on the order of 250 dB) with shots at every 15 seconds, 240 shots per hour, and 24 hours per day during active tests. Because they spend large amounts of time at depth and use low frequency sound sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll *et al* 1999). Furthermore, because of their apparent role as important predators of mesopelagic squid and fish, changes in their abundance could affect the distribution and abundance of other marine species.

Status and Trends. Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for sperm whales.

The best abundance estimate that is currently available for the western North Atlantic sperm whale population is 2,698 (CV=0.67) animals, and the minimum population estimate used for NMFS management purposes is 1,617 (CV=0.67) (Waring *et al. in prep.*). Due to insufficient data, no information is available on population trends at this time for the western North Atlantic sperm whale stock.

Threats. In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of 9 sperm whales per year from 1991-1995 (Barlow *et al.* 1997). Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Rice 1989, Hill and DeMaster 1999). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on fish caught in longlines in the Gulf of Alaska. During 1997, the first entanglement of a sperm whale in Alaska's longline fishery was recorded, although the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear.

Protected Species Surveys within the project area.

Surveys specifically targeting protected species were not conducted in the action area, however an Environmental Baseline Study and Impact Assessment were prepared. This assessment, literature reviews and consultations with NMFS serve as the basis for this biological assessment and the determination of which listed and protected species under NMFS' jurisdiction are found in the project area.

Sea Turtles

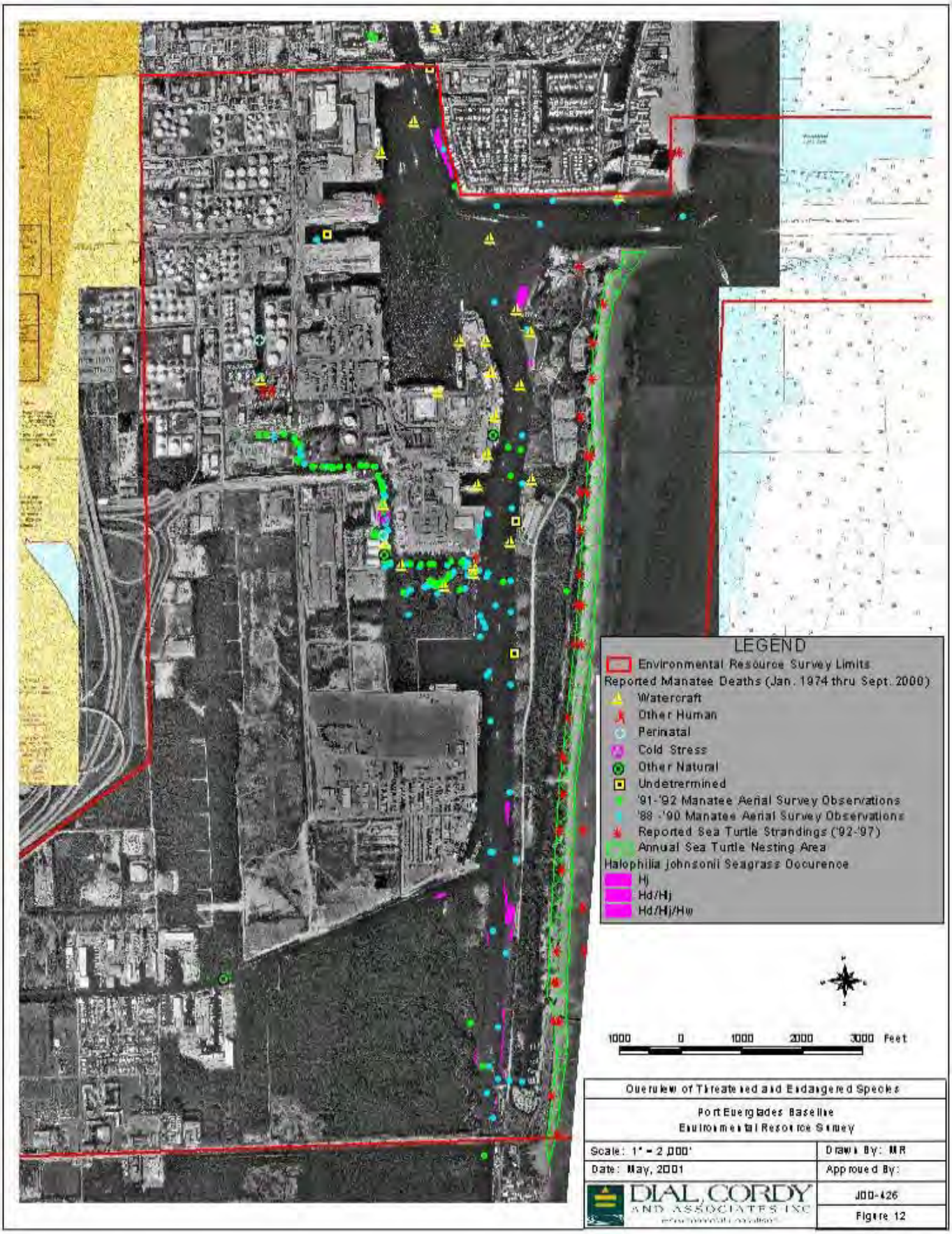
Broward County is within the normal nesting range of three species of sea turtles: the loggerhead (*Caretta caretta*), the green turtle (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*). The green sea turtle and leatherback sea turtle are both listed under the U. S. Endangered Species Act, 1973 and Chapter 370, F.S. The loggerhead turtle is listed as a threatened species (Burney and Margolis, 1999). A summary of sea turtle nesting in Broward County can be found in Tables 1, 2 and 3 in the species description section of this assessment. The majority of sea turtle nesting activity occurred during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis, 1999). The waters offshore of Broward County are also habitat used for foraging and shelter for the three species listed above and possibly the hawksbill turtle (*Eretmochelys imbricata*), and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE, 2000) (Figure 3).

Six (6) stranded threatened and endangered sea turtles have been reported within the Port boundaries: 3 loggerheads, 2 green turtles and 1 hawksbill. In addition there were 13 incidental capture records - 1 green turtle was caught on hook and line and 12 turtles (6 loggerheads, 2 green turtles, 2 hawksbills and 2 unidentified species) were caught in the power plant at Port Everglades (Wendy Teas, pers. Comm. 2002).

Johnson's Seagrass

Johnson's seagrass occurs within the project area, specifically in the Intracoastal Waterway east and south of the Main Turning Basin, and just west of the Dania Cutoff Canal, and in the Dania Cutoff Canal. Abundance and density values are low and the species is generally associated with *H. decipiens*. Johnson's seagrass also occurs south of the Dania Cutoff Canal within Whiskey Creek, along the western shore of the Intracoastal Waterway and within the West Lake Park embayment (Miller Legg, 2001). Cover-abundance and density were higher along the west shore of West Lake Park than was observed within the Port Everglades project area. No designated critical habitat is

Fig 3 – Endangered & Threatened Species Locations



found within the project boundaries or within the vicinity of the project site (Figure 4 & 5).

Smalltooth sawfish

This species inhabits softbottom estuarine habitats in depths generally less than 30 feet. Its former range in U.S. waters extended from Texas through Maryland. Currently, few are observed outside peninsular Florida. At least one recorded observation has occurred within the vicinity of Broward County (NMFS, 2000). Populations likely decreased due to a low intrinsic rate of natural increase, the long interval to time of reproduction, and human impacts, most notably overfishing, incidental take in nets (due in part to its body size and unusual morphology), and habitat loss (development of shoreline and nearshore habitats).

Humpback and Sperm Whales

These species are found offshore of the project area in deepwater beyond the third reef line. Sperm whales may be found year round near the project area, while humpbacks are found seasonally during their migration to and from breeding grounds in the Caribbean.

Other consultations of Federal actions in the area to date

The Corps has been working with the citizens of Broward County for several years on expanding and maintaining Port Everglades (Table 4). None of the projects authorized by Congress through 1968 were required to consult under the Endangered Species Act of 1973 (ESA). Port Everglades projects following implementation of the ESA include the 1974 deepening and widening of the entrance channel on a new alignment, as well as deepening the turning basin and add the channel now referred to as the Southport Access Channel.

The Corps is also working with Broward County on the Broward County Shore protection project, located outside of the port boundaries to the north and the south. Construction on the shore protection project is scheduled to begin in the fall of 2004. The Corps believes that the sea turtle species addressed in the current biological assessment may be affected, but not adversely affected in any way by the project. The NMFS Informal Section 7 consultation on that project (March 10, 2000) concurred with the finding of may affect, not likely to adversely affect listed species or adversely effect designated critical habitat under NMFS jurisdiction in the project area (consultation number 1514-22f.1.).

Table 4: Previously Authorized Federal Actions at Port Everglades Harbor

ACTS	WORK AUTHORIZED	DOCUMENTS
3 Jul 1930	Maintenance of harbor constructed by local interests.	H. Doc. 357/71/2
30 Aug 1935	Enlarge entrance channel to existing project dimensions and complete turning basin to 1,200 feet square.	R. & H. Comm. Doc. 25/74/1
20 Jun 1938	Widen turning basin 350 feet on north side.	H. Doc. 545/75/3
24 Jul 1946	Widen turning basin 200 feet on north side, 500 feet	H. Doc. 768/78/2

Fig 4 – Seagrass Locations in Northern portion

Fig 5 – Seagrass Locations in Southern portion

	on south side, and enlarge flare at entrance channel.	
3 Jul 1958	Deepen and widen entrance channel on a new alignment and increase turning basin in size and depth.	H. Doc. 346/85/2
H.R. 9 May 1974 S.R.31 May 1974	Deepen and widen entrance channel on a new alignment, deepen turning basin and add a new channel to the southeast of the turning basin.	H. Doc. 144/93/1

Projects completed by the Port without Federal assistance

1987	Port Everglades. Final Environmental Impact Statement, Proposed Expansion Port Everglades, Broward County, Florida. EIS for deepening and widening the Southport Access Channel, bulkheading port land, creation of the Turning Notch.

Protective Measures Taken in the Project Area as Part of the Proposed Action

Consideration of Plans and Methods to Minimize/Avoid Environmental Impacts. Conservation measures were a major focus during the plan formulation phase for the proposed project. Avoiding and minimizing some potential impact areas significantly decreased the risk of indirect effects on managed and protected species, and a great deal of consideration was given to the utilization of rock removal methods to decrease the likelihood of incidental take, injury, and behavioral modification of protected species. While efforts to reduce impacts to habitats were fruitful, it was determined that rock removal options not involving blasting were possibly more detrimental to populations and individuals of protected species. One alternative option was the use of a punchbarge/piledriver to break rock. However, it was determined that the punchbarge, which would work for 12-hour periods, strikes the rock approximately once every 60-seconds. This constant pounding would serve to disrupt animal behavior in the area. Using the punchbarge would also extend the length of the project, thus increasing any potential impacts to all fish and wildlife resources in the area. The Corps believes that blasting is actually the least environmentally damaging method for removing the rock in the Port. Each blast will last no longer than five (5) seconds in duration, and may even be as short as 2 seconds each. Additionally, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set, and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced as compared to an unconfined blast (see discussion below).

Development of Protective Measures. The proposed project includes measures to conserve sperm and humpback whale, sea turtles and smalltooth sawfish. Foremost among the measures are protective actions to ensure that sea turtles and smalltooth sawfish are not killed and whales are not harassed due to blasting activities, if in fact such methods are required as a part of the overall dredging operation. Development of the measures involved consideration of past practices and operations, anecdotal observations, and the most current scientific data. The discussion below summarizes the development of the conservation measures, which, although developed for marine mammals, will also be utilized to protect such species as sea turtles and smalltooth sawfish.

Blasting

To achieve the deepening of the Port Everglades pretreatment of the rock areas may be required. Blasting is anticipated to be required for some or all of the deepening and extension of the channel, where standard construction methods are unsuccessful. The work may be completed in the following manner:

1. Contour dredging with either bucket, hydraulic or excavator dredges to remove material that can be dredged conventionally and determine what areas require blasting.

2. Pre-treating (blasting) the remaining above grade rock, drilling and blasting the "Site Specific" areas where rock could not be conventionally removed by the dredges.

3. Excavating with bucket, hydraulic or excavator dredges to remove the pre-treated rock areas to grade.

All drilling and blasting will be conducted in strict accordance with local, state and federal safety procedures. Marine Wildlife Protection, Protection of Existing Structures, and Blasting Programs coordinated with federal and state agencies.

Based upon industry standards and USACE, Safety & Health Regulations, the blasting program may consist of the following:

The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock. The blasting would consist of up to 3 blasts per day, preparing for removal of approximately 1500 cubic yards per blast.

The following safety conditions are standard in conducting underwater blasting:

- Drill patterns are restricted to a minimum of 8 ft separation from a loaded hole.
- Hours of blasting are restricted from 2 hours after sunrise to 1 hour before sunset to allow for adequate observation of the project area for protected species.
- Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.
- Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.
- The blast design will consider matching the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.

Because of the potential duration of the blasting and the project area as habitat for listed and threatened species, a number of issues will need to be addressed. One of the key issues is the extent of a safety radius for the protection of marine wildlife. This is the distance from the blast site which any protected species must be in order to commence blasting operations. Ideally the safety radius is large enough to offer a wide buffer of protection for marine animals while still remaining small enough that the area can be intensely surveyed

There are a number of methods that can be used to calculate a safety radius. Little published data exists for actual measurements of sub aqueous blasts confined to a rock layer and their impacts to marine mammals or turtles. There is some information on the impacts to fish from similar blasts. Both literature searches and actual observations from similar blasting events will be used as a guide in establishing a safety radius that affords the best protection from lethal harm to marine wildlife. The following will be considered in establishing the radius for blasting inshore of the outer reef:

The U.S. Navy Dive Manual and the FFWCC Endangered Species Watch Manual the safety formula for an uncontrolled blast suspended in the water column, which is as follows:

$$R = 260 \text{ (cube root } w)$$

R = Safety radius

W = Weight of explosives

This formula is a conservative for the blasting being done within Port Everglades, as the blast will be confined within the rock and not suspended in the water column. This formula and plan are consistent with the plans for Miami Harbor Phase II and Miami Harbor GRR that the Corps consulted with NMFS on (I/SER/2002/00178 – September 23, 2002 and F/SER/2002/01094 – February 23, 2003, respectively). In both cases, NMFS found concurred with the Corps' determination that the proposed confined blasting at Miami Harbor "may affect, but is not likely to adversely affect sea turtles". The Port Everglades blasting plan has been designed to be consistent with the Miami Harbor projects. Should new information come from the Miami harbor projected (Phase II is scheduled to begin construction in Fall 2004) that would result in changes (as lessons learned) they will be incorporated into the plans for Port Everglades in consultation with all the resource agencies.

If blasting is required on the outer reef, the Corps proposes to use aerial and passive acoustic surveys to determine if there are sperm or humpback whales within a 1-nautical mile (nm) radius of the project area. In the Biological Opinion for the shock trial of the USS Winston Churchill (DDG-81) (NMFS, 2000b), NMFS required the Navy to establish a zone of 3 nm for acoustic monitoring and 2 nm for aerial monitoring for three 10,000 lb open water unconfined explosions. Blasting for the channel extension will utilize confined blasts drilled into the substrate, and as a result the Corps believes that any acoustic or pressure effects to the project area will be substantially less than those evaluated by NMFS in setting the safety zones for the Churchill tests.

Conservation Measures

It is crucial to balance the demands of the blasting operations with the overall safety of the species. A radius that is excessively large will result in significant delays that prolong the blasting, construction, traffic and overall disturbance to the area. A radius that is too small puts the animals at too great of a risk should one go undetected by the observers and move into the blast area. Because of these factors, the goal is to establish the smallest radius possible without compromising animal safety and provide adequate observer coverage for whatever radius is agreed upon.

Aerial reconnaissance, where feasible and possible, is critical to support the safety radius selected in addition to boat-based and land support reconnaissance. Additionally, an observer will be placed on the drill barge for the best view of the actual blast zone and to be in direct contact with the blaster in charge.

Prior to implementing a blasting program a Test Blast Program will be completed. The purpose of the Test Blast Program is to demonstrate and/or confirm the following:

- Drill Boat Capabilities and Production Rates
- Ideal Drill Pattern for Typical Boreholes
- Acceptable Rock Breakage for Excavation
- Tolerable Vibration Level Emitted

- Directional Vibration
- Calibration of the Environment

The Test Blast Program begins with a single range of individually delayed holes and progresses up to the maximum production blast intended for use. Each Test Blast is designed to establish limits of vibration and airblast overpressure, with acceptable rock breakage for excavation. The final test event simulates the maximum explosive detonation as to size, overlying water depth, charge configuration, charge separation, initiation methods, and loading conditions anticipated for the typical production blast.

The results of the Test Blast Program will be formatted in a regression analysis with other pertinent information and conclusions reached. This will be the basis for developing a completely engineered procedure for Blasting Plan. During the testing the following data will be used to develop a regression analysis:

- Distance
- Pounds Per Delay
- Peak Particle Velocities (TVL)
- Frequencies (TVL)
- Peak Vector Sum
- Air Blast, Overpressure

Other Rock Removal Options
The Corps investigated methods to remove the rock in Port Everglades without blasting using a punchbarge. It was determined that the punchbarge, which would work for 12-hour periods, strikes the rock below approximately once every 60-seconds. This constant pounding would serve to disrupt manatee behavior in the area, as well as impact other marine animals in the area. Using the punchbarge will also extend the length of the project temporally, thus increasing any potential impacts to all fish and wildlife resources in the area. A punchbarge has been tried in the past at Port Everglades without success due to rock hardness.

The Corps believes that blasting is actually the least environmentally damaging method for removing the rock in the Port. Each blast will last no longer than 5-seconds in duration, and may even be as short as 2 seconds, occurring no more than three times per day. As stated previously, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced as compared to an unconfined blast.

Effects of the Action on Protected Species.
As previously stated, the Corps believes that the loggerhead turtle, green turtle, smalltooth sawfish and Johnson's seagrass have the potential to be effected by the proposed dredging project. The project may have the following adverse impacts on listed/protected species are:

- direct effect of blasting in the turning basin.

- direct effect of dredging activities
- indirect effects

Direct Effects
Blasting

Sea turtles
Specific information regarding the likely direct impact of explosives on sea turtles is not available. Studies regarding the impacts of relatively minuscule explosives on humans noted that minor injuries such as small bruises or perforations of the intestinal tract occasionally occur well beyond ranges in which human lung damage could occur (Christian and Gaspin, 1974). Christian and Gaspin (1974) note that these minor injuries could become serious if left unattended. Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. In the Environmental Impact Statement prepared by the Navy to consider the effects of explosives used in shipshock tests, nervous system damage was cited as a possible impact to sea turtles caused by blasting. Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtles' shells would indeed afford such protection.

Studies conducted by Klima *et al*., (1988) evaluated blasts of only approximately 42 lbs on sea turtles (4 ridleys, 4 loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small explosive weights, implies that the turtles in the Klima *et al*. (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, 5 of 8 turtles were rendered unconscious at distances of 229 to 915 m from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates.

