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National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

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F/SER31:KL

SEP 08 2011

Mr. Eric Summa
Jacksonville District Corps of Engineers
Department of the Army
P.O. Box 4970
Jacksonville, FL 32232

Re: Miami Harbor

Dear Mr. Summa:

This constitutes the National Marine Fisheries Service's (NMFS) Biological Opinion based on our review of the Corps of Engineers' (COE) planned dredging activities for the expansion of the Miami Harbor. The COE requested reinitiation of consultation on the 2003 biological opinion for this project, based on the subsequent listing of threatened corals and designation of their critical habitat, both of which may be adversely affected by the proposed action. This biological opinion supersedes the 2003 opinion.

The project includes deepening the entrance channel from 44 feet to 52 feet and extending the width of the mouth of the existing channel 150 feet on either side (a total of 300 feet). The biological opinion analyzes the project's effects on staghorn coral (*Acropora cervicornis)* and its designated critical habitat in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, and is based on information provided in your letter dated January 6, 2011; subsequent information provided by e-mail correspondence on February 28, 2011; the biological assessment (BA) dated January 6, 2011, that was submitted with the consultation package; and information from previous NMFS' consultations involving staghorn coral. It is NMFS' biological opinion that the action, as proposed, is likely to adversely affect *A. cervicornis*, but is not likely to jeopardize its continued existence or adversely modify its designated critical habitat. Based upon our updated analysis, we no longer expect the project will adversely affect Johnson's seagrass or its designated critical habitat.

We look forward to further cooperation with you on other COE 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 e-mail at Kel.Logan@noaa.gov.

Sincerely,

Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure
File: 1514-22.F.4
Ref: F/SER/2011/00029

Endangered Species Act - Section 7 Consultation
Biological Opinion

Agency:	United States Army Corps of Engineers, Jacksonville District (COE)
Activity:	Dredging and expansion of Miami Harbor, Miami-Dade County, Florida (Consultation Number F/SER/2011/00029)
Consulting Agency:	National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS), Southeast Regional Office, Protected Resources Division, St. Petersburg, Florida
Approved By:	Roy E. Crabtree, Ph.D., Regional Administrator NMFS, Southeast Regional Office St. Petersburg, Florida
Date Issued:	

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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 shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species; Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary on any such action. NMFS and the U.S. Fish and Wildlife Service (FWS) share responsibilities for administering the ESA.

Consultation is required when a federal action agency determines that a proposed action "may affect" listed species or designated critical habitat. Consultation is concluded after NMFS determines that the action is not likely to adversely affect listed species or critical habitat or issues a biological opinion (opinion) that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat. The opinion states the amount or extent of incidental take of the listed species that may occur, develops measures (i.e., reasonable and prudent measures - RPMs) to reduce the effect of take, and recommends conservation measures to further conserve the species.

This document represents NMFS' opinion based on our review of impacts associated with the proposed action to expand the Miami Harbor in Miami-Dade County, Florida. This opinion analyzes the project's effects on *A. cervicornis* and its designated critical habitat, in accordance with Section 7 of the ESA, and is based on project information provided by COE and other sources of information including the published literature cited herein.

BIOLOGICAL OPINION

1 CONSULTATION HISTORY

The project was previously coordinated with NMFS on September 5, 2002, resulting in a biological opinion for effects on Johnson's seagrass and its designated critical habitat, dated February 26, 2003. As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required when a new species is listed or critical habitat is designated that may be affected by the identified action. On May 9, 2006, NMFS listed staghorn and elkhorn corals (*Acropora cervicornis* and *Acropora palmata,* respectively) as threatened under the Endangered Species Act (ESA). On December 28, 2008, NMFS issued a final rule designating critical habitat for both species of threatened corals. On January 6, 2011, NMFS received a request for reinitiation of ESA consultation from the COE which included a biological assessment (BA) dated May 2010. The COE determined that the project may affect *A. cervicornis* and its designated critical habitat; may affect, but is not likely to adversely affect swimming seaturtles, blue, fin, sei, humpback and sperm whales, Johnson's seagrass, and smalltooth sawfish; and would have no effect on *A. palmata*. The COE requested formal consultation with NMFS for staghorn coral. By letter dated February 23, 2011, NMFS requested information regarding the dredge type and disposal areas; impacts to smalltooth sawfish; turbidity control plans; project funding sources; and details regarding acreages of designated critical habitat within the project area. The COE responded with supplemental information via e-mail dated February 28, 2011. The COE indicated that the disposal sites are void of any seagrass or hardbottom resources and agreed to provide detailed turbidity control plans prior to dredging. Additional information was also provided by the National Coral Reef Institute (NCRI) at Nova Southeastern University dated March 26 and April 12, 2011. This information was used to more accurately determine the amount of critical habitat within the project area. NMFS reinitiated formal consultation on February 28, 2011. This opinion supercedes the 2003 opinion for the proposed action.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

The proposed action includes the widening and deepening of most of the major channels and turning basins within Miami Harbor. This action includes five components: (1) flaring the existing 500-foot wide entrance to provide an 800-foot wide entrance channel at Buoy 1, and deepening the entrance channel from a depth of 44 feet to a depth of 52 feet; (2) widening the southern intersection of Cut 3 and the Lummus Island Channel at Buoy 15, and deepening the area from 42 feet to 50 feet; (3) extending the existing Fisher Island turning basin to the north by approximately 300 feet near the west end of Cut 3, and deepening the area from 42 feet to 50 feet; and (4) increasing the width of the Lummus Island Cut by about 100 feet to the south of the existing channel, reducing the existing size of the Lummus Island turning basin to a diameter of 1,500 feet, and deepening the area from 42 feet to 50 feet. Hydraulic cutterhead, and/or clamshell and backhoe dredges may be used during the expansion. 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 traditional dredging methods. Where hard rock is encountered, the COE anticipates that explosives, and/or large cutterhead equipment will be used to remove the rock. Dredged material will be transported via barge and deposited in four locations: (1) an artificial reef site in the nearshore Atlantic Ocean off Dade County, Florida; (2) the Ocean Dredge Material Disposal Site (ODMDS) in the Atlantic Ocean approximately 4.5 miles offshore of Miami-Dade County, Florida; and (3) a previously dredged depression in Northern Biscayne Bay, Florida. The COE will maintain a minimum 400 foot buffer between the disposal site and any adjacent hardbottom resources.

The use of explosives will be limited to areas inshore of the outer reef. To protect marine mammals and sea turtles the following mitigative measures will be used:

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.

2. The danger zone will be monitored by a combination of aerial observers, on water observers, and observers on the drill vessel.

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 on its own volition.

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

5. If explosives are used, the COE 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.

The COE will require the contractor(s) to follow the Terms and Conditions in NMFS' 1997 Regional Biological Opinion (RBO) on Hopper Dredging along the South Atlantic Coast. The 1997 RBO incorporates (by reference) NMFS' 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,[1] because the proposed project is not located in or near the calving area. The COE will also require the contractor(s) to follow the enclosed NMFS' March 23, 2006, Sea Turtle and Smalltooth Sawfish Construction Conditions.

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[1] In the southeastern United States, this calving area is located in coastal waters between 31 degrees 15 seconds N (approximately located at the mouth of the Altamaha River in Georgia) and 30 degrees 15 seconds N (approximately Jacksonville, Florida) from the shoreline east to 15 nm offshore; and the waters between 30 degrees 15 seconds N and 28 degrees 00 seconds N (approximately Sebastian Inlet, Florida) from the shoreline out to 5 nm.

2.2 Action Area

50 CFR 404.02 defines action area as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The action area for this project includes the Port of Miami and the Miami Harbor which are located on the north side of Biscayne Bay in Miami-Dade County, Florida. This includes the access channel which extends approximately 3 miles into the Atlantic Ocean. The action area also includes the spoil disposal sites which consist of an artificial reef site in the nearshore Atlantic Ocean off Dade County, Florida; the ODMDS in the Atlantic Ocean approximately 4.5 miles off Miami-Dade County, Florida; and a previously dredged depression in North Biscayne Bay, Florida.

3 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

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*	
Sea Turtles		
Loggerhead sea turtle	*Caretta caretta*[2]	E/T
Hawksbill sea turtle	*Eretmochelys imbricata*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Green sea turtle	*Chelonia mydas*[3]	E/T
Fish		
Smalltooth sawfish	*Pristis pectinata*	E
Plants		
Johnson's seagrass	*Halophila johnsonii*	T
Invertebrates		
Elkhorn coral	*Acropora palmata*	T

[2] NMFS and USFWS published a proposed rule in the Federal Register on March 16, 2010 , to list nine Distinct Population Segments (DPSs) of loggerhead turtles worldwide, seven of which are endangered (including the Northwest Atlantic Ocean DPS) and two of which are threatened (75 FR 12598).

[3] Green turtles are listed as threatened except for breeding populations in Florida and the Pacific coast of Mexico, which are listed as endangered.

Staghorn coral	*Acropora cervicornis*	T

Critical Habitat
ESA-designated critical habitat for Johnson's seagrass, and elkhorn and staghorn coral occurs within the action area.