Blasting will affect nearby finfish and invertebrates and cause short-term changes to the physical characteristics of the benthos. Fish and invertebrates killed or injured by the blasting may provide a short-term enhancement of foraging opportunities for green and loggerhead sea turtles. Through new recruitment and local migrations, finfish and benthic invertebrates are expected eventually to repopulate the affected area. Any modifications of the local area's environment, as far as sea turtle habitat, are not expected to be significant in the long term.

Smalltooth Sawfish
Blasting rock underwater produces a pressure wave in water that can produce fish mortality. Different types of fish have different mortality thresholds. This depends on whether the fish dwell near the surface, on the bottom, or in between.

The magnitude of the pressure wave generated in greatly affected by the stemming of the blastholes, distance between holes, and the delay time of the holes.

Normally, mortality occurs in the range of 150-psi overpressure for fish. In practice this is a 75-foot to 100-foot radius around the blasting area.

Dredging

Sea Turtles

The effects of hopper dredging on sea turtles on the Atlantic coast were analyzed by NMFS in the 1997 biological opinion entitled "The continued hopper dredging of channels and borrow areas in the southeastern United States". If it is determined that a hopper dredge will be used, the Terms and Conditions of this opinion will be applied to the project. If a cutterhead or clamshell dredge is used, based on a finding in the November 25, 1991 biological opinion between NMFS and the Corps that states:

> "Pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely effect sea turtles".

Based on this determination, the Corps finds that use of a cutterhead dredge may effect, but is not likely to adversely affect sea turtles. If a clamshell dredge is used, there is no suction to capture a sea turtle and the turtle would have to be caught between the two halved of the clamshell. While this is not impossible, it is improbable. The Corps has also determined that use of a clamshell dredge may effect, but is not likely to adversely affect sea turtles.

Smalltooth sawfish

The smalltooth sawfish may be affected by dredging nearshore areas in channels that are currently suitable habitats (areas of sand and/or mud bottoms less than 30 feet in depth) and by blasting if there is an animal present in the blast zone at time of detonations, a stunned or damaged animal may be captured by the clamshell dredge if it could not move out of the way.

Johnson's Seagrass

Dredging will result in the removal of approximately 2.37 acres of seagrass beds where *H. johnsonii* is the sole constituent or associate of other seagrass species in the Intracoastal Waterway and Dania Cutoff Canal. This impact will include the direct removal of *H. johnsonii.* Changes in bottom depth through deepening and widening efforts within the Port is expected to make resulting habitats unsuitable for re-colonization of *H. johnsonii*. It is not known if *H. johnsonii* in areas adjacent to dredging zones would be resilient to changes in water quality or to impacts resulting from deposition of sediments on blades.

Indirect Effects

Sea Turtles

Since beaches of John U. Lloyd SRA provide important nesting areas for three sea turtle species, the project area comprises important resources for turtles. Removal of sections of hardbottom, reef, and seagrass habitats will eliminate potential foraging habitat for juvenile sea turtles. The reduction in such habitat may slightly decrease the carrying capacity of the region for turtles. Also, since these habitats are also utilized as refugia for hatchling turtles, an increase in predation may be anticipated.

Finally, dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches. In fact, the highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Entrance and Southport Access Channels. It is extremely likely that both the pressure and noise associated with blasting will physically damage sensory mechanisms and other physiological functions of individual sea turtles.

Johnson's seagrass

Areas of Johnson's seagrass adjacent to construction activities may be temporarily affected by increased turbidity and lower water clarity during construction.

Effect Determination

The Corps has determined that the proposed expansion of Port Everglades may adversely affect listed and proposed species within the action area and requests initiation of formal consultation with NMFS.

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Planning Division
Environmental Branch

Ms. Georgia Cranmore
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Dear Ms. Cranmore:

The U.S. Army Corps of Engineers (Corps), Jacksonville District proposes to conduct a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. An evaluation of benefits, costs, and environmental impacts determines Federal interest. This Feasibility Study was authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan main elements include: widening and deepening (to –53/-50 feet) the Outer Entrance Channel, deepening the Inner Entrance Channel and Main Turning Basin to –50 feet, widening and deepening (to –47 feet) the Southport Access Channel, widening and deepening (to –32 feet) the Dania Cutoff Canal, constructing a Turning Basin at the intersection of the Dania Cutoff Canal and the Southport Access Channel at –32 feet, deepening a portion of the South Turning Basin to –44 feet, and widening and deepening (to –47 feet) the Turning Notch. Other significant construction items include relocation of the U.S. Coast Guard (USCG) Basin easterly within essentially USCG property, port facility construction, and environmental mitigation.

Enclosed please find the Corps' biological assessment of the effects of the proposed project on listed species and marine mammals in the action area and a copy of the draft Environmental Impact Statement prepared for this proposed project.

We request initiation of consultation under section 7 of the Endangered Species Act concerning the effects of the proposed activities on the smalltooth sawfish, green, hawksbill, Kemp's ridley and loggerhead sea turtles and Johnson's seagrass. We also request an initiation of

consultation under the Marine Mammal Protection Act of 1972 concerning effects of the proposed activities on marine mammals within the action area.

If you have any questions, please contact Ms. Terri Jordan at 904-899-5195 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Jordan/CESAJ-PD-EA/3453/
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Scarborough/CESAJ-DP-C
Strain/CESAJ-PD-P
Duck/CESAJ-PD

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BIOLOGICAL ASSESSMENT
PORT EVERGLADES NAVIGATION PROJECT
BROWARD COUNTY, FLORIDA

Description of the Proposed Action

The U.S. Army Corps of Engineers (Corps) proposes to expand and deepen Port Everglades Harbor. A detailed description of the proposed project and all alternatives considered under the Feasibility Study are evaluated in the pending Draft Environmental Impact Statement. Broward County Port Department requested that the Corps study the feasibility of widening and deepening most of the major channels and basins within Port Everglades. Four major improvement goals were identified. 1) Improve transit in the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and Southport Access Channel (SAC) to accommodate liquid bulk, cruise, and container vessels; 2) Develop the Dania Cutoff Canal (DCC) to accommodate mid-size vessels; 3) Deepen the North Turning Basin to accommodate Panamax size container ships; and 4) Improve turning and berthing in the Turning Notch.

The purpose of the proposed action is to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment. The proposed action resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the port. This economic analysis has shown that improvements to most of the major Federal and non-Federal channels and basins are required to achieve efficient transit of the existing fleet, and to accommodate the future fleet. Substantial liquid bulk cargo cost savings can be achieved by deepening the OEC, IEC, and MTB. Widening of the OEC flare will allow safer transit for all the larger commercial vessels that experience sometimes troublesome cross currents at the channel entrance. Removal of the Widener Shoal and widening of the SAC allows for more efficient and safer transits of containerized cargo vessels past the Knuckles restriction where new generation cruise vessels are expected to be berthed. Lengthening and deepening of the TN will provide turning possibilities for larger vessels and will provide critical berthing for containerized cargo vessels. Deepening of the STB will allow for more efficient use Berths 16-18 by allowing Panamax vessel calls. Finally, widening and deepening of the DCC (in addition to a turning basin located adjacent to the SAC) will allow for relocation of smaller and midsize container, roll on/roll off (ro/ro) vessels, and general cargo traffic, thereby reducing congestion in the areas serviced by larger vessels.

The Corps expects the construction to be performed using a variety of methods including blasting and dredging with a cutterhead, clamshell, hopper or other type of dredge. Any blasting that will occur within the project will be confined blasting. Confined blasting is defined as a blast where the explosives had been placed in a hole bored into the rock substrate and capped with 3-4 feet of crushed rock known as “stemming”. Stemming forces the explosive blast downward into the rock instead of allowing the blast to expand into the water column.

Action Area

The Port Everglades Harbor is a major seaport located on the southeast coast of Florida, approximately 27 nautical miles (nm) north of Miami Harbor. The Harbor lies adjacent to cities of Dania and Fort Lauderdale (Broward County), with immediate access to the Atlantic Ocean and the Intracoastal Waterway. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. **Figure 1** shows major features located within and surrounding the project site.

Protected Species Included in this Assessment

Of the listed and protected species under NMFS jurisdiction occurring in the action area, the Corps believes that the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), smalltooth sawfish (*Pristis pectinata*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), Johnson's seagrass (*Halophila johnsonii*) may be adversely affected by the implementation of the Navigation Project.

Additional endangered species that are known to occur along the Atlantic coast include the finback (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), and sperm (*Physeter macrocephalus*) whales, and the leatherback sea turtle (*Dermochelys coriacea*). The Corps has determined that these species are unlikely to be adversely affected by the proposed construction activities.

The endangered Florida manatee (*Trichecus manatus*) also occurs with the action area and the Corps has initiated consultation with the U.S. Fish and Wildlife Service concerning the effects of the proposed action on that species.

Status and Distribution of the Species

Green Turtle

Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean, but are considered rare north of Cape Hatteras (Wynne and Schwartz, 1999). Several major nesting assemblages have been identified and studied in the western Atlantic (Peters 1954; Carr and Ogren, 1960; Carr *et al.*, 1978). Most green turtle nesting in the continental United States occurs on the Atlantic Coast of Florida (Ehrhart 1979). Green turtles are the largest of the hard-shelled sea turtles. Adult male green turtles are smaller than adult females whose lengths range from 92 to 110 cm (36 to 43 in.) and weights range from 119 to 182 kg (200 to 300 lbs). Their heads are small compared to other sea turtles and the biting edge of their lower jaws is serrated.

Green turtles have a more tropical distribution than loggerhead turtles; they are generally found in waters between the northern and southern 20°C isotherms (Hirth 1971). Green turtles, like most other sea turtles, are distributed more widely in the summer when warmer water temperatures allow them to migrate north along the Atlantic coast of North America. In the summer, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and continental North America from Texas to Massachusetts. Immature greens can be distributed in estuarine and coastal waters from Long Island Sound, Chesapeake Bay, and the North Carolina sounds south throughout the tropics (Musick and Limpus, 1997). In the United States, green turtles nest primarily along the Atlantic Coast of Florida, the U.S. Virgin Islands, and Puerto Rico. In the winter, as water temperatures decline, green turtles that are found north of Florida begin to

migrate south into subtropical and tropical water.

The green turtle was protected under the ESA in 1978; breeding populations off the coast of Florida and the Pacific coast of Mexico are listed as endangered, all other populations are listed as threatened. The greatest threat to this species is the loss of its nesting habitat. Throughout the tropical and subtropical distribution of this species, beaches are eroded, armored, renourished, or converted for residential or commercial purposes. Green turtles are also threatened by fibropapilloma disease; incidental takes in commercial or recreational fishing gear; and poaching (although poaching is infrequent in the United States). Green turtles are harvested in some nations for food, leather, and jewelry. Green turtles are also threatened by natural causes including hurricanes and predation by exotic species (fire ants, raccoons (*Procyon lotor*) and opossums (*Didelphus virginiana*)) and by poaching of eggs and nesting females.

There is evidence that green turtle nesting has been on the increase during the past decade. Recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Certain Florida nesting beaches where most green turtle nesting activity occurs have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989. Recent population estimates for the western Atlantic area are not available.

While nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging grounds. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida, the northwestern coast of the Yucatan Peninsula, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Post-pelagic green turtles feed primarily on sea grasses and benthic algae but also consume jellyfish, salps, and sponges. In the western Atlantic region, the summer developmental habitat encompasses estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds, and south throughout the tropics (Musick and Limpus, 1997). Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to southern waters in autumn, or face the risk of cold stunning.

General human impacts and entanglement

Anthropogenic impacts to the green sea turtle population are similar to those discussed above for other sea turtles species. Sea sampling coverage in the pelagic driftnet, pelagic longline, scallop dredge, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. In addition, the NMFS/Northeast Fisheries Science Center (NEFSC) is conducting a review of bycatch levels and patterns in all fisheries in the western Atlantic for

which observer data is available. Bycatch estimates will be made for all fisheries for which sample sizes are sufficiently large to permit reasonable statistical analysis. This will be compiled into an assessment report. Until that analysis is completed, the only information on the magnitude of takes available for fisheries in the action area are unextrapolated numbers of observed takes from the sea sampling data. Preliminary sea sampling data summary (1994-1998) shows the following total take of green turtles: one (anchored gillnet), two (pelagic driftnet), and two (pelagic longline). Stranding reports indicate that between 200-300 green turtles strand annually from a variety of causes (Sea Turtle Stranding and Salvage Network, unpublished data). As with the other species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality.

In 1998, NMFS designated the waters surrounding the islands of Culebra, Puerto Rico as critical habitat for the green turtle. This area supports major seagrass beds and reefs that provide forage and shelter habitat.

Loggerhead Turtle

The loggerhead sea turtle was listed as threatened under the ESA on July 28, 1978. Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, but generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (NRC 1990). The largest known nesting aggregation of loggerhead sea turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani, 1982). In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida. The best scientific and commercial data available on the genetics of loggerhead sea turtles suggests there are four major subpopulations of loggerhead sea turtles in the northwest Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); and (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990)(approximately 1,000 nests in 1998)(TEWG 2000). This biological opinion will focus on the northwest Atlantic subpopulations of loggerhead sea turtles, which occur in the action area.

Although NMFS and FWS have not completed the administrative processes necessary to formally recognize populations or subpopulations of loggerhead sea turtles, these sea turtles are generally grouped by nesting locations. Based on the most recent reviews of the best scientific and commercial data on the population genetics of loggerhead sea turtles and analyses of their population trends (TEWG, 1998; TEWG 2000), NMFS and FWS treat these loggerhead turtle nesting aggregations as distinct subpopulations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological

opinion will focus on the four nesting aggregations of loggerhead sea turtles identified in the preceding paragraph (which occur in the action area) and treat them as subpopulations for the purposes of this analysis. Natal homing to the nesting beach provides the genetic barrier between these subpopulations, preventing recolonization from turtles from other nesting beaches. The importance of maintaining these subpopulations in the wild is shown by the many examples of extirpated nesting assemblages in the world. In addition, recent fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco *et al.* 2000) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but generally are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal *et al.* 1983 : *in* NMFS SEFSC 2001).

The loggerhead sea turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern nesting subpopulation produces about 9% of the loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia: between 25 and 59 percent of the loggerhead sea turtles in this area are from the northern subpopulation (NMFS SEFSC 2001; Bass *et al*., 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears 1994, Sears *et al.,* 1995). In the Carolinas, the northern subpopulation is estimated to make up from 25% to 28% of the loggerheads (NMFS SEFSC 2001; Bass *et al.* 1998, 1999). About ten percent of the loggerhead sea turtles in foraging areas off the Atlantic coast of central Florida are from the northern subpopulation (Witzell *et al*., in prep). In the Gulf of Mexico, most of the loggerhead sea turtles in foraging areas will be from the South Florida subpopulation, although the northern subpopulation may represent about 10% of the loggerhead sea turtles in the Gulf (Bass pers. comm). In the Mediterranean Sea, about 45 - 47 percent of the pelagic loggerheads are from the South Florida subpopulation and about two percent are from the northern subpopulation, while only about 51% originated from Mediterranean nesting beaches (Laurent *et al.*, 1998). In the vicinity of the Azores and Madiera Archipelagoes, about 19% of the pelagic loggerheads are from the northern subpopulation, about 71% are from the South Florida subpopulation, and about 11% are from the Yucatán subpopulation (Bolten *et al*., 1998).

Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years. Turtles in this life history stage are called "pelagic immatures" and are best known from the eastern Atlantic near the Azores and Madeira and have been reported from the Mediterranean as well as the eastern Caribbean (Bjorndal *et al*., in press). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm SCL they recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immatures have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico (R. Márquez-M., pers. comm.). Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder *et al.*, 1998) along the south and western coasts of Florida as compared with the rest of the coast, but it is not known whether the larger animals actually are more abundant in these areas or just more abundant within the area relative to the smaller turtles.

Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly *et al.,* 1995; Keinath, 1993; Morreale and Standora, 1999; Shoop and Kenney, 1992), and migrate northward in spring. Given an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer and Limpus, 1998), the benthic immature stage must be at least 10-25 years long. NMFS SEFSC 2001 analyses conclude that juvenile stages have the highest elasticity and maintaining or decreasing current sources of mortality in those stages will have the greatest impact on maintaining or increasing population growth rates.

Although loggerhead sea turtles are most vulnerable to pelagic longlines during their pelagic, immature life history stage, there is some evidence that benthic immatures may also be captured, injured, or killed by pelagic fisheries. Recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic immatures, followed by permanent settlement into benthic environments. Some may not totally circumnavigate the North Atlantic. In addition, some of these turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or they may move back and forth between pelagic and coastal habitats (Witzell in prep.). Any loggerhead sea turtles that follow this developmental model would be adversely affected by shark gill nets and shark bottom longlines set in coastal waters, in addition to pelagic longlines.

Adult loggerhead sea turtles have been reported throughout the range of this species in the U.S. and throughout the Caribbean Sea. As discussed in the beginning of this section, they nest primarily from North Carolina southward to Florida with additional nesting assemblages in the Florida Panhandle and on the Yucatán Peninsula. Non-nesting, adult female loggerheads are reported throughout the U.S. and Caribbean Sea; however, little is known about the distribution of adult males who are seasonally abundant near nesting beaches during the nesting season. Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Based on the data available, it is not possible to estimate the size of the loggerhead sea turtle population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989-1998 represent the best dataset available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates. Given this, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,016-89,034 annually, representing, on average, an adult female population of 44,780 [(nests/4.1) * 2.5]. On average, 90.7% of the nests were from the South Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle subpopulation. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to what subpopulation they belong. Based on the above, there are only an estimated 3,800 nesting females in the northern loggerhead subpopulation. The status of this population, based on number of loggerhead nests, has been classified as stable or declining

(TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate, using genetics data from Texas, South Carolina, and North Carolina in combination with juvenile sex ratios from those states, that the northern subpopulation produces 65% males, while the Florida subpopulation is estimated to produce 80% females (NMFS SEFSC 2001, Part I).

From a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of this species: it is second in size only to the nesting aggregations in the Arabian Sea off Oman and represents about 35 and 40 percent of the nests of this species. The status of the Oman nesting beaches has not been evaluated recently, but they are located in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), the resulting risk facing this nesting aggregation and these nesting beaches is cause for considerable concern (Meylan *et al*., 1995).

Like other sea turtles, the movements of loggerheads are influenced by water temperature. Since they are limited by water temperatures, sea turtles do not usually appear on the summer foraging grounds until June, but are found in Virginia as early as April. The large majority leaves the Gulf of Maine by mid-September but may remain in these areas until as late as November and December. Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz, 1999). Under certain conditions they may also scavenge fish, particularly if they are easy to catch (e.g., caught in nets) (NMFS and USFWS, 1991).

General Human-related Impacts

Loggerhead sea turtles face a number of threats in the marine environment, including oil and gas exploration, development, and transportation; marine pollution; trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries; underwater explosions; dredging, offshore artificial lighting; power plant entrapment; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching. On their nesting beaches in the U.S., loggerhead sea turtles are threatened with beach erosion, armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; predation by exotic species such as fire ants, raccoons (*Procyon lotor*), armadillos (*Dasypus novemcinctus*), opossums (*Didelphus virginiana*); and poaching.

Loggerhead sea turtles also face numerous threats from natural causes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and loggerhead sea turtle nesting season (March to November); hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton *et al*., 1992). On Fisher Island near Miami, Florida, 69 % of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern subpopulation were destroyed by hurricanes, which made landfall in North Carolina in the mid to late 1990's. Sand accretion and rainfall that result from these storms can appreciably reduce hatchling success. These natural phenomena probably have significant, adverse effects

on the size of specific year classes; particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

Status and Trend of Loggerhead Sea Turtles

The most recent work updating what is known regarding status and trends of loggerhead sea turtles is contained in NMFS SEFSC 2001. The recovery plan for this species (NMFS and USFWS 1991) state that southeastern U.S. loggerheads can be considered for delisting if, over a period of 25 years, adult female populations in Florida are increasing and there is a return to pre-listing annual nest numbers totaling 12,800 for North Carolina, South Carolina, and Georgia combined. This equates to approximately 3,100 nesting females per year at 4.1 nests per female per season. NMFS SEFSC 2001 concludes, "…nesting trends indicate that the numbers of females associated with the South Florida subpopulation are increasing. Likewise, nesting trend analyses indicate potentially increasing nest numbers in the northern subpopulation" (TEWG 2000). However, NMFS SEFSC 2001 also cautions that given the uncertainties in survival rates (of the different life stages, particularly the pelagic immature stage), and the stochastic nature of populations, population trajectories should not be used now to quantitatively assess when the northern subpopulation may achieve 3,100 nesting females.

Several published reports have presented the problems facing long-lived species that delay sexual maturity in a world replete with threats from a modern, human population (Crouse *et al.,* 1987, Crowder *et al.,* 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high, annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general rule applies to sea turtles, particularly loggerhead sea turtles, because the rule originated in studies of sea turtles (Crouse *et al.,* 1987, Crowder *et al.,* 1994, Crouse 1999). Heppell *et al.* (in prep.) specifically showed that the growth of the loggerhead sea turtle population was particularly sensitive to changes in the annual survival of both juvenile and adult sea turtles and that the adverse effects of the pelagic longline fishery on loggerheads from the pelagic immature phase appeared critical to the survival and recovery of the species. Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles would adversely affect large segments of the total loggerhead sea turtle population.

The four major subpopulations of loggerhead sea turtles in the northwest Atlantic, northern, south Florida, Florida panhandle, and Yucatán are all subject to fluctuations in the number of young produced annually because of natural phenomena like hurricanes as well as human-related activities. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merrit Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection and probably cause fluctuations in sea turtle nesting success. Sea turtles nesting in the southern and central counties of Florida can be affected by beach armoring, beach renourishment, beach cleaning, artificial lighting, predation, and poaching (NMFS & FWS 1991).

As discussed previously, the survival of juvenile loggerhead sea turtles is threatened by a completely different set of threats from human activity once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North

Atlantic over several years (Carr 1987, Bjorndal 1994). During that period, they are exposed to a series of long-line fisheries that include an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar *et al*., 1995, Bolten *et al.,* 1994, Crouse 1999). Based on their proportional distribution, the capture of immature loggerhead sea turtles in long-line fleets in the Azores and Madiera Archipelagoes and the Mediterranean Sea will have a significant, adverse effect on the annual survival rates of juvenile loggerhead sea turtles from the western Atlantic subpopulations, with a disproportionately large effect on the northern subpopulation that may be significant at the population level.

In waters off coastal U.S., a suite of fisheries in Federal and State waters threatens the survival of juvenile loggerhead sea turtles. Loggerhead turtles are captured, injured, or killed in shrimp fisheries off the Atlantic coast; along the southeastern Atlantic coast, loggerhead turtle populations are declining where shrimp fishing is intense off the nesting beaches (NRC 1990). Conversely these nesting populations do not appear to be declining where nearshore shrimping effort is low or absent. The management of shrimp harvest in the Gulf of Mexico demonstrates the correlation between shrimp trawling and impacts to sea turtles. Waters out to 200nm are closed to shrimp fishing off of Texas each year for approximately a three-month period (mid-May through mid-July) to allow shrimp to migrate out of estuarine waters; sea turtle strandings decline dramatically during this period (NMFS, STSSN unpublished data). Loggerhead sea turtles are captured in fixed pound-net gear in the Long Island Sound, in pound-net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, in gill net fisheries in the mid-Atlantic and elsewhere, in fisheries for monkfish and for spiny dogfish, and in northeast sink gillnet fisheries (see further discussion in the *Environmental Baseline* of this Opinion). Witzell (1999) compiled data on capture rates of loggerhead and leatherback turtles in U.S. longline fisheries in the Caribbean and northwest Atlantic; the cumulative takes of these fisheries approach those of the U.S. shrimp fishing fleet (Crouse 1999, NRC 1990).

Hawksbill Turtle

Hawksbill turtles are small to medium-sized sea turtles. They are distinguished from other sea turtles by two pairs of prefrontal scales; thick carapace scutes that overlap towards the turtle's posterior, four pairs of costal scutes; and two claws on each flipper. There are two recognized subspecies of hawksbill sea turtles, one in the Atlantic Ocean (ssp. *imbricata*) and one in the Pacific Ocean (ssp. *squamata*).

Hawksbill turtles use different habitats for different stages in their life cycles. Post-hatchling hawksbill turtles remain in pelagic environments to take shelter in weedlines that accumulate at convergence points. Juvenile hawksbill turtles (those with carapace lengths of 20-25 cm) re-enter coastal waters where they become residents of coral reefs, which provide sponges for food and ledges, and caves for shelter. Hawksbill turtles are also found around rocky outcrops, high-energy shoals, and mangrove-fringed bays and estuaries (particularly in areas where coral reefs do not occur). Hawksbill turtles remain in coastal waters when they become subadults and adults.

Hawksbill turtles occur in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. In the United States, hawksbill sea turtles have been recorded in all states along the Gulf

of Mexico and along the Atlantic coast to Massachusetts. In the United States, hawksbill turtles nest on the Atlantic coast of Florida, the U.S. Virgin Islands, and Puerto Rico. Hawksbill turtles nests in Florida are relatively rare, but Richardson *et al*. (1989) estimated that the Caribbean and Atlantic portions of the U.S. support a minimum of 650 hawksbill turtle nests each year

The hawksbill turtle was listed as an endangered species on June 2, 1970 (35 FR 8491). The hawksbill turtle has been endangered by significant modifications of its coastal habitat throughout its range. The National Research Council (1990), and NMFS/FWS (1993) have published general overviews of the effects of habitat alteration on hawksbill turtles. In the U.S. Virgin Islands, problems such as egg poaching, domestic animals, beach driving, litter, and recreational use of beaches have presented problems for nesting hawksbill turtles. In addition, beachfront lights appear to pose a serious problem for hatchling hawksbill (and other) turtles in the U.S. Virgin Islands. At sea, activities that damage coral reefs and other habitats that are important to the hawksbill turtle threaten the continued existence of this species. Hawksbill turtles are also threatened by natural causes including hurricanes and predation by exotic species (fire ants, raccoons (*Procyon lotor*) and opossums (*Didelphus virginiana*)) and by poaching of eggs and nesting females.

In 1998, NMFS designated the waters surrounding Mona and Monito Islands, Puerto Rico as critical habitat for the hawksbill turtle.

Kemp's Ridley Sea Turtle

Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. The Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempi*) (USFWS and NMFS 1992) contains a description of the natural history, taxonomy, and distribution of the Kemp's ridley turtle. Kemp's ridleys nest in daytime aggregations known as arribadas. The primarily arribada in the Gulf of Mexico is located at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970's, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and there is cautious optimism that the population is now increasing.

Research being conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of these turtles were tracked (using satellite and radio telemetry) by biologists with the NMFS Galveston Laboratory. The tracking study was designed to characterize sea turtle habitat and to identify small and large-scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

After unprecedented numbers of Kemp's ridley carcasses were reported from Texas and Louisiana beaches during periods of high levels of shrimping effort, NMFS established a team of

population biologists, sea turtle scientists, and managers, known as the Turtle Expert Working Group (TEWG) to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in some years have increased at rates higher than the rate of increase in the Kemp's population (TEWG 1998). While many of the stranded turtles observed in recent years in Texas and Louisiana are believed to have been incidentally taken in the shrimp fishery, other sources of mortality exist in these waters. These stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters.

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service (FWS) and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of turtle excluder devices (TEDs). Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1,940 nests in 1995 and about 3,400 nests in 1999.

The TEWG (1998) was unable to estimate the total population size and current mortality rates for the Kemp's ridley population. However, the TEWG listed a number of preliminary conclusions. The TEWG indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of TEDs. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This trajectory of adult abundance tracks with trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The TEWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The population model in the TEWG projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. It determined that the data reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the

Atlantic.

The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular internesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

The area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. The TEWG (1998) assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Post-pelagic ridleys feed primarily on crabs, consuming a variety of species, including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal, 1997). Juvenile ridleys migrate south as water temperatures cool in fall, and are predominantly found in shallow coastal embayments along the Gulf Coast during fall and winter months.

Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 centimeters in carapace length, and weighing less than 20 kilograms (Klinger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June, and migrating to more southerly waters from September to November (Keinath *et al.*, 1987; Musick and Limpus, 1997). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick, 1985; Bellmund *et al.*, 1987; Keinath *et al.*, 1987; Musick and Limpus, 1997). The juvenile population in Chesapeake Bay is estimated to be 211 to 1,083 turtles (Musick and Limpus, 1997).

General human impacts and entanglement

Anthropogenic impacts to the Kemp's ridley population are similar to those discussed above. Sea sampling coverage in the northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. As with loggerheads, a large number of Kemp's ridleys are taken in the southeast shrimp fishery each year. Kemp's ridleys were also affected by the apparent large-mesh gillnet interaction that occurred in spring off of North Carolina. A total of five carcasses were recovered from the same North Carolina beaches where 277 loggerhead carcasses were found. This is expected to be a

minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all carcasses washed ashore.
Johnson's seagrass

Smalltooth Sawfish
All modern sawfish belong to the Suborder Pristoidea, Family Pristidae, and Genus *Pristis*. Although they are rays, sawfish appear to be more shark-like than ray-like, with only the trunk and especially the head ventrally flattened. The snout of all sawfish is extended as a long narrow flattened rostral blade with a series of transverse teeth along either edge, hence the vernacular name. Species in the genus *Pristis* are separable into two groups according to whether the caudal fin has a distinct lower lobe or not. The smalltooth sawfish, *Pristis pectinata*, is the sole known representative on the western side of the Atlantic of the group lacking a defined lower caudal lobe (NMFS, 2000).

Distribution
The smalltooth sawfish has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish (west and south of Port Arthur, TX) (Adams and Wilson, 1995). It also was an occasional visitor to waters as far north as New York. As with all sawfishes, it is euryhaline, occurring in fresh water, nearshore estuaries and in coastal waters to depths of 25 meters.

Pristis pectinata is the largest of the sawfishes, reported to reach 760 cm while more commonly growing to 550 cm (Last and Stevens 1994). Bigelow and Schroeder (1953) reported litter size of 15-20 embryos. Overall, life history parameters for this species are largely unknown.

In the United States, smalltooth sawfish are generally a shallow water fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. Records indicate that smalltooth sawfish have been found in the lower reaches of the St. Johns River and the Indian River lagoonal system. Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months.

Updated collection records from the Florida Museum of Natural History of the University of Florida include 13 records of *P. pectinata* from 1912 to 1998 (with one record not dated). Nine of these specimens were recorded from the Gulf of Mexico off Florida, three came from the Atlantic side of Florida, and one animal was caught in Pacific waters off Ecuador. Three additional records of smalltooth sawfish from the Atlantic coast of Florida have yet to be cataloged in this collection: one specimen is from 1979; the second is not dated (the Museum received both these fish from the Harbor Branch Oceanographic Institute); a third specimen was landed May 22, 1998 from the Indian River (Burgess, pers. comm.). There are eight reports of smalltooth sawfish along the Florida east coast in the 1990's, most from coastal rather than lagoonal areas.

General Human-related impacts
The principal habitats for smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving upriver in freshwater (Bigelow and Schroeder,

1953). The continued urbanization of the southeastern coastal states has resulted in substantial loss of coastal habitat through such activities as agricultural and urban development; commercial activities; dredge and fill operations; boating; erosion and diversions of freshwater run-off (SAFMC, 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity to shallow, estuarine systems. With the K-selected life history strategy of smalltooth sawfish, including slow growth, late maturation, and low fecundity, long-term commitments to habitat protection are necessary for the eventual recovery of the species.

A complete review of the factors contributing to the decline of the smalltooth sawfish can be found in the "Status Review of Smalltooth Sawfish (*Pristis pectinata*)", (NMFS, 2000) and will not be repeated in detail here.

Status and Trends of smalltooth sawfish

The smalltooth sawfish was added to the list of species as candidates under the ESA in 1991, removed in 1997, and placed back on the list again in 1999. In November 1999, NMFS received a petition from the Center of Marine Conservation requesting that this species be listed as endangered under the ESA. NMFS completed a status review for smalltooth sawfish in December 2000, and published a proposed rule to list this the U.S. population of this species as endangered under the ESA on April 16, 2001. On April 1, 2003, the National Marine Fisheries Service (NOAA Fisheries) announced its final determination to list smalltooth sawfish as an endangered species under the Endangered Species Act (ESA).

According to NMFS (2000) "The U.S. DPS of smalltooth sawfish has experienced a ninety percent curtailment of its range and severe declines in abundance. Agriculture, urban development, commercial activities, channel dredging, boating activities, and the diversion of freshwater run-off have resulted in the destruction and modification of smalltooth habitat throughout the southeastern U.S. Although habitat degradation is not likely the primary reason for the decline of smalltooth sawfish abundance and their contracted distribution, it has likely been a contributing factor. Over 50% of the U.S. human population lives within fifty miles of the ocean or Great Lakes. Migration to the coastlines for home, livelihood or recreation is predicted to increase by the year 2010 (National Ocean Service, 2000). Increases in coastal human populations will likely result in additional losses of marine habitats and increased pollution, further threatening the survival of smalltooth sawfish."

Simpfendorfer (2000) used a demographic approach to estimate intrinsic rate of natural increase and population doubling time. Since there are very limited life history data for smalltooth sawfish, much of the data (e.g. reproductive periodicity, longevity and age-at-maturity) were inferred from the more well-known largetooth sawfish. The litter size of smalltooth sawfish in the literature is given as 15 – 20 and Simpfendorfer used a mean of 17.5. However, the data on which this litter size is based are somewhat dubious. To account for uncertainty in the life-history parameters several different scenarios were tested, covering longevities from 30 to 70 years and ages-at-maturity from 10 to 27 years. The results indicated that the intrinsic rate of population increase ranged from 0.08/year to 0.13/ year, and population-doubling times ranged from 5.4 years to 8.5 years. These models assume the literature value for litter size is correct; doubling times would be longer if litter sizes are more in the range observed for largetooth sawfish (1 to 13, with a mean of 7.3). Simpfendorfer concluded:

The estimated population doubling times for smalltooth sawfish indicate that the recovery times for this population will be very long. There are no data available on the size of the remaining populations, but anecdotal information indicates that smalltooth sawfish survive today in small fragmented areas where the impact of humans, particularly from net fishing, has been less severe. Fragmenting of the population will increase the time that it takes for recovery since the demographic models used in the study above assume a single inter-breeding population. The genetic effects of recovery from very small population sizes may also impact conservation efforts. It is likely that even if an effective conservation plan can be introduced in the near future, recovery to a level where the risk of extinction is low will take decades, while recovery to pre-European settlement levels would probably take several centuries.

Johnson's Seagrass

Species Description

Johnson's seagrass was listed as threatened under the ESA on September 14, 1998 based on the results of fieldwork and a status review initiated in 1990 and is the first marine plant ever listed. Kenworthy (1993, 1997, 1999) discusses the results of the field studies and summarizes an extensive literature review and associated interviews regarding the status of Johnson's seagrass.

The species has only been found growing along approximately 200 km of coastline in southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world.

Johnson's seagrass occurs in dynamic and disjunct patches throughout its range. Growth appears to be rapid and leaf pairs have short life spans while horizontally spreading from dense apical meristems (Kenworthy 1997). Kenworthy suggested that horizontal spreading rapid growth pattern and a high biomass turnover could explain the dynamic patches observed in distribution studies. New information reviewed in Kenworthy (1999, 1997) confirms *H. johnsonii's* limited geographic distribution in patchy and vertically disjunct areas between Sebastian Inlet and northern Biscayne Bay. Surveys conducted by NMFS and Florida staff in Biscayne Bay, Florida Bay, the Florida Keys, outer Florida Bay, Puerto Rico, and the Virgin Islands provided no verifiable sightings of Johnson's seagrass outside of the range already reported.

<u>Extent of critical habitat:</u>

The northern and southern ranges of Johnson's seagrass are defined as Sebastian Inlet and central Biscayne Bay, respectively. These limits to the species' range have been designated as critical habitat for Johnson's seagrass. Within its range, Johnson's seagrass critical habitat designations have been designated for 10 areas: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. There is no designated critical habitat within the action area.

Life History

Reproductive strategy

The species is perennial and may spread even during winter months under favorable conditions (Virnstein *et al.* 1997). Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found; however, dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds either in the field or under laboratory conditions (Jewett-Smith *et al.* 1997). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting that the species does not reproduce sexually or that the male flowers are difficult to observer or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean, suggesting that inlet conditions are qualitatively better for flowering than conditions further inshore (Kenworthy pers. comm. 1998). It is possible that male flowers, if they exist, occur near inlets as well. Maintenance of good water quality around inlets may be essential for promoting flowering in the Johnson's seagrass population.

Niche

The essential features of habitat appear to be adequate water quality, salinity, water clarity and stable sediments free from physical disturbance. Important habitat characteristics include shallow intertidal as well as deeper subtidal zones (2-5 m). Water transparency appears to be critical for Johnson's seagrass, limiting its distribution at depth to areas of suitable optical water quality (Kenworthy 1997). In areas in which long-term poor water and sediment quality have existed until recently, such as Lake Worth Lagoon, *H. johnsonii* appears to occur in relatively higher abundance perhaps due to the previous inability of the larger species to thrive. These studies support unconfirmed previous observations that suspended solids and tannin, which reduce light penetration and water clarity, may be important factors limiting seagrass distribution. Good water clarity is essential for *Halophila johnsonii* growth in deeper waters.