3.1 Species and Critical Habitat Not Likely to be Adversely Affected

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. In addition, several marine mammals protected under the Marine Mammal Protection Act (MMPA) occur in the area of the proposed project, including bottlenose dolphin (*Tursiops truncatus*), spinner dolphin (*Stenella longirostris*), and long-finned pilot whales (*Globicephala melas*). If these or other non-ESA listed marine mammals may be adversely affected by the proposed action, a take authorization under the MMPA may be necessary. Please contact NMFS' Protected Resources headquarters office at 301-713-2332 for more information.

Smalltooth Sawfish
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 smalltooth sawfish by any type of dredge. Due to the species' mobility and the implementation of NMFS' Sea Turtle and Smalltooth Sawfish Construction Conditions, the risk of injury will be discountable. Sawfish may also be affected by blasting. Underwater explosions 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 (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 COE will require the contractor to adhere to the following safety conditions related to blasting:

1. Drill patterns will be restricted to a minimum of 8 feet of separation from a loaded hole.

2. Hours of blasting will be restricted from two hours after sunrise to one hour before sunset to allow for adequate observation of the project area for protected species.

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

4. 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 (Hempen et al., 2007).

5. 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.

Therefore, NMFS believes that the effects on sawfish from blasting will be insignificant. 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.

Johnson's Seagrass
Information provided by the COE in the May 2010 biological assessment and during the previous consultation indicated that the dredging area does not support seagrasses, including Johnson's seagrass. These findings were corroborated by the Florida Department of Environmental Protection Agency (DEP) Miami-Dade benthic habitat maps (Walker, B.K., 2009). Since Johnson's seagrass is not found within the action area it will not be considered further in this opinion.

Johnson's Seagrass Designated Critical Habitat
NMFS previously issued a biological opinion, dated 2003, which stated that designated critical habitat for Johnson's seagrass may be adversely affected by the proposed action. The project site occurs in Unit J of NMFS-designated critical habitat, described on the following pages. A total area of 24.9 acres of Johnson's seagrass critical habitat is present the action area, and there are approximately 18,757 acres of designated critical habitat within Unit J (NMFS 2002). Unit J is by far the largest of the designated critical habitat units, making up approximately 83 percent of total designated critical habitat for Johnson's seagrass throughout its 200-km range.

Critical habitat determinations focus on those physical and biological features that are essential to the conservation of the species (i.e., the essential features) (50 CFR 424.12). Federal agencies must ensure that their activities are not likely to result in the destruction or adverse modification of critical habitat through adverse effects to the essential features within defined critical habitat areas. Therefore, proposed actions that may impact designated critical habitat require an analysis of potential impacts to each essential feature. The essential features of Johnson's seagrass critical habitat are: (1) adequate water quality; (2) adequate salinity levels; (3) adequate water transparency; and (4) stable, unconsolidated sediments that are free from physical disturbance. All four essential features must be present in an area for it to function as critical habitat for Johnson's seagrass.

Based on our updated review of the proposed project, we have determined that the project is not likely to adversely affect Johnson's seagrass critical habitat. According to the COE, the Lummus Island Cut area that will be widened is currently -44 ft deep and the project will deepen the area to -52 feet. Johnson's seagrass cannot survive at these depths, likely due to the absence of sufficient light. Thus, in our judgment the water transparency essential feature is absent and this portion of the project area is not functioning as critical habitat. An additional 18.9 acres will be affected by the disposal of spoil material in the previously dredged depression. This area is 11 to 15 feet deep with suspended sediments causing low light at the bottom (Terri Jordan-Sellers, personal communication). The COE intends to fill this area to a depth of -4 feet and intends to use it for seagrass mitigation (Terri Jordan-Sellers, personal communication). This should increase the area's ability to support seagrasses including Johnson's seagrass by adjusting the bottom to a depth more conducive to light penetration and seagrass growth. Based on this information NOAA Fisheries believes that the filling of this depression may increase the area within the critical habitat that contains the essential features for the conservation of Johnson's seagrass and will add additional area for the expansion of Johnson's seagrass. Therefore, the action is not likely to adversely affect critical habitat for Johnson's seagrass.

Acropora palmata
No *Acropora palmata* was identified during the surveys. Since this species does not occur in the action area, it will not be considered further in this opinion.

3.2 Species and Critical Habitat Likely to be Adversely Affected

Sea Turtles
Five species of sea turtles (loggerhead, hawksbill, leatherback, Kemp's ridley, and green) may be found in or near the action area. Previous NMFS biological opinions have determined that

hopper dredges may adversely affect loggerhead, green, Kemp's ridley, and hawksbill sea turtles through entrainment by the draghead. NMFS has also determined that hopper dredges are not likely to adversely affect leatherback sea turtles. Hopper dredges will only be used to suction off accumulated shoal material from the existing channel prior to the expansion project. This activity is covered as maintenance dredging under the 1997 RBO. Any incidental take of loggerhead, green, Kemp's ridley, or hawksbill sea turtles due to hopper dredging has been previously authorized in NMFS' 1997 RBO on hopper dredging along the South Atlantic coast. The 1997 RBO authorized annual incidental take, by injury or mortality, of 35 loggerheads, 7 Kemp's ridleys, 7 green turtles, and 2 hawksbills. For fiscal year 2010, the COE has reported 6 incidental sea turtle takes by hopper dredges operating in the South Atlantic Division. The reported takes were 4 green turtles, 1 Kemp's ridley, and 1 loggerhead (http://el.erdc.usace.army.millseaturtles/info.cfin?Type=Division&Code=SAD). The COE must reinitiate consultation if any of these take limits are exceeded during the proposed action, and the COE must comply with the terms and conditions of the RBO. The incidental take authorized in the SARBO "resets" at the beginning of each Fiscal Year (1 October). Miami Harbor is expected to begin construction during FY12, and continue through FY13 and into Fy14. USACE is currently in reinitation of consultation with NMFS on the SARBO. When a new biological opinion is issued by NMFS, the terms and conditions of that SARBO will be incorporated into the Miami Harbor project.

Staghorn Corals and the Designated Critical Habitat for Elkhorn and Staghorn Corals
The COE submitted a resource survey conducted by Dial Cordy and Associates in 2010, using the NMFS-approved survey protocols for *Acropora* (NMFS 2007). According to the survey, there are 31 colonies of *A. cervicornis* within the action area (including the 150 meters adjacent to the channel proper on either side). The following subsections are synopses of the best available information on the life history, distribution, population trends, and current status of *Acopora cervicornis* and its designated critical habitat. Sources of background information on staghorn coral can be found in the Atlantic *Acropora* Status Review (Atlantic *Acropora* Biological Review Team (BRT) 2005).

3.2.1 Staghorn Coral

Staghorn coral was listed as threatened under the ESA on May 9, 2006, based on a status review initiated in 2004. The Atlantic *Acropora* Status Review presents a summary of published literature and other currently available scientific information regarding the biology and status of *A. cervicornis*. The following discussion summarizes those findings relevant to *A. cervicornis* and our evaluation of the proposed action.

Acropora cervicornis is one of the major reef-building corals in the wider Caribbean. *A. cervicornis* is characterized by staghorn-antler-like colonies, with cylindrical, straight, or slightly curved branches. Historically, this species formed dense thickets at shallow (<5 m) and intermediate (10 to 15 m) depths in many reef systems, including some locations in the Florida Keys, western Caribbean (e.g., Jamaica, Cayman Islands, Caribbean Mexico, Belize), and eastern Caribbean. Early descriptions of Florida Keys reefs referred to reef zones, of which the staghorn zone was described for many shallow-water reefs (Figure 1) (Jaap 1984, Dustan 1985, Dustan and Halas 1987). As summarized in Bruckner (2002), however, the structural and ecological roles of Atlantic

Acropora cervicornis in the wider Caribbean are unique and cannot be filled by other reef-building corals in terms of accretion rates and the formation of structurally complex reefs.

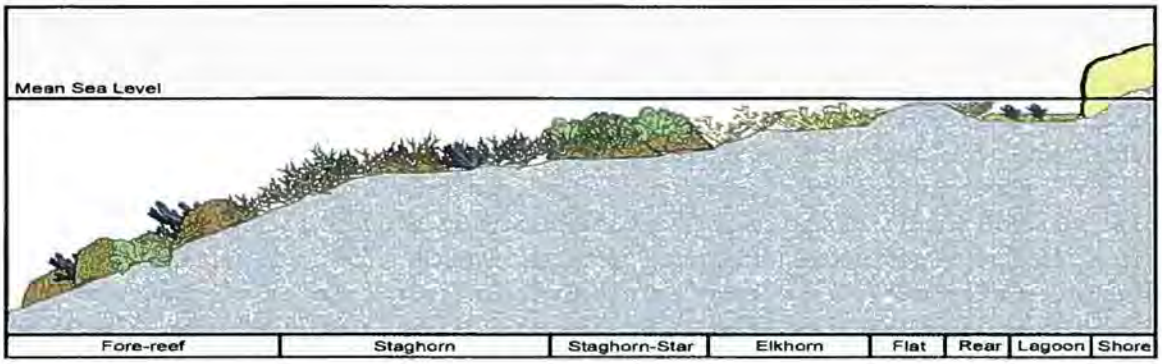

Figure 1: Reef zonation schematic example modified from several reef zonation-descriptive studies (Goreau 1959; Kinzie 1973; Bak 1977).