Johnson's seagrass occurs over varied depths, environmental conditions, salinities, and water quality. In tidal channels *H. johnsonii* is found in coarse sand substrates, although it has been found growing on sandy shoals, in soft mud near canals and rivers where salinity many fluctuate widely (Virnstein *et al.* 1997). Virnstein has called Johnson's seagrass a "perennial opportunistic species." Within his study areas in the Indian River Lagoon, *H. johnsonii* was found by itself, with other seagrass species, in the intertidal, and (more commonly) at the deep edge of some transects in water depths of up to 180 cm. *H. johnsonii* was found shallowly rooted on sandy shoals, in soft mud, near the mouths of canals, rivers and in shallow and deep water (Virnstein *et al.* 1997). Additionally, recent studies have documented large patches of Johnson's seagrass on flood deltas just inside Sebastian Inlet, as well as far from the influence of inlets (reported at the workshop discussed in Kenworthy, 1997). These sites encompass a wide variety of salinities, water quality, and substrates.

Competitors:

Halophila johnsonii appears to be outcompeted in ideal seagrass habitats where environmental conditions permit the larger species to thrive (Virnstein *et al.* 1997, Kenworthy 1997).

Population Dynamics

Population stability

A factor leading to the listing of *H. johnsonii* is its rareness within its extremely restricted geographic range. Johnson's seagrass is characterized by small size (it is the smallest of all of the seagrasses found within its range, averaging about 3 cm in height), fragile rhizome structure and associated high turnover rate, and is apparently reliant on vegetative means to reproduce, grow and migrate across the sea bottom. These factors make Johnson's seagrass extremely vulnerable to human or environmental impacts by reducing its capacity to repopulate an area once removed. The species and its habitat are impacted by human-related activities throughout the length its range, including bridge construction and dredging, and the species' threatened status produces new and unique challenges for the management of shallow submerged lands. Vessel traffic resulting in propeller and anchor damage, maintenance dredging, dock and marine construction, water pollution, and land use practices could require special management within critical habitat.

Population (genetic) variability:

The Boca Raton and Boynton Beach sites proposed for critical habitat designation have populations that are distinguished by a higher index of genetic variation than any of the central and northern populations examined to date (Kenworthy, 1999). These two sites represent a genetically semi-isolated group that could be the reservoir of a large part of the overall genetic variation found in the species. Information is still lacking on the geographic extent of this genetic variability.

Status and Distribution

Kenworthy (1997, 1999) summarized the newest information on Johnson's seagrass biology, distribution, and abundance and confirmed the limited range and rareness of this species within its range. Additionally, the apparent restriction of propagation through vegetative means suggests that colonization between broadly disjunct areas is likely difficult, suggesting that the species is vulnerable to becoming endangered if it is removed from large areas within its range by natural or anthropogenic means. Human impacts to Johnson's seagrass and its habitat include: (1) Vessel traffic and the resulting propeller dredging and anchor mooring; (2) dredging; (3) dock and marina construction and shading from these structures; (4) water pollution; and (5) land use practices including shoreline development, agriculture, and aquaculture.

Activities associated with recreational boat traffic account for the majority of human use associated with the proposed critical habitat areas. The destruction of the benthic community due to boating activities, propeller dredging, anchor mooring, and dock and marina construction was observed at all sites during a study by NMFS from 1990 to 1992. These activities severely disrupt the benthic habitat, breaching root systems, severing rhizomes, and significantly reducing the viability of the seagrass community. Propeller dredging and anchor mooring in shallow areas are a major disturbance to even the most robust seagrasses. This destruction is expected to worsen with the predicted increase in boating activity. Trampling of seagrass beds, a secondary effect of recreational boating, also disturbs seagrass habitat. Populations of Johnson's seagrass inhabiting shallow water and water close to inlets, where vessel traffic is concentrated, will be most affected.

The constant sedimentation patterns in and around inlets require frequent maintenance dredging, which could either directly remove essential seagrass habitat or indirectly affect it by redistributing sediments, burying plants and destabilizing the bottom structure. Altering benthic topography or burying the plants may remove them from the photic zone. Permitted dredging of channels, basins, and other in- and on-water construction projects cause loss of Johnson's seagrass and its habitat through direct removal of the plant, fragmentation of habitat, and shading. Docking facilities that, upon meeting certain provisions, are exempt from state permitting also contribute to loss of Johnson's seagrass through construction impacts and shading. Fixed add-ons to exempt docks (such as finger piers, floating docks, or boat lifts) have recently been documented as an additional source of seagrass loss due to shading (Smith and Mezich, 1999).

Decreased water transparency caused by suspended sediments, water color, and chlorophylls could have significant detrimental effects on the distribution and abundance of the deeper water populations of Johnson's seagrass. A distribution survey in Hobe and Jupiter Sounds indicates that the abundance of this seagrass diminishes in the more turbid interior portion of the lagoon where reduced light limits photosynthesis.

Other areas of concern include seagrass beds located in proximity to rivers and canal mouths where low salinity, highly colored water is discharged. Freshwater discharge into areas adjacent to seagrass beds may provoke physiological stress upon the plants by reducing the salinity levels. Additionally, colored waters released into these areas reduce the amount of sunlight available for photosynthesis by rapidly attenuating shorter wavelengths of Photosynthetically Active Radiation.

Continuing and increasing degradation of water quality due to increased land use and water management threatens the welfare of seagrass communities. Nutrient overenrichment caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural land run-off stimulates increased algal growth that may smother Johnson's seagrass, shade rooted vegetation, and diminish the oxygen content of the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities.

A wide range of activities funded, authorized or carried out by Federal agencies may affect the essential habitat requirements of Johnson's seagrass. These include authorization by the COE for beach nourishment, dredging, and related activities including construction of docks and marinas; bridge construction projects funded by the Federal Highway Administration; actions by the U.S. Environmental Protection Agency and the COE to manage freshwater discharges into waterways; regulation of vessel traffic by the U.S. Coast Guard; management of national refuges and protected species by the U.S. Fish and Wildlife Service; management of vessel traffic (and other activities) by the U.S. Navy; authorization of state coastal zone management plans by NOAA's National Ocean Service, and management of commercial fishing and protected species by NMFS.

<u>Rangewide trend</u>:
Lamentably, there is currently insufficient information to clearly determine trends in the

Johnson's seagrass population, which was described in 1980 and has only been extensively studied during the 1990s. Generally, seagrasses within the range of Johnson's seagrass have declined in some areas and increased in others. Where multiyear mapping studies have been conducted within the Indian River Lagoon, recent increases in Johnson's seagrass have been noted but may be attributed in part to the recent increase in search effort and increased familiarity with this species (Virnstein *et al.* 1997). The authors conclude that from 1994 through 1997, no strong seasonal distribution or increases or decreases in abundance or range can be discerned.

Protected Species Surveys within the project area.

Surveys specifically targeting protected species were not conducted in the action area, however an Environmental Baseline Study and Impact Assessment were prepared. This assessment, literature reviews and consultations with NMFS serve as the basis for this biological assessment and the determination of which listed and protected species under NMFS' jurisdiction are found in the project area.

Sea Turtles

Broward County is within the normal nesting range of three species of sea turtles: the loggerhead (*Caretta caretta*), the green turtle (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*). The green sea turtle and leatherback sea turtle are both listed under the U. S. Endangered Species Act, 1973 and Chapter 370, F.S. The loggerhead turtle is listed as a threatened species (Burney and Margolis, 1999). Within the 38.6 miles of beach from the Palm Beach County line to the Dade County line a total of 2,620 sea turtle nests were found in 1999 (Burney and Margolis 1999). From 1990 through 1999, an average of 2,446 sea turtle nests were discovered on Broward County beaches. Within John U. Lloyd SRA, a total of 212 sea turtle nests were observed during 1999 (DC&A, 2002). The majority of sea turtle nesting activity occurred during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis, 1999). The waters offshore of Broward County are also habitat used for foraging and shelter for the three species listed above and possibly the hawksbill turtle (*Eretmochelys imbricata*), and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE, 2000).

Six (6) stranded threatened and endangered sea turtles have been reported within the Port boundaries: 3 loggerheads, 2 green turtles and 1 hawksbill. In addition there were 13 incidental capture records - 1 green turtle was caught on hook and line and 12 turtles (6 loggerheads, 2 green turtles, 2 hawksbills and 2 unidentified species) were caught in the power plant at Port Everglades (Wendy Teas, pers. Comm. 2002).

Johnson's Seagrass

Johnson's seagrass occurs within the project area, specifically in the Intracoastal Waterway east and south of the Main Turning Basin, and just west of the Dania Cutoff Canal, and in the Dania Cutoff Canal. Abundance and density values are low and the species is generally associated with *H. decipiens*. Johnson's seagrass also occurs south of the Dania Cutoff Canal within Whiskey Creek, along the western shore of the Intracoastal Waterway and within the West Lake Park embayment (Miller Legg, 2001). Cover-abundance and density were higher along the west shore of West Lake Park than was observed within the Port Everglades project area.

Smalltooth sawfish

This species inhabits softbottom estuarine habitats in depths generally less than 30 feet. Its former range in U.S. waters extended from Texas through Maryland. Currently, few are observed outside peninsular Florida. At least one recorded observation has occurred within the vicinity of Broward County (NMFS, 2000). Populations likely decreased due to a low intrinsic rate of natural increase, the long interval to time of reproduction, and human impacts, most notably overfishing, incidental take in nets (due in part to its body size and unusual morphology), and habitat loss (development of shoreline and nearshore habitats).

Effects of the Action on Protected Species.

As previously stated, the Corps believes that the loggerhead turtle, green turtle, smalltooth sawfish and johnson's seagrass have the potential to be effected by the proposed dredging project. The project may have the following adverse impacts on listed/protected species are:

- direct effect of blasting in the turning basin.
- direct effect of dredging activities
- indirect effects

Direct Effects

Blasting

To assess and reduce the effects of blasting on endangered, threatened and otherwise protected species, the Corps contracted with Dr. Calvin Koyna, Precision Blasting Services to review previous Corps blasting projects, recommendations of Florida Fish and Wildlife Conservation Commission (FFWCC) (then known as the Florida Department of Natural Resources) and the U.S. Fish and Wildlife Service (FWS) prepared for a harbor deepening project at Port Everglades, Florida conducted in the mid 1980's. The recommendations prepared for the project were specifically aimed at protecting endangered manatees and endangered/threatened sea turtles.

Sea turtles

Specific information regarding the likely direct impact of explosives on sea turtles is not available. Studies regarding the impacts of relatively minuscule explosives on humans noted that minor injuries such as small bruises or perforations of the intestinal tract occasionally occur well beyond ranges in which human lung damage could occur (Christian and Gaspin, 1974). Christian and Gaspin (1974) note that these minor injuries could become serious if left unattended. Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. In the Environmental Impact Statement prepared by the Navy to consider the effects of explosives used in shipshock tests, nervous system damage was cited as a possible impact to sea turtles caused by blasting. Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtles' shells would indeed afford such protection.

Studies conducted by Klima *et al*., (1988) evaluated blasts of only approximately 42 lbs on sea turtles (4 ridleys, 4 loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small explosive weights, implies that the turtles in the Klima *et al*. (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, 5 of 8 turtles were rendered unconscious at distances of 229 to 915 m from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates.

Blasting will affect nearby finfish and invertebrates and cause short-term changes to the physical characteristics of the benthos. Fish and invertebrates killed or injured by the blasting may provide a short-term enhancement of foraging opportunities for green and loggerhead sea turtles. Through new recruitment and local migrations, finfish and benthic invertebrates are expected eventually to repopulate the affected area. Any modifications of the local area's environment, as far as sea turtle habitat, are not expected to be significant in the long term.

<u>Smalltooth Sawfish</u>
Blasting rock underwater produces a pressure wave in water that can produce fish mortality. Different types of fish have different mortality thresholds. This depends on whether the fish dwell near the surface, on the bottom, or in between.

The magnitude of the pressure wave generated in greatly affected by the stemming of the blastholes, distance between holes, and the delay time of the holes.

Normally, mortality occurs in the range of 150-psi overpressure for fish. In practice this is a 75-foot to 100-foot radius around the blasting area.

Dredging
<u>Sea Turtles</u>
The effects of hopper dredging on sea turtles on the Atlantic coast were analyzed by NMFS in the 1997 biological opinion entitled "The continued hopper dredging of channels and borrow areas in the southeastern United States". If it is determined that a hopper dredge will be used, the Terms and Conditions of this opinion will be applied to the project. If a cutterhead or clamshell dredge is used, based on a finding in the November 25, 1991 biological opinion between NMFS and the Corps that states:

> "Pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely effect sea turtles".

Based on this determination, the Corps finds that use of a cutterhead dredge may effect, but is not likely to adversely affect sea turtles. If a clamshell dredge is used, there is no suction to capture a sea turtle and the turtle would have to be caught between the two halved of the

clamshell. While this is not impossible, it is improbable. The Corps has also determined that use of a clamshell dredge may effect, but is not likely to adversely affect sea turtles.

Smalltooth sawfish

The smalltooth sawfish may be affected through dredging nearshore areas in channels that are currently suitable habitats (areas of sand and/or mud bottoms less than 30 feet in depth) and by blasting if there is an animal present in the blast zone at time of detonations.

Johnson's Seagrass

Dredging will result in the removal of approximately 1.79 acres of seagrass beds where *H. johnsonii* is the sole constituent or associate of other seagrass species in the Intracoastal Waterway and Dania Cutoff Canal. This impact will include the direct removal of *H. johnsonii.* Changes in bottom depth through deepening and widening efforts within the Port is expected to make resulting habitats unsuitable for re-colonization of *H. johnsonii*. It is not known if *H. johnsonii* in areas adjacent to dredging zones would be resilient to changes in water quality or to impacts resulting from deposition of sediments on blades.

Indirect Effects

Sea Turtles

Since beaches of John U. Lloyd SRA provide important nesting areas for three sea turtle species, the project area comprises important resources for turtles. Removal of sections of hardbottom, reef, and seagrass habitats will eliminate potential foraging habitat for juvenile sea turtles. The reduction in such habitat may slightly decrease the carrying capacity of the region for turtles. Also, since these habitats are also utilized as refugia for hatchling turtles, an increase in predation may be anticipated. Finally, dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches. In fact, the highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Entrance and Southport Access Channels. It is extremely likely that both the pressure and noise associated with blasting will physically damage sensory mechanisms and other physiological functions of individual sea turtles.

Dolphins

Dredging and construction activities in the area may alter behavior and migration routes of dolphins. Any disturbance of dolphins would be considered harassment of a marine mammal under the Marine Mammal Protection Act of 1972.

Effect Determination

The Corps has determined that the proposed expansion of Port Everglades may adversely affect listed and proposed species within the action area and requests initiation of formal consultation with NMFS.

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NMFS – Southeast Regional Office – Port Everglades Feasibility Study

ESA Consultation – Status, review and future plans April 28, 2008

*** Meeting Recorded on iPod for the record in addition to meeting notes 11am – 230pm

Attendees

- Kenneth Dugger - USACE
- Martha Robbart - Dial Cordy and Associates
- Terri Jordan - USACE
- Bob Hoffman – NMFS-PRD
- Audra Livergood – NMFS-PRD
- David Bernhart – NMFS-PRD

Agenda

1. Review Benthic Assessment – Martha. Power point will be posted o USACE FTP site with meeting notes when finalized.
2. Discussions

    a. Adequacy of the existing USACE coral survey
    b. Scope of the proposed action
    c. BO timing
    d. Possibility of conferencing on coral CH and what that entails.

Results

1. Martha presented an overview of the existing USACE Reef Survey that was conducted in March 2006 (methods), and the subsequent findings published in the Reef Report (Dial Cordy 2008).

    a. 150-m indirect impact buffer calculations based on Key West (2004-2006); Key West 2007; Broward County Shore Protection Project and the Port Everglades 1980-81 dredging monitoring reports.

    b. Hopper dredges used in Key West and Broward County; cutterhead used at Port Everglades. Hopper dredges have higher turbidity than cutterheads due to overflow.

    c. Review of towed video (2000, 2001 and 2002) and diver video (2006) collected for the project.

    d. Diver safety is a limiting factor in active Navigation channels.

    e. NMFS Interim *Acropora* protocol – 2 scales – small projects <.25 acres or large projects >.25 acres. For USACE to survey the 20 minute timed swim for all of the 106 acres (.43 sq kms) – 430, 000 sq meters = 430 survey sites. Assuming you can perform 5-10 survey lines a day (an active shipping channel greatly limits access) = 9-17 work weeks with perfect weather for just *Acropora* surveys – not including any other hardbottom

characterization efforts that would be needed for the project. No current documentation protocol included in the existing protocol.

i. USACE Recommendations – Port Everglades is not only project with this problem. Miami, Key West, Palm Beach all have projects with scales greater than .25 acres. Key West did drift dives during the 2004-2006 and 2007 construction. USACE recommends that a towed-video survey method for the initial survey effort to identify presence absence. You can make scale as tight as you need it. After video is complete, if *Acropora* colonies are identified – then diver assessment can be performed o the identified colonies. The towed video also creates permanent record that any one can review (the DVD of the video). Restrict systems to digital GPS with coordinates on the video to ensure location data.

ii. NMFS recommends focusing *Acropora* survey effort on the nearshore ridge complex since we know this is suitable habitat for staghorn coral (e.g., JUL6). NMFS recommends the highest density of transects on the nearshore ridge complex, followed by the inner, middle, and outer reefs, respectively. Number of transects needed for a representative sample will need to be coordinated with other NMFS staff (Dr. Margaret Miller, Dr. Lisamarie Carrubba, and Jennifer Moore).

f. USACE survey was never intended to be an *Acropora* survey. It was designed to be a direct impact characterization in the 2nd and 3rd reefs only.

2. Discussions

a. Critical Habitat Designation – Port Everglades – all 106 acres of direct and indirect impacts = .005% of the proposed CH for the Florida Unit (8,000+ sq kms). This is a conservative number. It is based on the total of the Florida Unit – all habitats (sand, turf, etc) and the complete footprint of all habitats of the project area (previously impacted area, sand, turf, etc).

b. Ultimate goal – NMFS provides USACE with a biological opinion. NMFS major concern is having a preferred alternative. NMFS would prefer to not have to complete a Biop, and then go back and have to do another in a year or so. USACE must finish an EIS to finish Feasibility. That EIS must complete an ESA consultation, this is Corps regulation requirement. The ESA consultation is recommended to be in the Draft EIS, however it is required for the Final EIS. The ROD can not be signed without the ESA consult, thus the Feasibility Study can not be completed and submitted to Congress for authorization. NMFS would be more comfortable with waiting until the DEIS is released to the public before beginning the ESA consultation. USACE agrees that this is an acceptable method for the completion of the ESA consultation.

c. Mangrove removal from the Turning Notch and the effect on smalltooth sawfish. Blasting areas will include Main Turning Basin, South Turning Basin and Southport Access channel. USACE is using the same blasting protocol as used in Miami Harbor with confined blasts with stemming, and a specific number of observers. Those will all be included in the proposed action. The TN mangroves are mature. NMFS had some confusion with the TN impacts in 1989 and with the mitigation areas for the 89 TN dredging o the western edge of JUL (east side of SAC). No rip-rap breaks exist in the TN rip-rap. There are breaks at the JUL mangroves, but n breaks exist in the TN rip rap. There is tidal access from the northern side of the TN using a mosquito ditch. NMFS has requested that USACE put the Env. Friendly bulkhead with rip-rap in the TN and include breaks in the rip-rap to allow potential access by sawfish into the mangroves to the north of the TN that they currently have n access into.

d. USACE has committed to relocate corals greater than 12 inches in size from the direct impact areas. USACE has committed to relocate ANY *Acropora,* visible to the naked eye found in the direct impact area, without regard to size.

e. Planning, Engineering and Design Phase (referred to as "PED") *Acropora* survey – using the towed video survey would be performed on the 150-meter indirect effect area as well as the direct impact area. Discussions included the locations of JUL-6 and the presences of the *Acropora* there. Most of the *Acropora* that is prolific in Broward is being found o the nearshore ridge complex. For future survey and monitoring work – NMFS would like to see a focus on the nearshore ridge complex to ensure that any effects on *Acropora* near the channel are documented. Clarify what direct and indirect impacts are defined as by the USACE document. Direct impacts – physical removal of the habitat or the species. Indirect impacts – siltation and shading from dredge generated turbidity and sedimentation.

    i. In the 1980 dredging – there were monitoring stations on both sides of the channels. In the 1st and 2nd reef the currents run from North to South, beyond the 2nd reef going to the 3rd reef the currents are dominated by the Gulf Stream and the eddies generated from the Gulf Stream and move from south to North. In the 1980 dredging, with a cutterhead in the channel, with lower water quality standards than are in place today – no effect of the dredging was seen at any of the monitoring stations (north or south of the channel) as compared to baseline sites further from the channel. The 1980 report is available on the FTP site for review.

    ii. NMFS would like to review the 150-meter and determine if that is an appropriate for monitoring when we get to PED. The 150-m buffer is based on the four previous projects and those results. Other projects and monitoring for future projects will also feed into this process. NMFS would like to be part of the development of monitoring site locations for the pre, during and post phase.

This is where we are in Miami Harbor and NMFS will be involved extensively with that process and that process would be mimicked for Port Everglades. NMFS would also like to have monitoring sites with *A. cervicornis* present and include that information in the monitoring.

iii. Can the Entrance Channel dredging be completed during a time of year that will not expose the already stressed *Acropora* (stress associated with summer sun, still water and warm water) to turbidity and sedimentation? USACE recommended that NMFS include any window in the Biop Terms and Conditions that can then be incorporated into the Environmental Commitments section of the FEIS and the plans and specifications that the contractors would then bid against and be able to plan for. Previous Entrance channel dredging in 1980 was completed in 109 dredging days between 4 May and 27 December 1980. Weather, ship traffic and equipment will play huge role in how long it takes to complete this work. A window will increase dredging time since weather can drive the dredge inshore more often. NMFS may recommend a July – early September window, in which dredging would be prohibited or limited to specified locations away from coral, due to water temperature and still, calm water (high levels of UV light).

f. Review of the document – National Academy of Science will review Baseline reports (Reef, seagrass, mangroves, etc); DEIS. NAS review will begin after the scope is complete. The first phase will be baseline materials. Second phase will be the DEIS. An interim report on the science will be provided by the NAS. Lead coordinator for the NAS process is the Center of Expertise for Deep Draft Navigation (Mobile District). SAJ is coordinating with them and NAS.

g. Discussions of Miami Harbor pending surveys (summer/early fall 2008) with a consultation in the fall 2008. Miami is in PED. Port of Palm Beach is also pending ESA consultation.

h. Alternative 5 in the DEIS is the maximum impact. Cooperating agency staffs believe that they feel they can remove the flare in the entrance channel. USGC and pilots specifically document accidents, allisions and collisions in the Feasibility Study. The larger ships (post-panamax) ships have already been turned away from Port Everglades due to lack of entrance channel depth. Documentation of these requests has been provided to USACE by the pilots and the ports. Pilots requested a 1,000 ft wide entrance channel flare – the ship simulation documented a need for no more than an 800 ft wide flare. Discussions also included the ability to use tugs, etc. David Bernhart agreed with USACE analysis regarding speed needs entering Port Everglades – which is faster than a tug can catch the ship to bring them in under tug power. There is n way to reduce the flare beyond the 800ft width currently proposed when considering vessel safety as the

primary consideration. If the 1,000 ft flare had been included in would have resulted in an additional 7.9 acres of reef impacts to the 2nd and 3rd reef.

i. Seagrass and mangrove mitigation discussion. Westlake Park construction of mitigation area to start in 200 – early mitigation as compared to impact proposed in 2012. 90% plans and specs being completed and getting ready to move forward with bidding to contractors which would allow construction to begin in 2009. Monitoring will be done by County to verify the success of mitigation efforts with reports to USACE/SFWMD/County.

Tasks/To Dos –

1. USACE will prepare a proposed draft protocol for using video as a baseline for *Acropora* surveys in large scale projects.

2. NMFS will review this protocol and make recommendations for change/accept the proposal for implementation (Audra/Margaret Miller/others). New protocol would be for four channels in Florida, five in Puerto Rico and two in the USVI. This may best be harbor/channel survey specific protocol. This would be technology based survey since humans in channels is a dangerous situation. Note: NMFS may recommend some in-water transects (by divers) outside of the channel in areas of potential indirect impact (from sedimentation and/or turbidity) that support hardbottom (i.e., areas that have the PCE for Acropora proposed critical habitat).

3. USACE will use DEIS, when released to the public, as the final item in the consultation initiation package. The DEIS will include a proposed action that USACE is consulting on and will include conservation/mitigation measures aimed at protected resources. Consultation will be based on what NMFS knows now and that proposed action.

    a. Breaks in rip rap bulkheads at TN to increase possible access for sawfish (also increased flushing for the mangroves).

    b. *Acropora* survey using video as the baseline in the PE&D phase of the project (2012 construction – 2009-2010 for PED assuming that there is WRDA 200 that would include Port Everglades – which may be a contingent authorization – however the report must be completed by the end of the calendar year. This would require FS and EIS to be completed by Dec 31, 2008. Not very likely).

    c. Monitoring sites for indirect effects from turbidity and sedimentation development of protocol and locations during PE&D phase.

    d. All blasting criteria used in Miami Harbor and lessons learned from Miami.

    e. NMFS-PRD can help write the mitigative measures with USACE for the DEIS under the cooperating agency agreement under CEQ NEPA regs.

4. NMFS will prepare a biological opinion (formal consultation) for the Port Everglades project.

    a. Will include final designated Critical Habitat in the Biop (expected to be final in Nov 2008, and Biop will likely be after the finalization of the CH).

    b. Survey is committed to – what does USACE/NMFS do if the *Acropora* is found during the survey during PED. If section 7 consultation is already complete, COE may need to reinitiate if colonies need to be re-located (since this would constitute take).

Attachments and Supplemental Information –

198 Monitoring Report – available on USACE FTP site –
ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination/Port_Everglades_Feasibility_Study/Documents/Previous%20Deeping%20Project%20Documents%20-%201980

Key West Report – 2004-2006 Dredging

ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination/Port_Everglades_Feasibility_Study/Meetings/02-Feasibility%20Phase%20Meetings/2007/Sept%2025%20&%2026%20HEA%20meeting/Other%20studies/Final%20RIAM%20Report%20Key%20West%202004-2006%20Dredge.pdf

Key West Report – 2007 Dredging

ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination/Port_Everglades_Feasibility_Study/Meetings/02-Feasibility%20Phase%20Meetings/2007/Sept%2025%20&%2026%20HEA%20meeting/Other%20studies/RHSM%20Report%202007.pdf

Terri has photos of the TN rip rap and the JUL rip rap if NMFS is interested – can email under separate cover

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701
(727) 824-5312, FAX (727) 824-5309
http://sero.nmfs.noaa.gov

MAR 26 2008 F/SER31:AL

Ms. Marie Burns
Environmental Branch Chief – Planning Division
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Ms. Burns:

The National Marine Fisheries Service (NMFS) Protected Resources Division (PRD) wishes to respond to numerous inquiries from your staff regarding the status of our biological opinion (BO) for the proposed Port Everglades dredging project in Broward County, Florida. As a cooperating agency for this project, we have reviewed and commented on the first version of the interim Draft Environmental Impact Statement (DEIS). Currently, the Corps of Engineers (COE) does not have an official proposed action for this project. In addition, we have not been provided with a draft mitigation plan. The proposed mitigation is part of the proposed action for the project and as such also needs to be considered for its effects on our species. It is quite possible that the scope of the proposed action may change depending on comments received from the cooperating agencies as well as comments received by the public once the DEIS is released for public comment.

We would like to reiterate the recommendations provided in our August 18, 2006, letter, a survey designed specifically to identify and quantify the presence and density of federally-listed acroporid coral colonies that may be present within or nearby the project area. We do not believe the information the COE has provided is sufficient to allow for an adequate review of the project's effects on these species. An analysis of the project's effects on listed corals based on the currently provided information would be arbitrary.

We are advising the COE that staghorn coral colonies have been documented approximately 3,500 feet south of the entrance channel to Port Everglades at JUL6, which is a permanent annual monitoring station for Broward County. Broward County Environmental Protection Department personnel have reported an increase in density of staghorn coral colonies at JUL6. This is supported by their data from 2004 and 2005, which showed an increase in density from 14 colonies per square meter in 2004 to 38 colonies per square meter in 2005. Examination of high resolution bathymetry for Broward County around Port Everglades indicates that the reef substrate that is characteristic of JUL6 appears to extend northward into the area of impact for the proposed project. Therefore, without a proper survey, it is reasonable to assume that staghorn coral colonies may occur closer than 3,500 feet from the entrance channel and may be present in close enough proximity to be adversely affected by turbidity and sedimentation from proposed dredging of the outer entrance channel.

In addition, NMFS has advised the COE (by e-mail dated February 6, 2008) that the extension of the Port Everglades outer entrance channel may affect proposed critical habitat for elkhorn and staghorn coral. We believe the primary constituent element (PCE) essential to the conservation of these species may be adversely affected by the proposed project. The proposed rule (50 CFR Parts 223 and 226) defines the PCE as "consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover...in water depths from mean high water to 30 meters." In Florida, Acropora critical habitat is proposed from the Dry Tortugas north to Palm Beach County, and includes substrate of suitable quality and availability in Broward County. We wish to reiterate that this project may affect proposed critical habitat for elkhorn and staghorn coral.

Based on the preceding, it would be premature for us to complete our draft biological opinion at this time. I propose you and I and our respective staffs meet at your earliest convenience to discuss moving forward on this high-profile project. If you have any questions, please contact me at (727) 551-5767, or by e-mail at David.Bernhart@noaa.gov.

Sincerely,

David M. Bernhart
Assistant Regional Administrator
for Protected Resources

cc:

F\SER47 - Jocelyn Karazsia
Chantal Collier, FDEP
Dr. Vladimir Kosmynin, FDEP
Erin McDevitt, FWC
Lisa Gregg, FWC
Ken Banks, Broward County EPD
Terri Jordan, COE Planning Division

Ref. F/SER/2002/00626
File: 1514-22.f.1.Fl

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

Planning Division
Environmental Branch

OCT 1 8 2006

Mr. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
263 13th Avenue South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

The U.S. Army Corps of Engineers (Corps), Jacksonville District is currently conducting a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. This letter is in response to your letter dated August 18, 2006. The letter references the recently completed Port Everglades Reef Mapping and Assessment Preliminary Draft, and finds that in National Marine Fisheries Service's (NMFS) opinion "the study is flawed. It does not provide the Service with the best scientifically or commercial data available or which can be obtained for an adequate review of the effects that the action may have upon listed species..." Initiation of consultation for this action was by letter dated March 28, 2002.

The Corps' survey teams spent a total of 144 man hours in the water on the impact and control areas, as well as collected and reviewed more than 50 hours of video of the impact and control areas. The total impact area surveyed is 54.6 acres (the direct project footprint and an area to be assessed for possible indirect impacts). Other survey efforts for the project area include towed video and diver transect surveys in 2001 as part of the baseline report development (USACE, 2001); an October 2002 resource assessment conducted by a group of resource agency staff (including Michael Johnson of NMFS) and ongoing research efforts by scientists from Broward County DPEP and NOVA University (Broward County, 2001 and Gillem *et al.*, 2004). Given the amount of time spent in the water by all parties, the amount of video footage collected and analyzed, after discussions with Dr. Precht, the research team, and other Acroporid coral experts, the Corps believes that if a stand of either Acroporid coral, greater in age than 1-2 years (the age at which they become visible to the naked human eye (NMFS, 2005)) were located in the impact zone or the control areas, they would have been noted and recorded. To date, neither species have been recorded in or near the project area.

The NMFS recommends "An active and quantitative survey designed specifically to identify and quantify the presence and abundance of elkhorn and staghorn coral should be conducted for the proposed impact areas and control sites." Based on the surveys cited above, the Corps believes that there is sufficient data available to make a determination. It is possible that all of this combined survey effort has missed some small isolated acroporid corals. If such small isolated acroporid corals were present, the affect would be classified as insignificant or

May 17 11 02 01p Joselyn Karazsia 3055954055 p.1

discountable, thus the basis of our June 2005 finding of "may affect, but not likely to adversely affect" is still valid.

NMFS cites the report's introduction that states the area was once "dominated" by Elkhorn coral as justification for the survey. The preceding sentence states "The reef communities that presently occur off Broward County cover drowned reefs formed during the Holocene". This was a citation from Lighty et al, 1978 which states "Radiocarbon dates obtained for the *Acropora palmata* facies indicate that the reef is Holocene in age, but has had no significant reef-framework accumulation for the past 6,000 years." The relic drowned reef at the mouth of the entrance channel at Port Everglades was built predominantly by *A. palmata* more than 6,000 years ago. Dr. Bill Precht has confirmed that neither *A.palmata*, nor *A.cervicornis* have been dominant on the reefs off of Broward County for about 6,000 years. The additional reference in the NMFS letter to documentation of *A.cervicornis* on the third reef dates back to a 1973 Goldberg reef survey off of Boca Raton, which is 22 miles north of the project area. However, a more recent study conducted by Gilliam *et al.* in 2004 throughout Broward County (with one of his survey areas – JUL #8 located 2,950 feet south of the proposed impact area) found no *A.cervicornis* on the third reef.

We understand the Service's concerns, and believe that we have addressed them. As part of the minimization and avoidance of impacts for the project, the Corps commitments to survey for and relocate any corals larger than 12 inches in size (30.48cm) prior to dredging the entrance channel extension. Should Acroporid species be found during this relocation effort, the Corps commits to relocating any *A.palmata* and *A.cervicornis* identified during the relocation surveys, even if they are less than 12 inches (30.48 cm) in size and reinitiating consultation with NMFS under Section 7 of the Endangered Species Act.

If you have any questions, please contact Ms. Terri Jordan at 904-232-1817 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Chief, Environmental Branch

Enclosure

Memo for the Record - Effects Determination – Acropora Palmata
For ESA consultation with NMFS
Per request from Audra Livergood, NMFS-PRD – Miami, FL

The Corps has previously sent an affect determination for *Acropora palmata* and *A.cervicornis* under the ESA via an email to Mr. Juan Levesque of NMFS dated June 23, 2005. A summary of that email and a determination of direct impacts are included below.

Indirect Effect –

From June 2005 email - "Juan - after reviewing the "Broward County Shore Protection Project Geographic Information System database" that compiled all available data on offshore resources in Broward county (a copy of this 9-cd notebook was provided to NMFS as part of the BCSPP in 2001), the Corps has determined that the nearest *Acropora cervicornis* patch is located 21,277 feet (4.02 statue miles) north of the north jetty of the Port Everglades entrance channel, and the nearest *Acropora palmata* patch is located 46,405 feet (8.79 statue miles) north of the north jetty of the Port Everglades entrance channel. The Corps has photo documentation of a small patch of A. cervicornis to the south of the entrance channel within the boundaries of the John U. Lloyd State Park approximately 2,000 feet south of the south jetty that was not mapped by Broward County (from what we can determine). We are working to get a more detailed assessment of where this patch is located. However, since the current is this area is directly influenced by the Gulf Stream, it is unlikely that any sediment in the water column would move south of the channel, it is more likely it will move north under the influence of the South to North current. Also - due to the distance from the channel to the northerly mapped stands, it is also unlikely there will be any effect from the deepening project in the entrance channel from turbidity or sedimentation.

The Corps determines that the Port Everglades Feasibility Study, may effect, but is not likely to adversely affect either *Acropora cervicornis* or *Acropora palmata*, both currently proposed as threatened under the Endangered Species Act of 1973 and ask that NMFS concur with this determination in a conference opinion.

Direct Effect –

Per the recently finalized "Port Everglades Reef Report" completed on 10-10-2006 and provided to NMFS and other resource agency staff on 10-13-2006. The Corps' survey teams spent a total of 144 man hours in the water on the impact and control areas, as well as collected and reviewed more than 50 hours of video of the impact and control areas. The total impact area surveyed is 54.6 acres (the direct project footprint and an area to be assessed for possible indirect impacts). Other survey efforts for the project area include towed video and diver transect surveys in 2001 as part of the baseline report development (USACE, 2001); an October 2002 resource assessment conducted by a group of resource agency staff (including Michael Johnson of NMFS) and ongoing research efforts by scientists from Broward County DPEP and NOVA University (Broward County, 2001 and Gilliam *et al*., 2004). Given the amount of time spent in the water by all parties, the amount of video footage collected and analyzed, after discussions with Acroporid coral experts, the Corps believes that if a stand of either Acroporid coral, greater in age than 1-2 years (the age at which they become visible to the naked human eye (NMFS, 2005))

were located in the impact zone or even the control areas, they would have been noted and recorded. To date, neither species have been recorded in or near the project area.

However, it is possible that all of this combined survey effort has missed some small isolated Acroporid corals. If such small isolated Acroporid corals were present, the affect would be classified as insignificant or discountable, thus the basis of our June 2005 finding of "may affect, but not likely to adversely affect" would not change.

During discussions with NMFS-PRD, the Corps reiterated a commitment prior to dredging the entrance channel extension, to survey for and relocate any corals larger than 12 inches in size (30.48cm). During this survey, the Corps will commit to relocating any *A.palmata* and *A.cervicornis* identified during the relocation surveys, even if they are less than 12 in (30.48 cm) in size.

Literature cited

Broward County. 2001. Broward County Shore Protection Project Graphic Information Systems Database. Database and Instruction Manual for Complete 9 CD Version. December 2001.

Gilliam, D.S., R.E. Dodge, R.E. Spieler, L.K.B. Jordan, J.A. Monty. 2004. Marine biological monitoring in Broward County, Florida: Year 4 annual report. Technical Report DPEP 04-01. Ft. Lauderdale, Florida: Broward County, Board of County Commissioners.