Life History and Distribution

Historically, staghorn coral was reported from depths ranging from <1 to 60 m (Goreau and Goreau 1973). It is suspected that 60 m is an extreme situation and that the coral is relatively rare below 20 m depth. The common depth range at which staghorn coral is currently observed is 5 to 17 m. In southeastern Florida, this species historically occurred on the outer reef platform (16 to 20 m) (Goldberg 1973), on spur-and-groove bank reefs and transitional reefs (Jaap 1984, Wheaton and Jaap 1988), and on octocoral-dominated hardbottom (Davis 1982). Colonies have been common in back- and patch-reef habitats (Gilmore and Hall 1976, Cairns 1982). Although *Acropora cervicornis* colonies are sometimes found interspersed among colonies of elkhorn coral, they are generally in deeper water or seaward of the elkhorn zone and, hence, more protected from waves. Historically, *Acropora cervicornis* was also the primary constructor of mid-depth (10 to 15 m) reef terraces in the western Caribbean, including Jamaica, the Cayman Islands, Belize, and some reefs along the eastern Yucatan peninsula (Adey 1978).

All Atlantic *Acropora* spp. are considered to be environmentally sensitive, requiring relatively clear, well-circulated water (Jaap et al. 1989). Atlantic *Acropora* spp. are almost entirely dependent upon sunlight for nourishment compared to massive, boulder-shaped species in the region (Porter 1976; Lewis 1977), which are more dependent on zooplankton. Therefore, *A. cervicornis* may not be able to compensate with an alternate food source, such as zooplankton and suspended particulate matter, like other corals. Subsequently, Atlantic *Acropora* spp. are much more susceptible to increases in water turbidity than some other coral species. Reductions in long-term water clarity can also reduce the coral photosynthesis to respiration ratio (P/R ratio). Telescnicki and Goldberg (1995) and Yentsch et al. (2002) found that elevated turbidity levels did not affect gross photosynthetic oxygen production, but did lead to increased respiration that consumed the products of photosynthesis with little remaining for coral growth.

Optimal water temperatures for staghorn corals range from 25° to 29°C, although colonies in USVI have been known to tolerate short-term temperatures around 30°C without obvious bleaching (loss of zooxanthellae) (Rothenberger et al. 2008). All *Acropora* spp. require near oceanic salinities (34 to 37 ppt). All Atlantic acroporids are susceptible to bleaching due to adverse environmental conditions (Ghiold and Smith 1990; Williams and Bunkley-Williams 1990). Jaap (1979) and Roberts et al. (1982) note an upper temperature tolerance of 35.8°C for *Acropora cervicornis.* Major mortality of *Acropora cervicornis* occurred in the Dry Tortugas, Florida, in 1977 due to a winter cold front that depressed surface water temperatures to 14° to 16°C. Some reduction in growth rates of *A. cervicornis* was reported in Florida when temperatures dropped to less than 26°C (Shinn 1966). The major El Niño/La Niña Southern Oscillation cycle in 1997-1998 resulted in a large bleaching event in the Caribbean and the Atlantic, as well as massive losses of corals in the Indian Ocean and Western Pacific (Wilkinson and Souter 2008). Elevated temperatures in the fall of 1998 led to a loss of coral cover in study sites in USVI (Rogers et al. 2008). However, the most significant bleaching event to date in the Caribbean occurred in 2005 when sea surface temperatures exceeded the 29.5°C coral bleaching threshold for twelve weeks, and maximum temperatures exceeded 30°C (Woody et al. 2008). Bleaching occurred in twenty-two species, including *Acropora* spp., over a wide range of depths and affected more than 90 percent of the coral cover, on average, between July and November in USVI (Woody et al. 2008).

A. cervicornis., like many stony coral species, propagate sexually and asexually through fragmentation. Staghorn corals reproduce sexually by broadcast spawning, meaning that coral larvae develop externally to the parental colonies (Szmant 1986). Gametes (eggs and sperm) are located in different layers of the same polyp (Soong 1991). The spawning season for staghorn corals is relatively short, with gametes released only a few nights during July, August, and/or September. Observations in USVI and Puerto Rico indicate that spawning of staghorn corals spawn within a week of the full moon in July and/or August (Lirman 2002). Annual egg production in staghorn populations studied in Puerto Rico was estimated to be 600 to 800 eggs per cm^2 of living coral tissue (Szmant 1986).

Fertilization and development of *A. cervicornis* are exclusively external. Embryonic development culminates with the development of planktonic larvae called planulae. Little is known concerning the settlement patterns (Bak 1977, Sammarco 1980, Rylaarsdam 1983). In general, upon proper stimulation, coral larvae, whether released from parental colonies or developed in the water column external to the parental colonies, settle and metamorphose on appropriate substrates, in this case preferably coralline algae. Initial calcification ensues with the forming of the basal plate. Buds that form on the initial corallite develop into daughter corallites.

Studies of staghorn corals on the Caribbean coast of Panama indicated that larger colonies (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). Only colonies of staghorn coral with a branch length larger than 9 cm were fertile and over 80 percent of colonies with branches longer than 17 cm (n=18) were fertile. The estimated size at puberty for staghorn coral was 17 cm in branch length and the smallest reproductive colony observed was 9 cm in branch length (Soong and Lang 1992). The growth rate for *Acropora cervicornis* has been reported to range from 3 to 11.5 cm/yr. This growth rate is relatively fast compared to other corals and historically enabled the species to construct significant reefs in several locations throughout the wider Caribbean (Adey 1978). Growth in *Acropora cervicornis* is also expressed in expansion, occurring as a result of fragmenting and forming new centers of growth (Bak and Criens 1982, Tunnicliffe 1981). A broken off branch may be carried by waves and currents to a distant location or may land in close proximity to the original colony. If the location is favorable, branches grow into a new colony, expanding and occupying additional area. Fragmenting and expansion, coupled with a relatively fast growth rate, facilitates potential spatial competitive superiority for *Acropora cervicornis* relative to other corals and other benthic organisms (Shinn 1976, Neigel and Avise 1983, Jaap et al. 1989). Because growth rates decline with increasing colony size, fragmentation may help maintain high growth rates by pruning colonies to create new, smaller units. However, severe fragmentation, such as caused by hurricanes, can limit sexual reproduction by breaking colonies to such a degree that energy is shifted from reproduction to stabilization and regeneration (Lirman 2002).

Spatial and temporal patterns of coral recruitment have been intensively studied on wider Caribbean reefs (Birkeland 1977, Bak and Engel 1979, Rogers et al. 1984, Baggett and Bright 1985, Chiappone and Sullivan 1996). Biological and physical factors that have been shown to affect spatial and temporal patterns of coral recruitment include substrate availability and community structure (Birkeland 1977), grazing pressure (Rogers et al. 1984, Sammarco 1985), fecundity, mode and timing of reproduction (Harriot 1985, Richmond and Hunter 1990), behavior of larvae (Lewis 1974, Goreau et al. 1981), hurricane disturbance (Hughes and Jackson 1985), physical oceanography (Baggett and Bright 1985, Fisk and Harriot 1990), the structure of established coral assemblages (Lewis 1974, Harriot 1985), and chemical cues (Morse et al. 1988). Studies of *Acropora* spp. from across the wider Caribbean confirm two overall patterns of sexual recruitment: (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.

Historically, throughout much of the wider Caribbean, *Acropora cervicornis* so dominated the reef within the 7 to 15 m depth that the area became known as the staghorn zone (Figure 1). It was documented in several reef systems such as the north coast of Jamaica (Goreau 1959) and the leeward coast of Bonaire (Scatteryday 1974). In many other reef systems in the wider Caribbean, most notably the western Caribbean areas of Jamaica, Cayman Islands, Belize, and eastern Yucatan (Adey 1977), *Acropora cervicornis* was a major mid-depth (10 to 25 m) reef-builder. Principally due to wind conditions and rough seas, *Acropora cervicornis* has not been known to build extensive reef structures in the Lesser Antilles and southwestern Caribbean. Studies of historical distribution and abundance patterns focus on percent coverage, density, and relative size of the corals during three periods: pre-1980, the 1980 – 1990 decades, and recent (since 2000). Few data are present before the 1980 baseline, likely due in part to researchers' tendencies to neglect careful measurement of abundance for ubiquitous species.

Population Dynamics and Status

Recent information is available on the status of Atlantic *Acropora* spp. from 60 to 75 percent of all the reefs where these species are known to occur (Bruckner 2002). Both elkhorn and staghorn corals still occupy their historic range, but localized range reductions and extirpations have occurred with most populations experiencing losses from 80-98 percent of their 1970s baseline (Bruckner 2002). The 1970s were established as a baseline for stable, healthy populations through the historic range of Atlantic *Acropora* spp. and the 1980s was established as the baseline for the regional decline due to mortality events associated with white band disease outbreaks and hurricanes (Richards Kramer 2002, Rogers et al. 2002). For this reason, available information on the historical distribution and abundance patterns focus on percent coverage, density, and relative size of the corals during three periods: pre-1980, the 1980 – 1990 decades, and recent (since 2000).

A. cervicornis underwent a precipitous decline in the early 1980s throughout its range and this decline has continued, albeit at a much slower rate. 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 USVI), declines in abundance (coverage and colony numbers) are estimated at >97 percent. Although this decline has been documented as continuing in the late 1990s, and even in the past five years in some locations, local extirpations (i.e., at the island or country scale) have not been definitively documented. In addition to declines in numbers of colonies and percent cover, the total surface area of live tissue is now much less than historically because colonies are small and sometimes encrusting rather than complex, three-dimensional structures. Historically, colonies stood meters above the substrate with live tissue from the branches down to the base of the colony.

In many locations, populations of Atlantic *Acropora* spp. have been reduced to such an extent that the potential for recovery through re-growth of fragments is limited and recovery is dependent on sexual reproduction. This can have long-term implications as the genetic variability of remaining colonies can become reduced due to the reduced potential for exchange of genetic material between populations that are spatially further apart as numbers of colonies in various locations dwindle (Bruckner 2002). The dominance of asexual reproduction combined with broadcast spawning means that, once colonies become rare, the distance between colonies may limit fertilization success. Data on levels of genetic diversity and population structure suggest that there is a population structure among islands, and even over spatial scales of no more than 20 km, as well as varying degrees of genetic diversity within local populations (Lirman 2002, Vollmer 2002). For instance, one clone of staghorn coral may dominate areas up to 10 m^2 in size and the clones are generally spatially discrete with larval exchange between staghorn populations as close as 2 to 15 km being extremely limited, suggesting that larval sources need to be conserved on a very small spatial scale (Baums 2002, Vollmer and Palumbi 2007).

Figure 2 summarizes the abundance trends of specific locations throughout the wider Caribbean where quantitative data exist illustrating the overall trends of decline of elkhorn and staghorn corals since the 1980s. It is important to note that the data are from the same geographic area, not repeated measures at an exact reef/site that would indicate more general trends. The overall regional trend depicted is a >97 percent loss of coverage (area of substrate the species occupy).

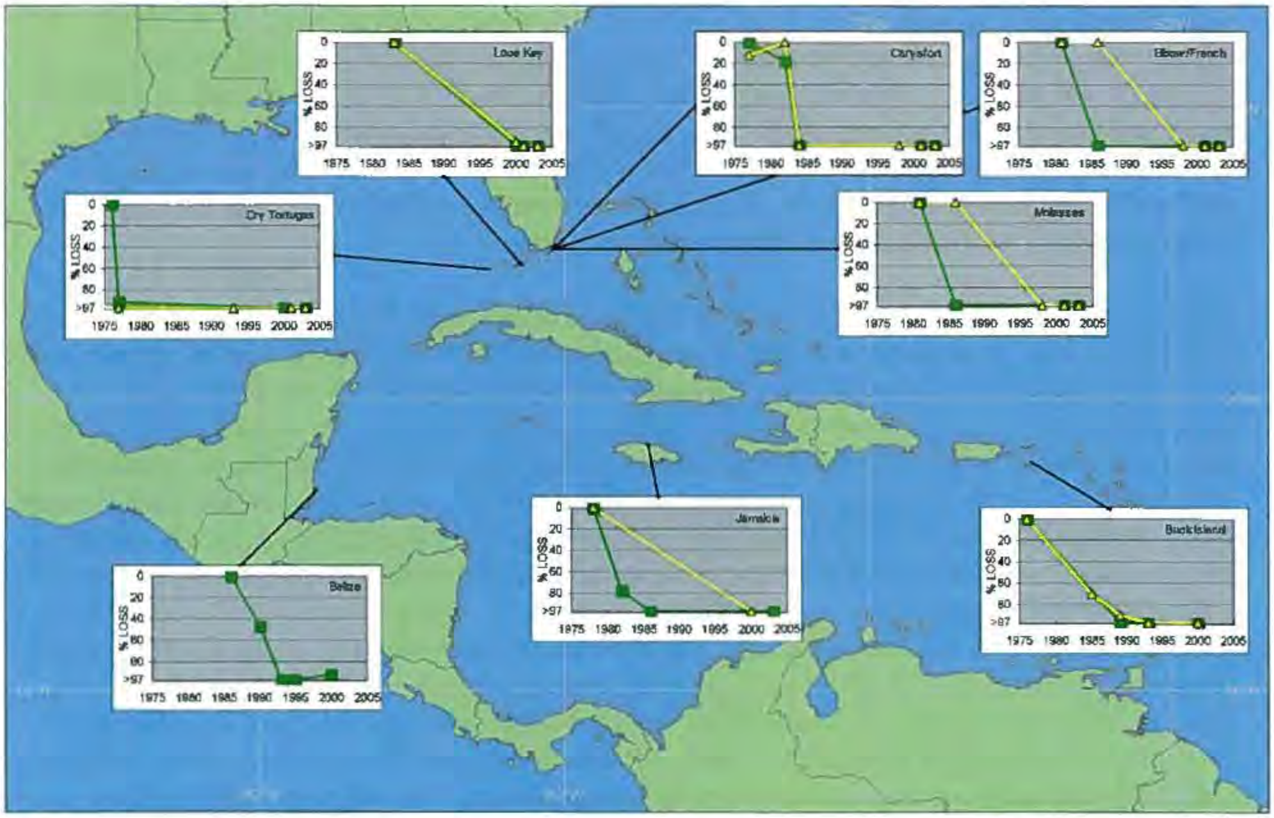

Figure 2. Percent loss of staghorn coral (green squares) and elkhorn coral (yellow triangles) throughout the Caribbean for all locations (n=8) where quantitative trend data exist. Shaded areas on map illustrate the general range of elkhorn and staghorn corals (*Acropora* BRT 2005).

Threats

Staghorn corals face myriad stressors that in some cases act synergistically. Diseases, temperature-induced bleaching, and physical damage from hurricanes are deemed to be the greatest threats to staghorn corals' survival and recovery. The impact of disease, though clearly severe, is poorly understood in terms of etiology and possible links to anthropogenic stressors. Impacts from anthropogenic physical damage (e.g., vessel groundings, anchors, and divers/snorkelers), coastal development, competition, and predation are deemed to be moderate. The major threats (e.g., disease, elevated sea surface temperature, and hurricanes) to staghorn corals' persistence are severe, unpredictable, likely to increase in the foreseeable future, and, at current levels of knowledge, unmanageable. However, managing some of the stressors identified as less severe (e.g., nutrients, sedimentation) may assist in decreasing the rate of staghorn corals' decline by enhancing coral condition and decreasing synergistic stress effects. Table 1 summarizes the factors affecting the status of staghorn coral and the identified sources of those stressors.

Virtually all of the threats impacting coral reef ecosystems, including land-based and marine pollution, overfishing, global climate change, and ocean acidification, have been suggested as drivers or facilitators of infectious disease. Infectious disease in corals has increased in frequency and distribution since the 1970s when white band disease was first reported in Atlantic *Acropora* spp. There has since been an exponential increase in the numbers of reported diseases, host species, and locations where infections have been observed (Raymundo et al. 2008). Current research suggests that human activities that lead to point and non-point source discharges of nutrients, sediments, and other substances from land and discharges of ballast water and vessel waste, among others, may exacerbate existing opportunistic infections in combination with stressors such as poor water quality and sea surface temperature increases. It may be that increased temperatures enhance the virulence of pathogens, or that the ability of corals to fight infections at higher temperatures is lessened.

White band disease (WBD), which affects acroporid corals, was first observed on reefs around St. Croix in 1977 (Gladfelter et al. 1978). In the Caribbean, the incidence of WBD ranges from <1 to 64 percent of the colonies in a single area. WBD is thought to be the major factor responsible for the rapid loss of Atlantic *Acropora* spp. due to mass mortalities. WBD is the only coral disease to date that has been documented to cause major changes in the composition and structure of reefs (Humann and Deloach 2003). Land-based pollution, in particular human waste streams that enter coastal waters, has been implicated in the search for causal agents of coral disease. Isolates from diseased tissues of elkhorn coral were found to match *S. marcescens*, a fecal enteric bacterium in humans (Patterson et al. 2002). Enteric bacteria associated with human fecal material have been found in surface mucus layers of corals in the Florida Keys, but the study by Patterson et al. (2002) is one of the first to isolate a specific bacterium from diseased tissue that implicates human fecal contamination as the causal agent for white pox. Data from the study by Patterson et al. also indicate that the rate of tissue loss due to white pox correlates with seasonal conditions of elevated temperature. This supports work by other scientists indicating that elevated temperatures lead to accelerated growth of pathogens and reduce the capacity of the coral's immune system to combat the disease.