National Marine Fisheries Service. 2005. *Acropora* Biological Review Team. 2005. Atlantic *Acropora* status Review Document. Report to the National Marine Fisheries Service, Southeast Regional Office. March 3, 2005. 152p+App.

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Planning Division
Environmental Branch

Mr. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
263 13th Avenue South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

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control areas, they would have been noted and recorded. To date, neither species have been recorded in or near the project area.

The NMFS recommends “An active and quantitative survey designed specifically to identify and quantify the presence and abundance of elkhorn and staghorn coral should be conducted for the proposed impact areas and control sites.” Based on the surveys cited above, the Corps believes that there is sufficient data available to make a determination. It is possible that all of this combined survey effort has missed some small isolated acroporid corals. If such small isolated acroporid corals were present, the affect would be classified as insignificant or discountable, thus the basis of our June 2005 finding of “may affect, but not likely to adversely affect” is still valid.

NMFS cites the report’s introduction that states the area was once “dominated” by Elkhorn coral as justification for the survey. The preceding sentence states “The reef communities that presently occur off Broward County cover drowned reefs formed during the Holocene”. This was a citation from Lighty et al, 1978 which states “Radiocarbon dates obtained for the *Acropora palmata* facies indicate that the reef is Holocene in age, but has had no significant reef-framework accumulation for the past 6,000 years.” The relic drowned reef at the mouth of the entrance channel at Port Everglades was built predominantly by *A. palmata* more than 6,000 years ago. Dr. Bill Precht has confirmed that neither *A.palmata*, nor *A.cervicornis* have been dominant on the reefs off of Broward County for about 6,000 years. The additional reference in the NMFS letter to documentation of *A.cervicornis* on the third reef dates back to a 1973 Goldberg reef survey off of Boca Raton, which is 22 miles north of the project area. However, a more recent study conducted by Gilliam *et al.* in 2004 throughout Broward County (with one of his survey areas – JUL #8 located 2,950 feet south of the proposed impact area) found no *A.cervicornis* on the third reef.

We understand the Services concerns, and believe that we have addressed them. As part of the minimization and avoidance of impacts for the project, the Corps commitments to survey for and relocate any corals larger than 12 inches in size (30.48cm) prior to dredging the entrance channel extension. Should Acroporid species be found during this relocation effort, the Corps commits to relocating any

A.palmata and *A.cervicornis* identified during the relocation surveys, even if they are less than 12 inches (30.48 cm) in size and reinitiating consultation with NMFS under Section 7 of the ESA.

If you have any questions, please contact Ms. Terri Jordan at 904-232-1817 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

Marie R. Burns
Chief, Environmental Branch

Enclosure

Jordan/CESAJ-PD-EC/1817/
Dugger/CESAJ-PD-EC
Ross/CESAJ-DP-C
Burns/CESAJ-PD-E

L: group/pde/jordan/Port Everglades Sec 7 response to Aug 18 2006 letter.doc

Literature Cited

Aronson, R.B., P.J. Edmunds, W.F. Precht, D.W. Swanson, and D.R. Levitan. 1994. Large-scale, long-term monitoring of Caribbean coral reefs: simple, quick, inexpensive techniques. Atoll Research Bulletin 421:1-19.

Aronson, R.B., and W.F. Precht. 1995. Landscape patterns of reef coral diversity: A test of the intermediate disturbance hypothesis. Journal of Experimental Marine Biology and Ecology 192:1-14.

Aronson, R.B., and D.W. Swanson. 1997. Video surveys of coral reefs: Uni- and multivariate applications. Proceedings of the 8th International Coral Reef Symposium 2:1441-1446.

Aronson, R.B., W.F. Precht, T.J.T. Murdoch, and M.L. Robbart. 2005. Long-term persistence of coral assemblages on the Flower Garden Banks, northwestern Gulf of Mexico: Implications for science and management. Gulf of Mexico Science (1):84-94

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Section 7 Consultation Package –

US Fish and Wildlife Service

March 25, 2002

Planning Division
Environmental Branch

Mr. James J. Slack
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960-3559

Dear Mr. Slack:

The U.S. Army Corps of Engineers (Corps), Jacksonville District proposes to conduct a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. An evaluation of benefits, costs, and environmental impacts determines Federal interest. This Feasibility Study was authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan's main elements include: widening and deepening (to –53/-50 feet) the Outer Entrance Channel, deepening the Inner Entrance Channel and Main Turning Basin to –50 feet, widening and deepening (to –47 feet) the Southport Access Channel, widening and deepening (to –32 feet) the Dania Cutoff Canal, constructing a Turning Basin at the intersection of the Dania Cutoff Canal and the Southport Access Channel at –32 feet, deepening a portion of the South Turning Basin to –44 feet, and widening and deepening (to –47 feet) the Turning Notch. Other significant construction items include relocation of the U.S. Coast Guard Basin (USCG) easterly within essentially USCG property, port facility construction, and environmental mitigation.

The Corps originally initiated consultation on this project on October 22, 1998 by sending a Biological Assessment to your office with a finding that the proposed project may affect, but was not likely to adversely affect manatees within the action area. On December 21, 1998, your office concurred with our finding. A copy of this original concurrence is included with this new assessment for your information.

The proposed project has changed significantly since this original consultation was concluded, and as a result,

the Corps requests re-initiation of consultation under Section 7 of the ESA. Enclosed please find the Corps' biological assessment of the effects of the project as currently proposed on listed species and marine mammals in the action area and a copy of the draft EIS prepared for this proposed project.

After preparing this Biological Assessment of the impacts of the proposed project, the Corps has determined that the proposed project may affect, but is not likely to adversely affect the endangered Florida manatee (*Trichecus manatus*) found in the action area and we request that you concur with this finding.

If you have any questions, please contact Ms. Terri Jordan at 904-899-5195 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Copy furnished w/encl:

Dr. Robbin Trindell, Florida Fish and Wildlife Conservation Commission, Office of Environmental Services, Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-6000

Jordan/CESAJ-PD-EA/3453/
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Schwictenberg/CESAJ-DP-C
Strain/CESAJ-PD-P
Duck/CESAJ-PD

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BIOLOGICAL ASSESSMENT
PORT EVERGLADES NAVIGATION PROJECT
BROWARD COUNTY, FLORIDA

Description of the Proposed Action

The U.S. Army Corps of Engineers (Corps) proposes to expand and deepen Port Everglades Harbor. A detailed description of the proposed project and all alternatives considered under the Feasibility Study are evaluated in the Draft Environmental Impact Statement enclosed with this Biological Assessment. Broward County requested that the Corps study the feasibility of widening and deepening most of the major channels and basins within Port Everglades. Four major improvement goals were identified. 1) Improve transit in the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and Southport Access Channel (SAC) to accommodate liquid bulk, cruise, and container vessels; 2) Develop the DCC (DCC) to accommodate mid-size container vessels; 3) Deepen the North Turning Basin to accommodate Panamax (and larger) size container ships; and 4) Improve turning and berthing in the Turning Notch (TN).

The purpose of the proposed action is to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment. The proposed action resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the port. This economic analysis has shown that improvements to most of the major Federal and non-Federal channels and basins are required to achieve efficient transit of the existing fleet, and to accommodate the future fleet. Substantial liquid bulk cargo cost savings can be achieved by deepening the OEC, IEC, and MTB. Widening of the OEC flare will allow safer transit for all the larger commercial vessels that experience sometimes troublesome cross currents at the channel entrance. Removal of the Widener Shoal and widening of the SAC allows for more efficient and safer transits of containerized cargo vessels past the Knuckles restriction where new generation cruise vessels are expected to be berthed. Lengthening and deepening of the TN will provide turning possibilities for larger vessels and will provide critical berthing for containerized cargo vessels. Deepening of the STB will allow for more efficient use Berths 16-18 by allowing Panamax vessel calls. Finally, widening and deepening of the DCC (in addition to a turning basin located adjacent to the SAC) will allow for relocation of smaller and midsize container, roll on/roll off (ro/ro) vessels, and general cargo traffic, thereby reducing congestion in the areas serviced by larger vessels.

The Corps expects the construction to be performed using a variety of methods including blasting and dredging with a cutterhead, clamshell or other type of dredge. Any blasting that will occur within the project will be confined blasting. Confined blasting is defined as a blast where the explosives had been placed in a hole bored into the rock substrate and capped with 3-4 feet of crushed rock known as “stemming”. Stemming forces the explosive blast downward into the rock instead of allowing the blast to expand into the water column.

Action Area

The Port Everglades Harbor is a major seaport located on the southeast coast of Florida. It is

located within the cities of Hollywood, Dania Beach and Fort Lauderdale, with immediate access to the Atlantic Ocean. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. Figure 1 shows the location of the project site.

Figure 1 - Location of Project

The existing Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide, an Inner Entrance Channel (IEC) that is 450 feet wide and 42 foot deep, a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (NTB) that is 31 feet deep, a South Turning Basin that is (STB) 31 to 36 feet deep, a Southport Access Channel (SAC) that is 390-400 feet wide and 42 feet deep, and a Turning Notch (TN) that is 42 feet deep. To the east of the port is a barrier island that contains a U.S. Navy facility, a NOVA Southeastern University facility, a U.S. Coast Guard facility, and John U. Lloyd State Recreation Area and its adjacent beaches. South of the port's DCC is the Westlake Park area. West of the port is Federal Highway which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the port is a mixture of small craft waterways and commercial and residential development.

Protected Species Included in this Assessment

Of the listed and protected species under FWS jurisdiction occurring in the action area, the Corps believes that only the Florida manatee (*Trichecus manatus*) may be affected by the implementation of the Navigation Project. Although there is designated critical habitat for the Florida manatee throughout south Florida, the action area is not located within this designated habitat (50 CFR 17.95).

The Federal government has recognized the threats to the continued existence of the Florida manatee for more than 30 years. The West Indian manatee was first listed as an endangered species in 1967 under the Endangered Species Preservation Act of 1966 (16 U.S.C. 668aa(c)) (32 FR 48:4001). The Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa(c)) continued to recognize the West Indian manatee as an endangered species (35 FR 16047), and the West Indian manatee was also among the original species listed as endangered pursuant to the Endangered Species Act of 1973. Critical habitat was designated for the manatee in 1976. The justification for listing as endangered included impacts to the population from harvesting for flesh, oil, and skins as well as for sport, loss of coastal feeding grounds from siltation, and the volume of injuries and deaths resulting from collisions with the keels and propellers of powerboats. Manatees are also protected under the provisions of the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq*.) and have been protected by Florida law since 1892. Florida provided further protection in 1978 by passing the Florida Marine Sanctuary Act designating the state as a manatee sanctuary and providing signage and speed zones in Florida's waterways.

Species and suitable habitat descriptions

Status and Distribution of the Florida manatee

All manatees belong to the Order Sirenia. The living sirenians consist of one species of dugong and three species of manatee. A fifth species, the Steller's sea cow, was hunted to extinction by 1768. The Greek name for this order is derived from the sirens of Greek mythology. Sirens were female, partly human creatures that lured ships onto the rocks by their mesmerizing songs.

All living sirenians are found in warm tropical and subtropical waters. The West Indian manatee

was once abundant throughout the tropical and subtropical western North and South Atlantic and Caribbean waters. However, the manatee's numbers have been greatly reduced. Today the West Indian manatee is listed as an endangered species throughout its range.

Habits

Florida manatees are herbivores that feed opportunistically on a wide variety of submerged, floating and emergent vegetation. Shallow grass beds with ready access to deep channels are the preferred feeding areas in coastal and riverine habitats. Bengtson (1983) estimated that the annual mean consumption rate for manatees feeding in the upper St. John's Ricer at 4% to 9% of their body weight per day depending on season. A complete review of manatee biology is included in the manatee section of the South Florida Multi-species Recovery Plan (FWS, 1999) and will not be repeated here.

Distribution

The manatee occurs throughout the southeastern United States. The only year-round populations of manatees occur throughout the coastal and inland waterways of peninsular Florida and Georgia (Hartman 1974). During the summer months, manatees may range as far north along the East Coast of the U.S. as Rhode Island, west to Texas, and, rarely, east to the Bahamas, FWS 1996, Lefebvre *et al.* 1989). There are reports of occasional manatee sightings from Louisiana, southeastern Texas, and the Rio Grande River mouth (Gunter 1941, Lowery 1974).

In Florida, manatees are commonly found from the Georgia/Florida border south to Biscayne Bay on the east coast and from Wakulla River south to Cape Sable on the west coast (Hartman 1974, Powell and Rathbun 1984) (Figure 1). Manatees are also found throughout the waterways in the Everglades and in the Florida Keys. Although temperatures are suitable for manatees in the Florida Keys, the low number of manatees has been attributed to the lack of fresh water (Beeler and O'Shea 1988). Manatees also occur in Lake Okeechobee.

In warmer months (April to November), the distribution of manatees along the east coast of Florida tends to be greater around the St. Johns River, the Banana and Indian rivers to Jupiter Inlet, and Biscayne Bay. On the west coast of Florida, larger numbers of manatees are found at the Suwannee, Crystal and Homosassa rivers, Tampa Bay, Charlotte Harbor/Matlacha Pass/San Carlos Bay area, the Caloosahatchee River and Estero Bay area, the Ten Thousand Islands, and the inland waterways of the Everglades. On the west coast, manatee's winter at Crystal River, Homosassa Springs, and other warm mineral springs (Powell and Rathbun 1984, Rathbun *et al.* 1990). In the winter, higher numbers of manatees are seen on the east coast at the natural warm waters of Blue Spring and near man-made warm water sources on or near the Indian River Lagoon, at Titusville, Vero Beach, Ft. Pierce, Riviera Beach, Port Everglades, Ft. Lauderdale, and throughout Biscayne Bay and nearby rivers and canals (FWS 1996). They also aggregate near industrial warm water outflows in Tampa Bay, the warmer waters of the Caloosahatchee and Orange rivers (from the Ft. Myers power plant), and in inland waters of the Everglades and Ten Thousand Islands.

Habitat preferences

The Florida manatees inhabit rivers, bays, canals, estuaries, and coastal areas rich in seagrass and other vegetation. They can live in fresh, saline (salt), and brackish water. They move freely

between salinity extremes. Manatee may be found in any waterway over 3.25 ft. (1 m) deep and connected to the coast. They prefer water above 70 degrees F (21 degrees C). Florida manatees rarely venture into deep ocean waters. However, there are reports of manatees in locations as far offshore as the Dry Tortugas Islands, approximately 50 mi. (81 km) west of Key West, Florida. The patchy distribution of manatees throughout all their ranges is due to the distribution of suitable habitat: plentiful aquatic plants and a freshwater source.

Migration

Florida manatees move into warmer waters when the water temperature drops below about 68 degrees F (20 degrees C). The geographic distribution of manatees within Florida has changed since the 1950s and 60s (Lefebvre *et al.* 1989) and prominent shifts in seasonal distribution are also evident. Before man introduced warm effluents from power plants to the natural environment in the early 1950s, the winter range of the manatee in Florida was most likely limited on its northern bounds by the Sebastian River on the east coast and Charlotte Harbor on the west coast (Moore 1951). Since that time, manatees altered their normal migration patterns and appreciable numbers of manatees began aggregating at new sites. As new power plants became operational, more and more manatees began taking advantage of the sites by traveling great distances just to bask in the warm waters. Among the most important of the artificial warm-water discharges are the Florida Power and Light Company's power plants at Cape Canaveral, Fort Lauderdale, Port Everglades, Riviera Beach, and Fort Myers, as well as the Tampa Electric Company's Apollo Beach power plant in Tampa Bay, Florida. These artificially heated sources have allowed manatees to remain north of their historic wintering grounds. They may have replaced natural warm water springs destroyed or made inaccessible through human development. More than 200 manatees have been reported at some power plants during cold weather. The introduction of power plants and paper mills in northern Florida, southern Georgia, Louisiana, and Texas has given manatees the opportunity to expand their winter range to areas not previously frequented (Hartman 1979). However, warm water industrial discharges alone are not suitable alternatives to the natural warm water refugia provided by natural springs because they usually lack the vegetation necessary to sustain the manatees.

Status of the species

Determining exact population estimates or trends is difficult for this species. The best indicator of population trends is derived from mortality data and aerial surveys (Ackerman *et al.* 1992, Ackerman *et al.* 1995, Lefebvre *et al.* 1995). Aerial surveys conducted for more than 20 years have shown an increase in numbers, but this information is not an accurate account of trends since data has been obtained using different survey methods. O'shea (1988) found no firm evidence of a decrease or increase between the 1970s and 1980s, even though aerial survey counts have increased. Increases in the number of recovered dead manatees have been interpreted as evidence of increasing mortality rates (Ackerman *et a*l. 1992, Ackerman *et al.* 1995). Because manatees have low reproductive rates, these increases in mortality may lead to a decline in the population (O'shea *et al.* 1988, 1992).

Although there are no accurate estimates of manatee population size, the Florida Department of Environmental Protection's (DEP) 1996 aerial surveys conducted from February 18-19, determined there were at least 2,639 manatees in Florida's waters. DEP conducted two surveys in 1997. The January survey determined that 2,229 manatees were present in Florida's waters:

900 on the east coast and 1,329 manatees on the west coast. The February survey determined that 1,709 manatees were present in Florida's waters: 791 manatees on the east coast and 918 on the west coast. Surveys conducted by DEP in 1996 and 1997 determined that numbers of manatees on the east coast and west coasts of Florida are almost equal (Rathbun *et al.* 1992). These estimates represent the minimum number of manatees in Florida waters and may not represent the total population size. As of the January 2001 census, the minimum Florida manatee population was 3,276 (FWRI 2002).

Mortality

Despite the lack of accurate estimates of the manatee population size, human activities have significantly affected manatees by eliminating or modifying suitable habitat, altering migratory access routes, increasing mortality, and decreasing abundance, all of which in turn, can affect manatee reproduction, recruitment, distribution, and behavior. To understand manatee mortality trends in Florida, Ackerman *et al.* (1995) evaluated the number of recovered carcasses between 1974 and 1992 and categorized the causes of death. During that time interval, the number of manatees killed in collisions with watercraft increased each year by 9.3 percent. The number of manatees killed in collisions with watercraft each year correlated with the total number of pleasure and commercial watercraft registered in Florida (Ackerman *et al.* 1995). Other human-related threats include manatee death or injury from flood-control structures and navigational locks, entanglement in fishing line, entrapment in culverts, and poaching. These other threats accounted for 162 known mortalities between 1974 and 1993 (FRMI 2002a). Deaths from flood control structures and other human-related deaths did not change significantly but deaths due to these categories decreased more than deaths from other causes.