Disease has also been linked to sunscreen use in areas containing corals based on a study of tourist destinations in Indonesia, Akumal, Mexico (Caribbean), Thailand, and the Red Sea (Danovaro et al. 2008). Nubbins from *Acropora* spp., as well as samples from two other corals were collected from various colonies, washed with virus-free seawater, and incubated in situ. In all replicates and sampling sites, sunscreen additions even at very low concentrations resulted in the release of large amounts of mucus by the corals within 18 to 48 hours, and complete bleaching of hard corals within 96 hours (Danovaro et al. 2008). Different sunscreen brands, protective factors, and concentrations were compared, and all were found to cause bleaching, although bleaching rates were faster the more sunscreen was used and under conditions of elevated temperatures. Viral abundance in seawater surrounding coral branches also increased significantly when sunscreens were added. Because the corals were washed and incubated in virus-free seawater prior to any treatments, Danovaro et al. (2008) concluded that sunscreen caused coral bleaching by inducing the lytic cycle in zooxanthellae with latent viral infections. Based on their results, Danovaro et al. (2008) concluded that, because at least 25 percent of the amount of sunscreen applied washes off during a 20-minute swim and based on the annual production of UV filters and the estimated number of tourists per year in tropical reef areas, a potential release of 4,000 to 6,000 tons/year of sunscreen is released in coral areas. They further concluded that, because 90 percent of tourists are expected to be concentrated in approximately 10 percent of all reef areas, up to 10 percent globally of coral reefs are potentially threatened by sunscreen-induced coral bleaching.

Many factors, including both intrinsic life history characteristics, as well as external threats, are important to consider in assessing the status and vulnerability of staghorn coral. Recovery from its current level of decreased abundance depends upon rates of recruitment and growth outpacing rates of mortality. This species has a rapid growth rate and high potential for propagation via fragmentation. However, while fragmentation is an excellent life history strategy for recovery from physical disturbance, it is not as effective when fragment sources (i.e., large extant colonies) are scarce.

Table 1. Factors affecting the species.

Natural abrasion and breakage Source: storm events	**Disease** Source: undetermined/understudied
Sedimentation Source: land development/run-off dredging/disposal sea level rise major storm events	**Anthropogenic abrasion and breakage** Source: divers vessel groundings anchor impact fishing debris
Temperature Source: hypothermal events global climate change power plant effluents El Niño-Southern Oscillation events	**Predation** Source: overfishing natural trophic reef interactions **Loss of genetic diversity** Source: population decline/bottleneck
Nutrients Source: point-source non-point-source	**Contaminants** Source: point-source non-point-source
Competition Source: overfishing	**CO_2** Source: fossil fuel consumption
Sea level rise Source: global climate change	**Sponge boring** Source: undetermined/understudied

Thus, it is anticipated that successful sexual reproduction will need to play a major role in *A. cervicornis'* recovery (Bruckner 2002). Meanwhile, there is substantial evidence to suggest that sexual recruitment of staghorn coral is currently compromised. Reduced colony density in this broadcast-spawning, self-incompatible species, compounded in some geographic areas by low genotypic diversity, suggests that fertilization success and consequently, larval availability, has been reduced. Species at reduced abundance are at a greater risk of extinction due to stochastic environmental and demographic factors (e.g., episodic recruitment factors). *A. cervicornis* has persisted at extremely reduced abundance levels (in most areas with quantitative data available, less than 3 percent of prior abundance) for at least two decades. In addition, appropriate substrate availability for fragments to attach has been reduced due to changes in benthic community structure on many Caribbean reefs related to changes in sediment deposition patterns and algal growth associated with coastal development and other anthropogenic activities. These factors are expected to further reduce successful larval recruitment below an appropriate scale that can compensate for observed rates of ongoing mortality. In reef study sites in St. John, USVI, for instance, the total number of colonies increased from 358 to 655 between 2005 and 2006, but the average volume per colony decreased by 55.9 percent (Rogers et al. 2008). This suggests that, where there was originally one large colony, mortality led to the creation of remnant patches of tissue so separated from the original colony as to be considered separate small colonies. Predation by coral eating snails was also found to increase on these colonies, with numbers of snails doubling from 40 to 82 over the study period (Rogers et al. 2008).

The impacts on staghorn coral from all of the above mentioned stressors could be exacerbated by reduced genetic diversity, which often results when species undergo rapid decline like *A. cervicornis* has in recent decades. This expectation is heightened when the decline is due to a potentially selective factor such as disease, in contrast to a less selective factor such as hurricane damage, which will likely cause disturbance independent of genotype. If the species remains at low densities for prolonged periods of time, genetic diversity may be significantly reduced. Thus, given the current dominance of asexual reproduction, the rapid decline (largely from a selective factor), and the lack of rapid recovery of *A. cervicornis*, it is plausible that this species has suffered a loss of genetic diversity that could compromise its ability to adapt to future changes in environmental conditions. Recent work in Puerto Rico to determine the genetic diversity of elkhorn and staghorn corals from eight locations around the island, as well as samples from Lee Stocking Island in the Bahamas, shows evidence of heterozygosity, indicating that sexual reproduction is occurring, but the level of heterozygosity is low (4 out of 10 patches of staghorn and 4 out of 11 patches of elkhorn). No genetic variation was found within colonies of either species and no single point mutations were detected between colonies of either species (Schizas and Garcia 2006).

As noted in the discussion above, one of the stressors with the greatest effect on corals is the increase in sea surface temperatures, which causes increased stress to corals and results in coral bleaching and, often, mortality, due in part to associated reductions in the ability of corals to combat infections and their increased susceptibility to other stressors. Bleaching results in a loss of zooxanthellae and a reduction in the energy producing systems of corals; this can lead to severe stress and mortality. Coupled with increasing CO_2 concentrations, which lower the pH of seawater, reducing the capacity of corals and other organisms to produce calcium carbonate skeletons, and local stressors such as declining water quality and overfishing, these stressors reduce the resiliency of coral reefs and reef-building organisms such as *A. cervicornis*. Sea surface temperatures rose by an average of 0.3°C between the 1950s and 1990s making it likely that corals are now 1°-1.5°C closer to their upper thermal limit and explaining why sustained temperatures as little as 1°-2°C above the normal summer maximum are sufficient to cause coral bleaching (Kleypass and Hoegh-Guildberg 2008).

3.2.2 Designated Critical Habitat for Elkhorn and Staghorn Coral

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 are found those physical or biological features essential to the conservation of the species. 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 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 three 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 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 (Torres 2001).

Long-term monitoring of sites in USVI 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 two 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 3, below, shows the boundaries of the Florida unit for *Acropora* critical habitat. The Florida area contains three 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 within sub-area B within the Florida unit of critical habitat. The entire Florida unit is comprised of 1,329 square miles of designated critical habitat.

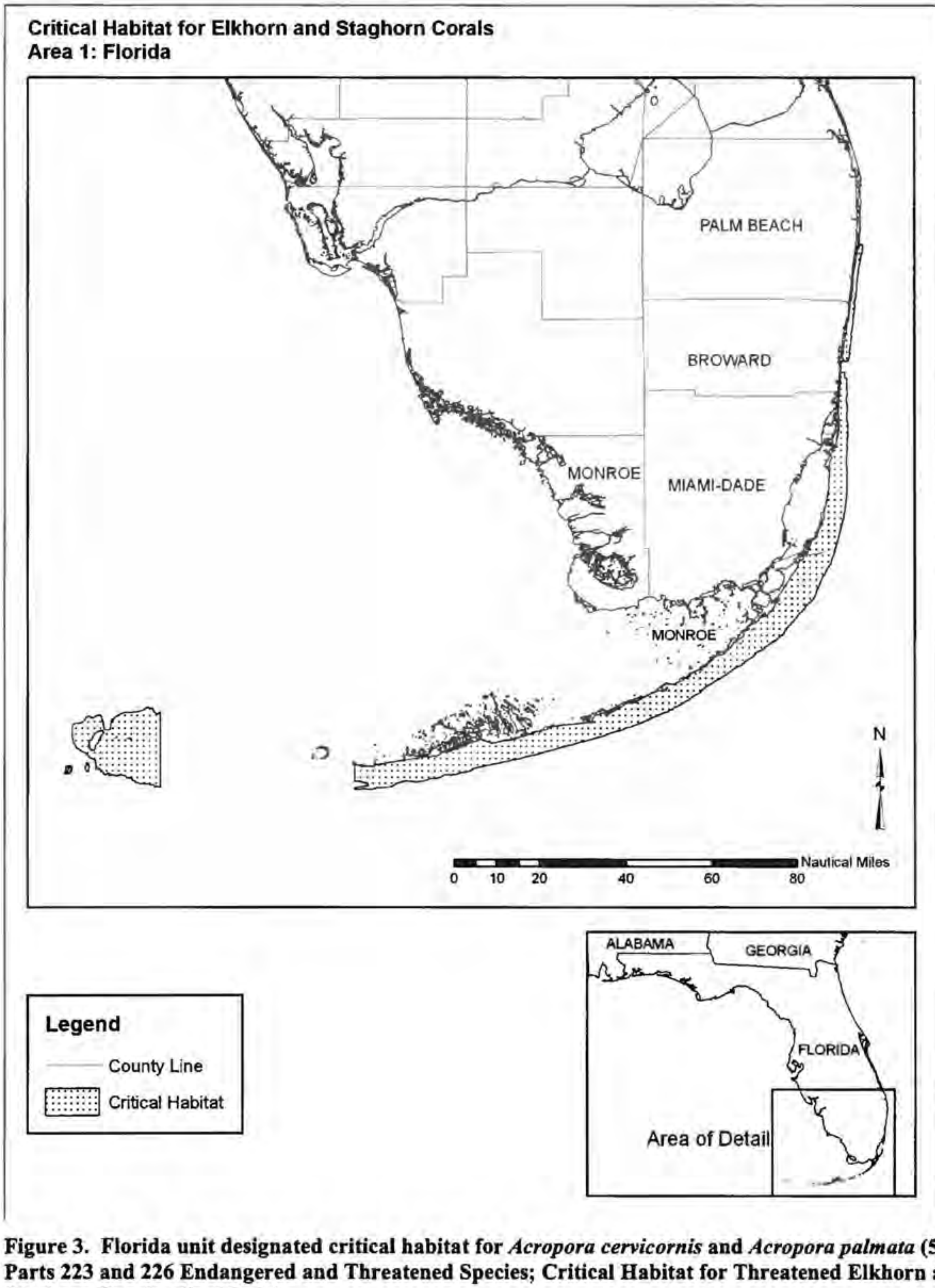

Figure 3. Florida unit designated critical habitat for *Acropora cervicornis* and *Acropora palmata* (50 CFR Parts 223 and 226 Endangered and Threatened Species; Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule).

4 ENVIRONMENTAL BASELINE

This section contains a description of the effects of past and ongoing human activities leading to the current status of the species, its habitat, and the ecosystem, within the action area. The environmental baseline is a snapshot of the factors affecting the species and includes federal, state, tribal, local, and private actions already affecting the action area, or that will occur contemporaneously with the consultation in progress. Unrelated, future federal actions affecting the same species in the action area that have completed formal or informal consultation are also part of the environmental baseline, as are implemented and ongoing federal and other actions within the action area that may benefit listed species.

The environmental baseline for this opinion includes the effects of several activities that affect the survival and recovery of *Acropora cervicornis* and its designated critical habitat in the action area that may be affected by the proposed action.

4.1 Status of *Acropora cervicornis* and its Designated Critical Habitat within the Action Area

In Section 3.2.1, we described the range-wide status of *Acropora cervicornis*. Within the action area, *Acropora cervicornis* occurs on the middle reef tract adjacent to the channel and within the proposed flare area. According to resource surveys provided by the COE, there are 31 colonies of *A. cervicornis* within the action area. An analysis of the DEP Miami-Dade benthic habitat maps (Walker, B.K., 2009) indicated that there are approximately 162.8 acres of designated critical habitat for elkhorn and staghorn coral within the project area.

4.2 Factors Affecting *Acropora cervicornis* and its Designated Critical Habitat within the Action Area

Acropora cervicornis colonies are non-motile and susceptible to relatively localized adverse effects as a result. Localized adverse effects to *Acropora cervicornis* in the action area are likely from many of the same stressors affecting *Acropora cervicornis* throughout its range, namely anthropogenic breakage, disease, and intense weather events (i.e., hurricanes and extreme cold water disturbances). Below is a list of potentially adverse actions.

4.2.1 Federal Actions

Federal actions with potential to adversely affect *Acropora cervicornis* in the action area include:

- Commercial and recreational fisheries authorized by the National Marine Fisheries Service. Given the morphology and distribution of *Acropora cervicornis*, certain types of fishing gear (e.g., hook-and-line, trap gear) may adversely affect this species. NMFS recently 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 COE-permitted discharges to surface waters. 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 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).

- COE-permitted dredge-and-fill activities. These activities can directly affect *A. cervicornis* via fragmentation/breakage or abrasion. They can also affect the species by physically altering or removing benthic habitat suitable for *A. cervicornis* colonization. Dredge-and-fill activities may also cause increases in sedimentation that may cause shading, deposition of sediment on *A. cervicornis*, 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.*

- U.S. Environmental Protection Agency (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 recently settled a lawsuit requiring them to promulgate nutrient limitations for marine waters.

- The National Marine Sanctuary Program and the National Park Service-regulated activities within their boundaries that are conducted in shallow water coral reef areas including collection of coral, alteration of the seabed, discharges, boating, anchoring, fishing, recreational scuba diving and snorkeling, and scientific research.

In addition:

- NMFS is currently working on a Section 7 consultation (SER/2010/03876) with the COE for a beach renourishment project in Miami-Dade County, Florida which will result in impacts to *A. cervicornis* and its designated critical habitat, although the total amounts are unknown at this time. Impacts from the project include direct burial of *A. cervicronis*, as well as sedimentation and turbidity impacts which may cause shading, and/or loss of substrate for fragment reattachment or larval settlement. Additional impacts may include physical impacts and shading from pipeline placement.

4.2.2 Other Non-Federal Actions Affecting *Acropora cervicornis* and its Designated Critical Habitat.

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 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 stimulate plankton blooms in closed or semi-closed estuarine systems. An example is the large area of the Louisiana continental shelf with seasonally depleted oxygen levels (< 2 mg/l), caused by eutrophication from both point and non-point sources. Most aquatic species cannot survive at such low oxygen levels and these areas are known as "dead zones."

Diseases have been identified as the major cause of *Acropora cervicornis* 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. Several types of fishing gears used within the action area may adversely affect staghorn 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. 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 are evaluated under Section 7 of the ESA.

4.3 Conservation and Recovery Actions Benefiting Listed Corals

Education and outreach activities, as part of the NOAA Coral Reef Conservation Program (CRCP), as well as through NMFS' ESA program, are ongoing through the Southeast Regional Office. NOAA's Restoration Center has also established a contract position in Puerto Rico to participate in grounding response and carry out restoration activities. The summaries below discuss these measures in more detail.

A draft recovery plan for elkhorn and staghorn corals is in preparation. A recovery team comprised of fishers, scientists, managers, and agency personnel from Florida, Puerto Rico, and USVI, and federal representatives has been convened and is working towards creating a draft recovery plan for public review based upon the latest and best available information.

4.3.1 Regulations Reducing Threats to Listed Corals

Numerous management mechanisms exist to protect corals or coral reefs in general. Existing 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 may prohibit many actions pertaining to *Acropora*, including but not limited to: importing or exporting these species from or into the United States; taking of these species from U.S. waters, its territorial sea, or the high seas; or possessing or selling these species. 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.

On October 29, 2008, NMFS published a final Section 4(d) rule extending 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 has exceptions for some activities, including scientific research and species enhancement, and restoration carried out by authorized personnel. On November 26, 2008, NMFS published a final rule designated critical habitat for listed elkhorn and staghorn corals. The critical habitat designation requires, as part of a Section 7 consultation with NMFS, that all actions with a federal nexus ensure that the no adverse modification of critical habitat occurs.

The final Section 4(d) rule for elkhorn and staghorn corals also allows certain restoration activities, defined in the rule as "the methods and processes used to provide aid to injured individuals," when they are conducted by certain federal, state, territorial, or local government agency personnel or their designees acting under existing legal authority, to be conducted promptly without the need for ESA permits.

4.3.2 Other Listed Coral Conservation Efforts

Outreach and Education
The Southeast Regional Office of NMFS has developed outreach materials regarding the listing of staghorn corals, the 4(d) rule, 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.

4.4 Summary and Synthesis of Environmental Baseline for *Acropora cervicornis* and Designated Critical Habitat

In summary, several factors are presently adversely affecting staghorn coral and its designated critical habitat within the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action:

- Disease outbreaks;
- Temperature-induced bleaching events;
- 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;
- Vessel traffic that will continue to result in abrasion and breakage due to accidental groundings and poor anchoring techniques; and
- 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 coral throughout its range, and in the action area.

5 EFFECTS OF THE ACTION

NMFS believes that the proposed project is likely to adversely affect staghorn coral and it's designated critical habitat. Based on the information submitted by the COE, NMFS believes the project is likely to adversely affect 31 colonies of *A. cervicornis*, 168.2 acres of designated critical habitat for elkhorn and staghorn coral. As part of the biological opinion and because the action will result in adverse effects to threatened coral, NMFS must evaluate whether the action is likely to jeopardize the continued existence of staghorn coral and develop reasonable and prudent alternatives to avoid the likelihood of jeopardy to the species, if appropriate. NMFS may authorize the incidental take of listed corals if we determine the action is not likely to jeopardize their continued existence. The analysis in this section forms the foundation for our jeopardy analysis in Section 7. A jeopardy determination is reached if we would reasonably expect the proposed action to cause, either directly or indirectly, reductions in numbers, reproduction, or distribution that would appreciably reduce a listed species' likelihood of surviving and recovering in the wild.