Table #2 – Statewide manatee mortalities – FRMI – Marine Mammal Pathology Lab database

Year	Watercraft	Flood Gate/ Canal Lock	Other Human	Perinatal	Cold Stress	Natural	Undetermined	Unrecovered	Total
1974	3	0	2	0	0	0	2	0	7
1975	6	1	1	7	0	1	10	3	29
1976	10	4	0	14	0	2	22	10	62
1977	13	6	5	9	0	1	64	16	114
1978	21	9	1	10	0	3	34	6	84
1979	24	8	9	9	0	4	18	5	77
1980	16	8	2	13	0	5	15	4	63
1981	24	2	4	13	0	9	62	2	116
1982	20	3	1	14	0	41	29	6	114
1983	15	7	5	18	0	6	28	2	81
1984	34	3	1	25	0	24	40	1	128
1985	33	3	3	23	0	19	32	6	119
1986	33	3	1	27	12	1	39	6	122
1987	39	5	2	30	6	10	22	0	114
1988	43	7	4	30	9	15	23	2	133
1989	50	3	5	38	14	18	39	1	168
1990	47	3	4	44	46	21	40	1	206
1991	53	9	6	53	1	13	39	0	174
1992	38	5	6	48	0	20	45	1	163
1993	35	5	6	39	2	22	34	2	145
1994	49	16	5	46	4	33	37	3	193
1995	42	8	5	56	0	35	53	2	201
1996	60	10	0	61	17	101	154	12	415
1997	54	8	8	61	4	42	61	4	242
1998	66	9	6	53	9	12	72	4	231
1999	82	15	8	53	5	37	69	0	269
2000	78	8	8	58	14	37	62	8	273
2001	81	1	7	61	32	33	108	2	325

Of interest is the increase in the number of perinatal deaths. The frequency of perinatal deaths (stillborn and newborn calves) has been consistently high over the past 5 years. This estimate may not be a true representation of the actual number of perinatal deaths that occur because the carcasses of these young animals may not be recovered. The cause of the increase in perinatal deaths is uncertain, but may result from a combination of factors that includes pollution, disease, or environmental change (Marine Mammal Commission 1992). It may also result from the increase in collisions between manatees and watercraft because some newborn calves may die when their mothers are killed or seriously injured by boat collisions, when they become separated from their mothers while dodging boat traffic, or when stress from vessel noise or traffic induces premature births (Marine Mammal Commission 1992). As a result of the high perinatal death rate, there are fewer young age classes present in the population.

Of the 1,907 manatee carcasses that have been recovered in Florida between 1989 and 1997, (DEP 1998) nearly half were female. The reduction of mature females places an additional

burden and pressure on younger, less-experienced females to be the foundation for population growth. Younger females may be more apt to abandon their calves and less successful in calf rearing (Marine Technical Advisory Council 1994). A loss of mature, experienced males may also reduce the likelihood of successful mating. The greatest present threat to manatees is the high rate of manatee mortalities caused by watercraft collisions. O'Shea *et al.* (1985) recognized the dramatic increase in the rate of boat use in manatee habitat and, consequently, the increase in the potential of boat-related manatee injury or death. Between 1986 and 1992, watercraft collisions accounted for 37.3 percent of all manatee deaths, where the cause of death could be determined (Ackerman *et al.* 1995). The significance of manatee mortalities related to watercraft appears to be the result of dramatic increases in vessel traffic. Ackerman *et al.* (1995) showed a strong correlation between the increase in recorded manatee mortality and increasing boat registrations. In 1960, there were approximately 100,000 registered boats in Florida; by 1990, there were more than 700,000 registered vessels in Florida (Marine Mammal Commission 1992, Wright *et al.* 1995). Approximately 97 percent of these boats are registered for recreational use. The most abundant number of registered boats is in the 16-foot to 26-foot size class. Between 1974 and 1997, there were 3,270 known manatee mortalities in Florida. Of these, 749 were watercraft-related. Since 1974, an average of 31 manatees have died from watercraft-related injuries each year; between 1983 and 1993, manatee mortalities resulting from collisions with watercraft reached record levels (DEP 1994). Approximately twice as many manatees died from impacts suffered during collisions with watercraft than from propeller cuts; this has been a consistent trend over the last several years. Medium or large-sized boats cause most lethal propeller wounds, while impact injuries are caused by fast, small to medium-sized boats (Wright *et al.* 1992). Watercraft-related mortalities were most significant in the southwest and northeast regions of Florida; deaths from watercraft increased from 11 to 25 percent in southwestern Florida. In all of the counties that had high watercraft-related manatee deaths, the number of watercraft and the seasonal abundance of manatees were high (Ackerman *et al.* 1995).

Action area status information

Historical records regarding manatees in Broward County are sparse. Manatees are mentioned in documents that are dated as early as the mid 1800's and early 1900's (O'Shea 1988). Moore (1951) references observations told to him of common manatee use of the New River. It is unknown if these early accounts of manatees were associated with the Lauderdale Power Plant which began operations in 1926 (Mezich 2001). Prior to the Broward county power plants, Dade County may have been important historically to wintering manatees. Moore (1951) also notes the importance of the Miami River, including the 1943 anecdotal observation of more than 100 manatees killed during the deepening of the Miami River Channel and his 1956 reference of 195 manatees aggregating at the Miami power plant discharge (Mezich 2001). Additionally, the rivers, creeks and canals that open into Northern Biscayne Bay were locations noted for their manatee abundance.

Power plant usage as warm water refuge

Hartmann (1974) reported that an aggregation of as many as 30 manatees used the lower reaches of Port Everglades power plant's discharge canal during the early 1970's. The first organized aerial counts occurred in 1976 when the U.S. Fish and Wildlife Service funded them (Irvine and Campbell 1978). During the first survey on January 30, 1976, 78 manatees including 10 calves were counted in Broward County, all but two located at a power plant (Irvine and Campbell

1978). Since 1977, Florida Power and Light (FPL) has continued winter aerial surveys of at all of their coastal power plants. The increasing numbers of manatees counted at the Port Everglades plant during the early and mid 1970'a may have been a result of two factors. First, as noted by Rose and McCutcheon (1980) the Miami River Power plant closed in 1973, where Moore (1956) estimated as many as 195 manatees aggregated during the winter. Secondly, during the same time frame the FPL-Lauderdale plant was beginning to operate less consistently, which may have discouraged manatees from this site.

Data prior to 1993 corresponds with later information that manatees have favored the Port Everglades facility over the Lauderdale plant. The USGS-Sirenia Project radio tagged 71 manatees and monitored their movements over a 12-year period from 1986 to 1998. Seventeen of these individuals visited the Port Everglades facility as opposed to 5 visiting the Lauderdale facility. Additionally, in 1986 a total of 124 individual manatees had been cataloged at Port Everglades by photographic records of distinctive scar patterns (Reid and Rathburn 1995).

Mezich (2001) believes that the manatee preference for the Port Everglades may be changing. The Lauderdale plant repowered in 1993 and began operating more consistently. Since that time, manatees have used this plant in greater numbers (Reynolds 2000). The numbers of manatees using the Lauderdale plant has grown to a point, where for the first time on a January 2000 synoptic survey, more manatees were counted at the Lauderdale plant than at the Port Everglades plant – 124 to 111 respectively. During the 2001 survey the Lauderdale plant had an all time high count of 143 animals. Reynolds (2000b) noted this interesting change in behavior, "the importance of certain locations can change dramatically over time, and it provides some empirical data on this timing of transitions". The growing preference for the Lauderdale plant, maybe due to the new consistency of warm water in the cooling canals in conjunction with the lack of human disturbance. Reynolds also speculates that this preference would be manifested primarily in females and calves. In 1999-2000 the FPL-Lauderdale had the highest increase in calves for all plants.

The warm-water refuge at the Port Everglades plant is located approximately 7-miles seaward of the Lauderdale plant. Beeler and O'Shea (1988) concluded that in Broward County, the Lauderdale and Port Everglades power plants were the only areas known to be used in numbers by manatees. Despite the fact that these plants are located well within the manatee's winter range, it is debatable as to the level of importance of the Broward County power plants to the winter survival of manatees. Only two cold stress deaths have been recorded in Broward County since 1974 (Mezich 2001). Although the number of cold related deaths is low, this indicates that manatees are not immune to cold weather in southeastern Florida. In addition to being warm-water refugia, these power plants offer respite from heavily trafficked waterways, incidents of human-related harassment.

Manatees that aggregate at the FPL plants in Broward County are known to travel between the Lauderdale and Port Everglades plants as well as other warm-water refugia on the on the east coast of Florida (Deutsch 2000 and MMC 1998). The high single day winter manatee counts for these warm-water are: FPL-Lauderdale (143) and FPL-Port Everglades (276). The last five annual survey counts done at FPL-Lauderdale and FPL-Port Everglades have shown a great deal of variability. Several factors can affect these aerial counts (i.e. weather conditions that affect

manatee distribution and poor water clarity). Table #2 presents all of the aerial survey data for FPL-Port Everglades from 1977-2001.

Table #2 – Aerial survey abundance data for FPL-Port Everglades

Survey year	FPL-Port Everglades High Count
1977-1978	114
1978-1979	125
1979-1980	86
1980-1981	110
1981-1982	57
1982-1983	56
1983-1984	35
1984-1985	234
1985-1986	185
1986-1987	182
1987-1988	276
1988-1989	173
1989-1990	227
1990-1991	75
1991-1992	212
1992-1993	70
1993-1994	224
1994-1995	207
1995-1996	13
1996-1997	60
1997-1998	183
1998-1999	60
1999-2000	134
2000-2001	290

Source – Mezich 2001

Foraging

During the winter, water temperature is a primary factor that dictates when manatees leave warm-water refugia and where they forage. Manatees that winter at the Broward county power plants are foraging primarily on aquatic vegetation in Dade County (Mezich 2001). Distribution and abundance of freshwater aquatic vegetation in the area of Broward County power plants is relatively limited and relegated to vegetation growing in canals or on the shoreline, including overhanging plants and trees. In freshwater environments in Dade County, manatees are feeding primarily on the exotic *Hydrilla verticillata*.

Even though manatees may travel in excess of 20 miles to get to foraging areas in Dade County, this is not inordinately farther than distances traveled by manatees on the west coast of Florida to get from warm water refugia to foraging grounds.

Mortality

The causes for manatee deaths in Broward County are varied; however, Broward County does not have any cause of death category that ranks as one of the highest in the state. Deaths related to cold stress have been almost non-existent over the past 25 years of record keeping, with only three being reported in that time period. Port Everglades is well within the historic range for the Florida manatee described by Moore (1951b). Water temperatures seldom reach stressing levels for extended periods of time and the power plants in Broward County have likely ameliorated cold related stress. Table #3 depicts the manatee mortalities reported for Broward County since 1974.

The highest number of manatee deaths in Broward County result from watercraft interactions. Over half of the deaths related to this category are concentrated within a 1.5-mile radius of Port Everglades. The amount of deaths in this area is likely due to high recreational and commercial vessel traffic converging with a manatee travel corridor. In the vicinity of these deaths there are two power plants, an inlet, a port, and a major manatee migration corridor (Mezich, 2001).

Broward County has also had six floodgate deaths since 1974, but only one in the last five years. Floodgates often have qualities that are attractive to manatees. Freshwater is often available at floodgates as are slightly warmer the ambient water temperatures. An example of this situation is the floodgate on the Little River in Dade County. This site is known to attract manatees during mild portions of winter. This location has a 1-degree Celsius higher water temperature than surrounding areas and freshwater is available (Deutsch 2000). Also, freshwater vegetation is often washed down from upriver and made available when the gates are opened. Overall, Broward County ranks 10th out of 43 counties that have documented manatee deaths.

The Corps and the South Florida Water Management District (SFWMD) have identified 17 water control structures in Broward County needing to have manatee protection devices installed. The Corps will be starting work on two of these structures (S-13 and S-33) in the near future (Overstreet, pers. comm. 2002). The locations of all water control structures in Broward County, operated by the SFWMD, are shown in Figure 2. Structure S-13 is located on the DCC, and by placing the manatee protection device at this structure, manatees transiting the DCC will be less likely to die as a result of crushing or entrapment in the structure.

Figure 2 - Locations of Water Control Structures in Broward County

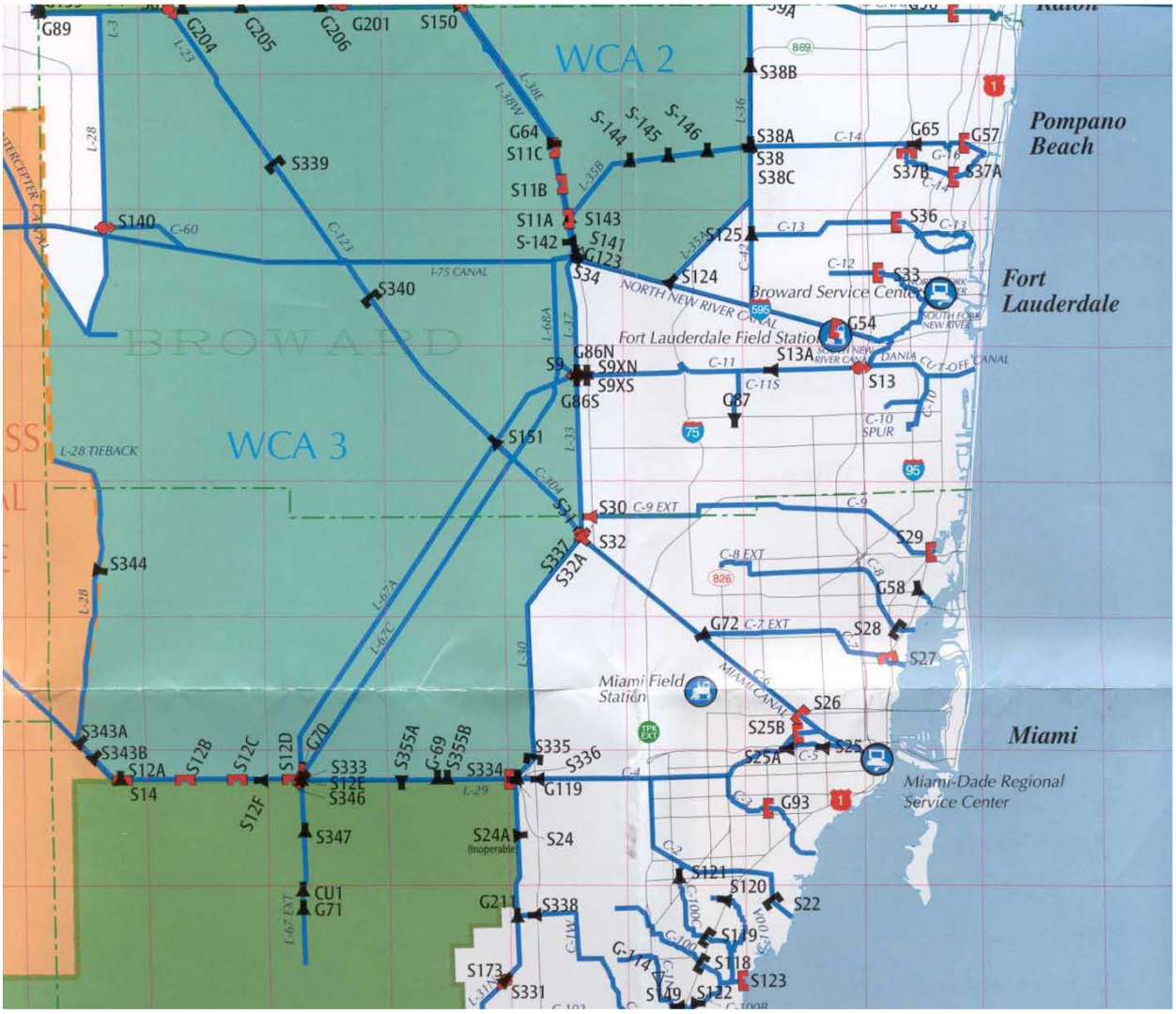


Table #3 – Manatee deaths in Broward county 1974-2001

Year	Watercraft	Flood Gate/ Canal Lock	Other Human	Perinatal	Cold Stress	Natural	Undetermined	Unrecovered	Total
1974	0	0	0	0	0	0	1	0	1
1975	1	0	0	0	0	0	0	0	1
1976	1	0	0	0	0	0	0	0	1
1977	0	0	1	1	0	0	2	0	4
1978	0	0	0	1	0	0	0	1	2
1979	0	0	0	0	0	0	2	0	2
1980	2	1	0	2	0	0	1	4	10
1981	1	0	0	0	0	0	1	0	2
1982	2	1	0	0	0	0	1	0	4
1983	1	0	0	0	0	1	0	0	2
1984	2	0	0	0	0	0	3	0	5
1985	0	1	2	0	0	0	1	0	4
1986	2	0	0	2	1	0	0	1	6
1987	5	0	0	0	0	0	1	0	6
1988	2	0	0	0	1	1	0	0	4
1989	3	0	1	1	0	0	0	0	5
1990	1	0	0	0	0	0	0	0	1
1991	2	1	0	0	0	0	0	0	3
1992	2	0	0	5	0	0	2	0	9
1993	2	0	0	1	0	0	1	0	4
1994	3	0	0	1	0	0	0	0	4
1995	0	1	0	4	0	0	0	0	5
1996	1	0	0	2	0	2	2	0	7
1997	0	0	0	1	0	2	2	0	5
1998	2	1	0	2	0	2	2	0	9
1999	5	0	0	4	0	5	5	0	19
2000	2	0	0	1	0	1	1	0	5
2001	4	0	0	3	1	0	0	0	8

Description of suitable manatee habitats within the action area

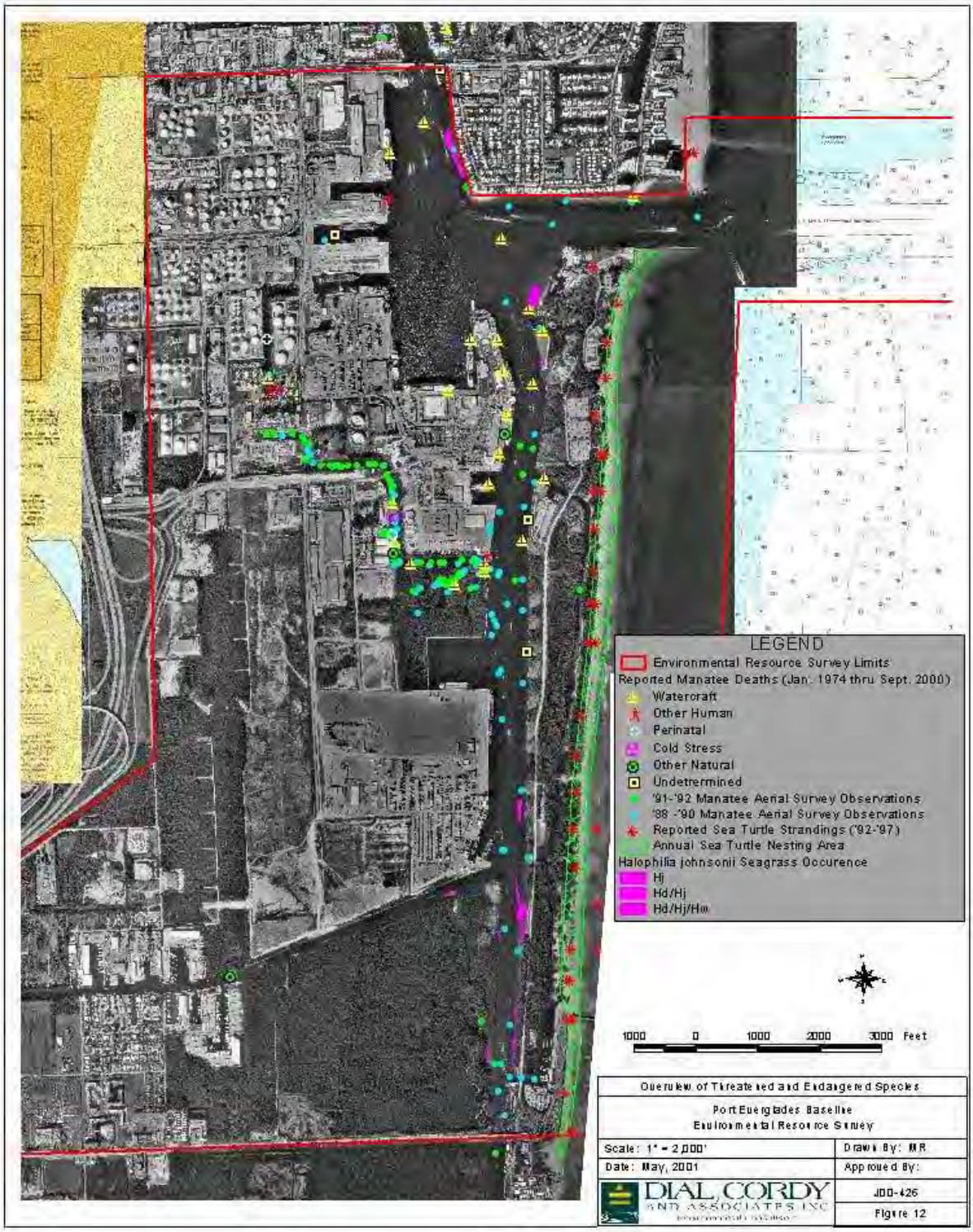
Manatees occur in both fresh- and saltwater habitats within tropical and subtropical regions. They depend on areas with access to natural springs or manmade warm water and access to areas with vascular plants and freshwater sources. Several factors contribute to manatee distribution. These factors are habitat-related and include proximity to warm water during cold weather, aquatic vegetation availability, proximity to channels of at least 2m in depth, and location of fresh water sources (Hartman 1979).