5.1 Effects of the Action on *Acropora cervicornis*

The analyses in this section are based upon the best available data on *A. cervicornis* biology and the effects of the proposed action. Data pertaining to effects from the proposed action relative to interactions with *A. cervicornis* are limited, so 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., would lead to conclusions of higher, rather than lower, risk to endangered or threatened species). We believe the proposed project will adversely affect staghorn coral. There are 31 colonies of *A. cervicornis* within the action area. According to the resource survey conducted by Dial Cordy and Associates in May 2010, *A. cervicornis* colonies are present on the inner reef and shallow colonized pavement, in water depths ranging from 23 to 28 feet. The COE proposed to transplant any staghorn colonies greater that 10 cm located within the project area in accordance with the transplantation protocol in Appendix A. NMFS has previously stated that transplanting coral colonies less than 10 cm in size was not feasible because detaching such small colonies would likely result in breakage and the survivability of those colonies would be very low due to injury and decreased overall surface area of living coral tissue. This recommendation was based on information relating to encrusting corals and does not apply to branching corals such as *A. cervicornis*.

This opinion will require transplantation of all 31 known *Acropora cervicornis* colonies out of the project area to nearby suitable reef sites as a reasonable and prudent measure (RPM) to reduce the impact of effects of the action as proposed. Lirman et al. (2010) indicated that clippings as small as 2 cm in length can be transplanted successfully if the transplant site is nearby. However, clippings of approximately 3-4 cm in length are recommended if they must be transported to a recipient site some distance away, due to higher mortality rates associated with transportation of smaller clippings. Similarly, two *Acropora* coral nurseries, one in Broward County and one Miami-Dade, have successfully transplanted 3 cm coral fragments of *Acropora cervicornis*. Based on work with the *Acropora* nursery in Broward County (Florida), there is no minimum size for Acroporid relocation in terms of the biology of the species. (David S. Gilliam, Ph.D., pers. comm., February 11, 2011, Nova Southeastern University, NCRI.) As previously mentioned in Section 3.2 above, asexual fragmentation is the main reproductive method of staghorn coral; therefore, NMFS believes that transplantation of colonies smaller than 10 cm is feasible. The colonies within the project area range in size from 3 cm to 80 cm in length, and are therefore capable of surviving transplantation.

Collection of small *A. cervicornis* fragments (i.e., approximately 3 cm fragments) will also be required to help achieve recovery goals for the species. Collection of fragments will reduce the impact of take by providing a secondary inventory within a controlled nursery setting, this will help to ensure that the genetic material of each of the transplanted colonies will survive even if the larger transplanted colony does not. Fragments will be grown in nurseries, 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 the transplantation and fragment collection actions involve directed take of *A. cervicornis*, they constitute legitimate RPMs because they reduce the level of almost certain lethal take of *A. cervicornis* through direct removal via dredging, anchor placement, and cable drag, allow the colonies to be collected and relocated out of the dredge footprint to where they will have a high likelihood of continued survival, and ensure the survival of the unique genetic material of the transplanted colonies, and the potential 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 *A. cervicornis* take through relocation and fragment collection, so that these levels can be included in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

NMFS believes 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 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 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, Becker 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 cervicornis* 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 by the process itself. This observation has been supported by other nursery managers who report post-relocation coral fragment mortality rates closer to 1 percent (Ken Nedimeyer, pers. comm. 2009).

NMFS believes that all 31 colonies of *A. cervicornis* could be lethally taken during dredging if not relocated. We believe coral transplantation will be highly successful and relocating these corals outside the project area is appropriate to minimize the impact of this take. Similar habitat, influenced by the same environmental conditions currently affecting these colonies, exists nearby the proposed project. Because suitable transplantation habitat is nearby and proper handling techniques are available and will be required (see Appendix A), we have confidence that transplantation survival rates similar to those noted elsewhere will be likely in this case. We believe a 17 percent coral fragment morality rate may be artificially high, brought on more by unusual environmental conditions than actual transplantation. To be conservative, we use a 17 percent mortality rate in our estimates, but believe actual mortality may be lower. Therefore, we anticipate an 83 percent survival rate of transplanted colonies.

In summary, all 31 known staghorn colonies will be relocated, with fragments collected from each relocated colony for genotyping. Of the colonies transplanted, we anticipate that up to 5 will suffer mortality after relocation and result in lethal takes; the remaining 26 colonies will survive.

5.2 Effects of the Action on Coral Designated Critical Habitat

As described below, NMFS believes the proposed action will adversely affect designated critical habitat for staghorn coral. The Florida unit, 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 elkhorn and staghorn corals 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 fleshy macroalgae cover and sediment cover. Approximately 162.8 acres of coral critical habitat is found within the action area, based on the DEP Miami-Dade benthic habitat maps (Walker, B.K., 2009). The habitat mapping was accomplished using a combined-technique approach incorporating laser bathymetry, aerial photography, acoustic ground discrimination, video ground truthing, limited sub-bottom profiling, and expert knowledge (Walker et al. 2008). NMFS must evaluate whether a proposed action may result in the destruction or adverse modification of critical habitat and develop reasonable and prudent alternatives to avoid such impacts.

The flaring of the entrance channel will result in the elimination of approximately 3.2 acres of designated critical habitat for listed corals through direct removal by explosives and dredging. Deepening of the existing channel will result in the further elimination of 1.5 acres of critical habitat which is located within the present channel which may have been re-exposed (likely by storms) subsequent to the last dredging event in 1993. The transplant of corals from the dredging area requires breakage of the substrate to which the corals are attached, thus resulting in the loss of approximately an additional 0.1 acre of designated critical habitat. Additionally, based on the DEP Miami-Dade benthic habitat maps (Walker, B.K., 2009) for the area (including the 150 meter indirect impact zone adjacent to the existing channel), the project may impact up to 158.1 acres of critical habitat adjacent to the channel via anchor placement and cable drag as well as through sedimentation. The resuspension of sediment during construction will result in sediment transport and deposition onto benthic substrate containing the physical element essential for coral designated critical habitat. Sedimentation affects larval settlement. Coral larvae settle preferentially on vertical surfaces to avoid sediments and cannot successfully establish themselves in shifting sediment (Army Engineer Research Development Center 2005). Sedimentation has been linked to lower coral growth rates and reduced coral recruitment (Rogers 1990). Studies have also shown that the survivorship of fragments from branching corals is significantly affected by the type of substrate, with increased mortality being linked to the presence of sandy sediments (Lirman 2000).

NMFS believes that effects on designated critical habitat from sedimentation will be temporary in nature. The COE will require continuous monitoring of sedimentation and turbidity levels within the project area in accordance with the state water quality certification. Therefore, NMFS has determined that impacts from sedimentation will be insignificant. Impacts from anchor placement and cable drag would not change the suitability of available critical habitat and are insignificant.

5.3 Summary of the Effects of the Action on Listed Corals and Designated Critical Habitat

Activities conducted through this project and take of the species that will occur will have permanent adverse effects on staghorn corals and are likely to result in mortality of entire coral colonies. Dredging will result in temporary, pulsed impacts through sediment resuspension and transport, as well as damages from anchor placement and cable drag. Coral transplantation is likely to result in mortality of up to 5 staghorn colonies (approximately 17 percent of 31 colonies).

The harbor expansion will also have permanent adverse effects on coral designated critical habitat through direct removal of approximately 4.8 acres of critical habitat. The project will also impact up to 158.1 acres of critical habitat through sedimentation and anchor and cable drag, however, these impacts will be insignificant. Sedimentation impacts will be temporary and localized. Sediments will return to background levels upon project completion. Anchor and cable drag may scour some of the rock, but will not remove any of the essential features necessary for it to function as designated critical habitat. Anchor and cable drag may even remove some of the existing sedimentation, creating more available bare substrate for future coral recruitment. The total amount of designated critical habitat in the Florida unit is 1,329 square miles (850,560 acres); therefore, the project would result in the permanent loss of less than 0.000006 percent of all *Acropora* critical habitat within the Florida unit.

6 CUMULATIVE EFFECTS

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

No categories of effects beyond those already described are expected in the action area. Activities affecting *A. cervicornis* are highly regulated federally; therefore, any future activities within the action area will likely require ESA Section 7 consultation.

7 JEOPARDY ANALYSIS

This section considers the likelihood that the proposed action will jeopardize the continued existence of listed staghorn corals. 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 "Effects of the Action" section (Section 5) describes the effects of the take resulting from the proposed action on staghorn coral and its designated critical habitat. Sections 5 and 7 inform the context of these effects, with respect to the environmental baseline and cumulative effects. 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 the listed species. The analysis next considers whether any such reduction would in turn result in an appreciable reduction in the likelihood of survival of the species in the wild and the likelihood of recovery of the species in the wild.

As noted in Section 5.1, we believe *Acropora cervicornis* is likely to be adversely affected by the authorization of the Miami Harbor Expansion. We must now determine if the action would reasonably be expected to appreciably reduce, either directly or indirectly, the likelihood of survival and recovery in the wild. *A. cervicornis'* abundance began declining in the 1970s throughout its range. Studies have shown that *A. cervicornis'* abundance has declined by between 80 to 98 percent of their 1970s baseline (Bruckner 2002).