Manatees are also dependant upon location of foraging sites. As previously discussed, radio-tracking of manatees at the Port Everglades power plant has shown that they transit south, into Dade county to forage due to the lack of foraging area available to them near the power plant.

Manatees often seek out quiet areas in canals, lagoons or rivers. These areas provide habitat not only for feeding, but also for resting, cavorting, mating, and calving. Deeper channels are often used as migratory routes (Kinnaird 1983). Manatees seek out natural or artificial freshwater sources, especially manatees that spend time in estuarine and brackish water (FWS 1996).

The former "EPA slip" within the Port has been identified as an area of high manatee useage, and has been documented as a site utilized by calving mothers (Port Everglades, 2002). Figure #3 displays the location of manatees sighted during aerial surveys conducted from 1988 – 1992.

Figure 3 – Manatee locations – Aerial Surveys



Protective Measures taken in the project area separate from conservation measures the Corps will take as part of the proposed action

Port Everglades

Port Everglades has taken numerous steps to reduce manatee-human interaction, injury and mortalities within the port. The port has spent more than $600,000 to increase protective measures for manatees within the port (Sosnow 2002 pers.comm). These steps have included:

- Posting of manatee warning and speedzone signage throughout the Port.
- The Port desigated the former "EPA slip" in the FPL discharge canal as a "Manatee Nursery Area" to restrict the area's use from boaters and the general public. The area has been documented as a site utilized by calving mothers (Port Everglades 2002).
- Development and implementationof a Manatee protection plan for use during dredging for use during dredging activites within the Port.
- Development and implementation of a Manatee protection plan for use during blasting activites within the Port.
- Manatee Lagoon Improvements – the Port deepened tha lagoon and the water below the mangroves adjacent to the FPL canal. Thes improvements allow manatees to stay in the lagoon during all tidal stages; as well as increasing flushing of warm water into the area. The port also placed floating barricades and signage to keep the public out of the area. The area has been documented as a site utilized by calving mothers (Sosnow 2002 pers.comm.).
- Lagoon Protection at the John U. Lloyd State Recreation Area.
- Funding of research on manatees within the port conducted by the FWS and the Miami Seaquarium and other researchers (White, Reynolds, Fleetameyer).
- Participation in law enforcement activities to prevent harrassment of manatees by individuals swimming with them.
- Each year before the manatee "season" (Nov 15-Mar 31) begins, the Port sends letters to tug companies and pilots reminding them about the upcoming season and about the protective measures that the port has implemented to protect manatees in the port.
- The port has placed fenders throughout the entire port at 50 ft centers to fender off ships – when a ship is tied to the bulkhead, the fender is approximately 4 feet in width. These fenders prevent manatees from being crushed between the ships and the bulkhead walls.
- Development of outreach programs and materials including brochures, seminars and public talks. The port opened a platform/sea life viewing area to educate the public about the manatees and other animals that are in the port. 400,000 people visited the platform in one year. This viewing area caused traffic and parking problems near the port and had to be closed.

Broward County

Broward County is one of 13 Florida counties required to have a manatee protection plan developed under the Local Government Comprehensive Planning and Land Development Regulation Act (LGCPALDRA) of 1985. The LGCPALDRA requires these plans include speed and no entry zones, boat facility siting policies and other measures to protect manatees. Broward

County has prepared a plan, and incorporated it into the county's "Comprehensive Plan". These plans are submitted to the State, through the Florida Fish and Wildlife Conservation Commission, and to the Federal government through the US Fish and Wildlife Service. As of November 2001, neither the state nor the USFWS had approved the Broward County plan (USFWS 2001). The county's Manatee protection element of the comprehensive plan is located in the "Conservation Component" of the plan (Chapter 13, book 2).

Speed & No Entry Zones
Seasonal no-entry zones around the power plants were created in 1979 and amended in 1983. A Broward County wide speed zone rule was adopted in May 1993 (68C-22.010, Florida Administrative Code). Placement of speed zone signage for the Broward County rule was completed in October 1994. The County has worked with FPL to restrict or prohibit access to certain waterways and waterbodies that appear to be manatee high use areas.

Boating facility Siting Policies
The LGCPALDRA requires "manatee" counties to prepare policies concerning the siting of boating facilities. The County has not taken an approach to boat facility siting since it is considered built out (Arnold 2001). New facilities are likely to be conversions of either existing property to multifamily residential or the redevelopment of commercial facilities to accommodate larger vessels usually by lowering the number of slips at a site (Arnold 2001). Therefore, new boat facility development and the expansion or conversion of of existing facilities will be reviewed for impacts to manatees and their habitat through normal state permitting. The County will provide guidance to potential boat facility developers by guiding them to be consistent with the plan and to incorportate Best Management Practices within their application.

Designation of Essential Habitat for Manatees within the County
Broward County has identified areas to be designated as essential habitat: the FPL plant discharge areas; Port and Whiskey Creek; the Hollywood Canal; the residential canals located approximately one quarter mile west of the Florida Turnpike and immediately north of I-595 (Plantation Isles subdivision), and the Hillsborough Inlet (Arnold, 2001).

Scientific Research on Manatees
Regulations developed under the ESA allow for the taking of ESA-listed manatees for the purposes of scientific research. In addition, the ESA also allows for the taking of listed species by states through cooperative agreements developed per section 6 of the ESA. Prior to issuance of these authorizations for taking, the proposal must be reviewed for compliance with section 7 of the ESA. Research permits for manatees are issued by the FWS' headquarters in Arlington, VA (Valade 2002 pers.com). Research activities currently conducted under permit from FWS in the action area include:

- Photo identification study of manatees by the USGS-Sirenia project
- Photo identification study by Dr. Ed Keith of NOVA University
- Carcass recovery and necropsy activities conducted by the State of Florida through the Florida Marine Research Institute's Marine Mammal Pathology Laboratory.

Other consultations of Federal actions in the area to date

The Corps has been working with the citizens of Broward County since 1930 on improving and maintaining Port Everglades Harbor (USACE 2002). The following table lists the improvements authorized by Congress. None of the projects authorized by Congress through 1958 were required to consult under the ESA, it is unknown if a consultation under Section 7 of the ESA was conducted on the 1974 project.

ACTS	WORK AUTHORIZED	DOCUMENTS
3 Jul 1930	Maintenance of harbor constructed by local interests.	H. Doc. 357/71/2
30 Aug 1935	Enlarge entrance channel to existing project dimensions and complete turning basin to 1,200 feet square.	R. & H. Comm. Doc. 25/74/1
20 Jun 1938	Widen turning basin 350 feet on north side.	H. Doc. 545/75/3
24 Jul 1946	Widen turning basin 200 feet on north side, 500 feet on south side, and enlarge flare at entrance channel.	H. Doc. 768/78/2
3 Jul 1958	Deepen and widen entrance channel on a new alignment and increase turning basin in size and depth.	H. Doc. 346/85/2
H.R. 9 May 1974 S.R.31 May 1974	Deepen and widen entrance channel on a new alignment, deepen turning basin and add a new channel to the southeast of the turning basin. This project was completed in 1984.	H. Doc. 144/93/1

Projects completed by the Port without Federal assistance

1987	Port Everglades. Final Environmental Impact Statement, Proposed Expansion Port Everglades, Broward County, Florida. EIS for deepening and widening the Southport Access Channel, bulkheading port land, creation of the Turning Notch. This project was completed

<u>Effects of the proposed action</u>

Direct effects

As previously stated, during winter months a large population of manatees uses the warm water refuge at the FP&L Power Plant at Port Everglades and at the Lauderdale power plant at the end of the DCC.

The highest potential to directly effect endangered manatees may be the use of explosives to remove areas of rock within the Entrance Channel and Southport Access Channel. Both the pressure and noise associated with blasting can injure marine mammals. Noise and pressure effects to manatees have not been well documented, however, it is assumed that manatees will be impacted similar to dolphins, where documentation is available.

Blasting

To assess and reduce the effects of blasting on endangered, threatened and otherwise protected species, the Corps contracted with Dr. Calvin Konya, Precision Blasting Services, to review previous Corps blasting projects, recommendations of Florida Fish and Wildlife Conservation Commission (FFWCC) (then known as the Florida Department of Natural Resources) and the U.S. Fish and Wildlife Service (FWS) prepared for a harbor deepening project at Port Everglades, Florida conducted in the mid 1980's. A copy of this plan has been previously provided to the FWS during coordination activities on this action.

Historic Blasting in Port Everglades and Manatee Protections

During the consultation process on the 1983 blasting in Port Everglades, the FWS and FFWCC recommended that a formula proposed by Johnson, Commander, USN and Project Manager and Coordinator of OICC TRIDENT.

An arc having a radius defined by delineated the danger zone:

$$D = (13000\ W^{1/3})/P$$

Where:

D = radius of the danger zone in feet
W = weight of the explosive charge in pounds
P = overpressure created by the explosion shockwave, where
P = 50 psi+ ambient pressure

However, it was later pointed out by an expert in blasting and dredging activities that this formula could not be applied to the Port Everglades blasting project because it was based on an unconfined blast instead of a confined blast. An unconfined blast is defined as an open air or open water blast without any physical restrictions that will slow down its development. A confined blast is usually associated with drilling and blasting within the restrictions of rock strata. As a result of this information, the consultation group rejected the formula.

Alternatively, the physical parameters used during an ongoing dredge project in Kings Bay, Georgia. The physical parameters of distance vs. overpressure for the Kings Bay project were determined by a test blasting conducted between 28 June and 2 July 1983 at Kings Bay, Georgia. Assuming a water overpressure of 50 psi or less would not harm a manatee, the results of the test program indicated that this overpressure would not be exceeded at a distance of 400 feet given a blast of 780 pounds of explosives per day. The Corps also decided to extend the blasting danger zone to 600 feet to ensure a safety margin.

To adequately ensure the safety of manatees while blasting, a 14-point plan was developed. Agencies involved in designing this plan include FFWCC, FWS, the Corps and the Florida Audubon Society. The manatee protection program used during the Port Everglades harbor deepening project in the mid-1980's was successful and will be used as a model in the upcoming project.

Aerial surveys were conducted prior to the beginning of the blasting project. A Bell helicopter was used to survey the Port area on three consecutive days prior to the beginning of the blasting. Provisions were included in a "Manatee Protection Plan" stated that if more than five (5) animals were observed on those surveys, the project would be delayed until the number of animals fell below five. The surveys were flown at ground speed, which ranged between 10 kts and 60 kts and at an altitude that ranged between 50 meters and 200 meters.

Results of the 1983 blasting in Port Everglades
During the period between 4 April and 8 May when this program was in operation, a total of 58 manatee sightings were made on 28 separate occasions were made. A table of these observations is included in Konya (2001) (Table #2). Three of these sightings were made with the fathometer, while the remaining 25 were visual observations made by either the boat observer or observers stationed on the drill barge.

These observations necessitated shutting down the blasting operation for a total of 14 times and for a total of 222 minutes, the average time being 15 minutes, 12 seconds. On April 19, 1984, because of the number of manatees observed near the dynamite drill barge, the operation was shut down prematurely and was not resumed until the next day.

Possibility for injury or mortality in mammals in the project area
To protect mammals (manatees and dolphins), the following relationship has been used in the past and has been into previous Corps dredging projects. This formula is based on the Navy Diver Formula, which is designed for unconfined charges.

$$\text{Caution zone radius} = 260(\text{lbs/delay})^{1/3}$$

$$\text{Safe zone radius} = 520(\text{lbs/delay})^{1/3}$$

The caution zone is the radius from the blast where mortality will not occur.

New data obtained from the 1983 Port Everglades blasting project indicates that the Navy Diver Formula is extremely conservative for predicting safe distances from the charges that are placed in boreholes. In his report, Koyna (2001) proposes a new formula that incorporates actual measurements of pressures generated from underwater blasts with explosives in boreholes. The new equation is:

$$\text{Caution zone} = 132(\text{lbs/delay})^{1/3}$$

$$\text{Safe zone radius} = 56(\text{lbs/delay})^{1/3}$$

The Corps plans to utilize this new formula in the proposed blasting at Port Everglades. Additionally, the Corps will prepare a marine mammal and sea turtles protection plan similar to the one used in the previous deepening project will be employed. Based on the previous mid-1980 program a 600 feet safety zone will be used. Trained, experienced observers would monitor the safety zone by helicopter, high vantage points, and boat. Examples of the provisions to be included in the protection plan are included below:

In order to provide dependable verification of presence of manatees within the blast zone, a detection system was designed which included the following three provisions:

- Provision 7: A trained observer will be stationed on the sighting tower or catwalk of the dynamite drill barge.

- Provision 8: An observer in a boat will make a systematic survey of the danger zone prior to blasting.

- Provision 9: An electronic color enhanced fathometer will be utilized to monitor underwater manatee movement.

Additionally, special conditions will be placed into the specifications for the project to protect manatees in the area.

1. A marine mammal watch will be conducted by no less than 2 qualified observers from a small watercraft, at least ½ hour before and after the time of each detonation, in a circular area at least three times the radius of the above described danger zone (this is called the watch zone).
2. Any marine mammal(s) in the danger zone or the watch zone shall not be forced to move out of those zones by human intervention. Detonation shall not occur until the animals(s) move(s) out of the danger zone on its own volition.
3. No blasting will occur in the south channel during the “manatee season”.
4. In the event a marine mammal or marine turtle is injured or killed during blasting, the Contractor shall immediately notify the Contracting Officer as well as the following agencies:
    a. Florida Marine Patrol "Marine Mammal Stranding Hotline" 1-800-342-5367
    b. FWS – Vero Beach Office
    c. National Marine Fisheries Service – Protected Resources Division, St. Petersburg

Other Rock Removal Options

The Corps investigated methods to remove the rock in Port Everglades without blasting using a punchbarge. It was determined that the punchbarge, which would work for 12-hour periods, strikes the rock below approximately once every 30-seconds. This constant pounding would serve to disrupt manatee behavior in the area, as well as impact other marine animals in the area. Using the punchbarge will also extend the length of the project temporally, thus increasing any potential impacts to all fish and wildlife resources in the area.

The Corps believes that blasting is actually the least environmentally impactful method for removing the rock in the Port. Each blast will last no longer than 25 seconds in duration, and may even be as short as 2 seconds, and will be spaced out twelve hours apart. Additionally, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced as compared to an unconfined blast.

Indirect effects

The regulations for interservice consultation found at 50 CFR 402 define indirect effects as "are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur". The Corps does not believe that the project will have any indirect effects on manatee in the action area.

Effects of interrelated and interdependent actions

The regulations for interservice consultation found at 50 CFR 402 define interrelated actions as "those that are part of a larger action and depend on the larger action for their justification" and interdependent actions as "those that have no independent utility apart from the action under consideration."

The Corps does not believe that there are any interrelated actions for this proposed project; however, the recommended plan for Port Everglades contains widening components and deepening components. As a result of the widening components of the project, larger container vessels will call at Port Everglades. As a result of both the widening and the deepening components of the project, more tonnage will be carried per vessel call, so the total number of vessel calls will be reduced (Dawedit 2002. pers comm.). This will be an indirect benefit to the manatees since there will be fewer ships in the area to potentially affect them. Additionally, the wider channel will provide manatees more room to maneuver around incoming and outgoing vessels throughout the action area.

The Corps believes that the increase in size within the Port will not have an adverse effect on manatees in the area for three reasons:

1) Recent data shows that manatees are not using the Port itself as a primary habitat. Aerial surveys conducted between 1988-1992 show that very few manatees use the area of the Port proper. They congregate in the canal to the Port Everglades power plant, as well as in the "EPA slip" – both of which are located south of the Port (Figure 2);
2) The Port has developed a manatee protection plan and implemented items included in the plan – including the placement of 4-ft wide bumpers along the slips to hold ships 4-feet away from the bulkheads, thus reducing the potential for a manatee to be crushed by a ship; The Port has also put into place regulations drafted by the state that requires ships to travel at the slowest speed possible that maintains steerage, and
3) Fewer manatees are utilizing the Port Everglades power plant as a winter thermal refuge – so there are fewer animals in the area that could be affected by the project.

Cumulative effects
The regulations for interservice consultation found at 50 CFR 402 define cumulative effects as "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 consideration." The Corps is not aware of any future state or provate activites, not involving Federal activities that are reasonably certain to occur within the action area."

Take Analysis
Due to the restrictions and special conditions placed in our construction specifications the Corps does not anticipate any take of the endangered Florida manatee.

Determination
The Corps has determined that the proposed expansion and deepening of Port Everglades Harbor is likely to affect, but not likely to adversely affect listed species within the action area. The Corps believes that the restrictions placed on the blasting previously discussed in this assessment will diminish the effect of the project on protected species within the action area.

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