The final listing rule for *Acropora* (71 FR 26852; May 9, 2006) provides the following rationale for listing the species as threatened and not endangered: (1) the species geographic range remains intact, (2) there are believed to be a high number of colonies still in existence throughout its range, and (3) asexual reproduction provides a source for new colonies that can buffer natural demographic and environmental variability. However, as noted in the final listing rule (71 FR 26857; May 9, 2006) and discussed in Section 3.2 (Table 1), NMFS believes the abundance and distribution of Atlantic acroporid corals is likely to become further reduced and local extirpations will occur within the next 30 years. Staghorn corals were listed as threatened because of the major threats to the species persistence as indicated by: (1) recent drastic declines in abundance that has occurred throughout its range, and abundance, though still high, is at a historic low, (2) the species is vulnerable to range constrictions due to local extirpations resulting from a single stochastic event, such as a hurricane, (3) sexual recruitment is limited in some areas and unknown in most; fertilization success from clones is virtually zero; and settlement of larvae is often unsuccessful given limited amount of appropriate habitat, and (4) fertilization success is declining as a result of greatly reduced densities of adult colonies. Thus, we can evaluate whether these metrics will be worsened by any predicted reductions in numbers, reproduction or distribution expected to result from the proposed action, and if so whether that would appreciably reduce the species likelihood of survival and recovery.

We estimate the proposed action may result in take of 31 colonies of *Acropora cervicornis* by transplantation, and that 5 of these colonies may suffer post-transplantation mortality. As discussed above, the collection of tissue sample fragments from each of the transplanted coral colonies will not result in reductions in numbers or reproduction of coral colonies.

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 5 of the 31 transplanted colonies would result in a reduction in *A. cervicornis* distribution in the immediate action area. However, the species is found throughout the wider Caribbean region. In Florida, *A. cervicornis* is generally found from Palm Beach County through Monroe County. The action area for this project is located in the middle of this range. The potential mortality of up to 5 colonies would cause no noticeable change or fragmentation in the distribution of the species, either in Florida or the wider Caribbean. The RPMs for this action require the COE to relocate 31 colonies from out of the path of potential mortality from the dredging, to appropriate reef habitat nearby. This RPM further minimizes the potential of species range fragmentation.

The potential mortality of 5 transplanted colonies of *A. cervicornis* would constitute a reduction in the numbers of the species, and those losses might also result in a loss of reproduction. However, a high number of colonies are believed to be still in existence through the species' range. Surveys within Miami-Dade County at Biscayne National Park have identified 112 colonies of *A. cervicornis* on four patch reefs. The project will eventually sample 5,000 patch reefs (D. Corsett, Biscayne National Park, pers. comm. 2009). If this current rate of occurrence holds, as many as 140,000 *A. cervicornis* colonies may exist inside the park alone. Even if this number is off by half, there may still be as many as 70,000 colonies occurring within just a portion of Miami-Dade County. Miller et al. (2008) estimate over 13 million *A. cervicornis* colonies likely exist currently in the Florida Keys, and while the absolute number of colonies is unknown, it is estimated that as many as a billion individual colonies may exist range wide (71 FR 26852; May 9, 2006). The loss of up to 5 colonies is unlikely to have any measurable effect on the other colonies. As discussed in Section 3.2.1 above, staghorn coral propagates mainly through asexual fragmentation. The potential loss of up to 5 colonies would cause no noticeable change in the distribution of the species and would not appreciably reduce the number of colonies available for fragmentation, therefore it is not likely to cause a measurable reduction in the species ability to reproduce.

Although no change in *A. cervicornis* 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 following analysis considers the effects of the anticipated loss of 5 colonies on the likelihood of recovery in the wild. The lethal take of up to 5 of *A. cervicornis* 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 *A. cervicornis* reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

A recovery plan for *Acropora cervicornis* is not yet available, though a list of threats and causal listing factors exists (Table 2). Anthropogenic abrasion and breakage, and sedimentation, are currently considered moderate threats to *Acropora cervicornis*. The *Acropora* BRT concluded that secondary stressors should be the main focus of regulatory and recovery actions such that the species would be better able to adapt to and recover from the continuing impacts of primary stressors such as diseases and rising sea surface temperatures. Further, as noted in the critical habitat rule (73 FR 72210, November 26, 2008), the loss of suitable habitat is one of the greatest threats to the recovery of listed coral populations. Increasing sexual and asexual reproduction in order to increase abundance, distribution, and genetic diversity, is the key objective for the conservation of the species. Currently, sexual recruitment of elkhorn and staghorn corals is limited in some areas and absent in most locations studied. Compounding the difficulty of documenting sexual recruitment is the difficulty of visually distinguishing some sexual recruits from asexual recruits (Miller et al., 2007). Hughes and Connell (1999) have documented that the limited availability of appropriate substrate has reduced the successful settlement of larvae or attachment of fragments since the 1980s. Natural consolidated hard substrate is necessary for elkhorn and staghorn coral recruits to attach and grow. In addition to being limited, the availability of appropriate habitat for successful sexual and asexual reproduction is susceptible to becoming reduced further due to overgrowth of fleshy macroalgae. Similarly, sediment accumulation impedes sexual and asexual reproductive success by covering available substrate and smothering coral recruits. Turf algae also preempts space and exacerbates the effect of sedimentation by trapping sediment. As described above, features that will facilitate successful larval settlement and recruitment, and reattachment and recruitment of asexual fragments, are essential to the conservation of elkhorn and staghorn corals. Without successful recruits (both sexual and asexual), the species will not increase in abundance, distribution, and genetic diversity.

The proposed action may adversely affect staghorn coral through transplantation and potential mortality of a few colonies. The loss of up to 5 colonies is not likely to reduce the chances of *A. cervicornis'* reproductive success or recovery in the wild. Tissue samples will be collected from every transplanted colony and transferred to a permitted *Acropora* nursery which will further preserve the genotypic material from the transplanted colonies. These fragments and their genetic material will thus be available for future re-transplantation.

Stressors such as sedimentation lead to abrasion, disease, and physical responses (such as increases in mucous production) that affect the corals' ability to generate enough energy to reproduce sexually. The proposed action may cause temporary impacts through sedimentation. The COE will be required to conduct sedimentation monitoring and sedimentation levels are expected to return to background levels upon project completion. The proposed project would not cause an increase in any of the other stressors listed in Table 2. Therefore, NMFS believes that sedimentation caused by the proposed action is not likely to reduce the chances of *A. cervicornis'* recovery in the wild.

Based on the above, the proposed action is not likely to appreciably reduce staghorn coral's likelihood of surviving and recovering in the wild.

Table 2. Rank of stressor severity to *Acropora* without (w/out) and with (w/) prohibition/protection of existing regulatory mechanisms (regs)* (*Acropora* BRT 2005)

Stressor	**A. cervicornis**	
	Rank w/o Regs	Rank w/ Regs
Disease	5+	5+
Temperature	5	5
Over-harvest	5*	1
Natural abrasion and breakage	4	4
Anthropogenic abrasion and breakage	2	1
Competition	3	3
Predation	3	3

Sedimentation	3	2
African Dust	1	1
CO_2	1	1
Nutrients	1	1
Sea level rise	1	1
Sponge boring	1	1
Contaminants	U	U
Loss of genetic diversity	U	U

*A rank of 5 represents the highest threat, 1 the lowest, and U undetermined/unstudied.

8 ANALYSIS OF DESTRUCTION OR ADVERSE MODIFICATION OF DESIGNATED CRITICAL HABITAT FOR ELKHORN AND STAGHORN CORAL

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. 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 is and will continue to support the conservation of the species and progress toward recovery.

The proposed action will result in the direct removal of 4.8 acres of critical habitat via dredging. As noted in the critical habitat rule, the key objective for the conservation and recovery of listed coral species 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. Impacts from dredging would permanently remove less than 0.000006 percent of the total amount of critical habitat within the Florida unit, and less than 0.02 percent of the potentially suitable habitat within the action. Impacts from anchor and cable drag would be temporary and insignificant and would not reduce the available critical habitat in and around the action area. NMFS does not believe that this loss will impede the recovery of the listed corals in the action area or range-wide. Therefore, the proposed project would not destroy or adversely modify the designated critical habitat for listed corals.

9 CONCLUSION

After reviewing the current status of *Acropora cervicornis* and its critical habitat, the environmental baseline for the action area, the effects of the proposed dredging activities, and the cumulative effects of future state, local, or private actions that are reasonably certain to occur in the action area considered in this opinion, it is NMFS biological opinion that the COE's proposed expansion of the Miami Harbor, as described in the Proposed Action section of this opinion, are not likely to jeopardize the continued existence of *Acropora cervicornis* or destroy or adversely modify its designated critical habitat.

10 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and protective regulations issued pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and 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 the incidental take statement (ITS).

10.1 Anticipated Amount or Extent of Incidental Take

NMFS has determined that the proposed dredging will result in the take of 31 staghorn corals via transplantation, 5 of which may be lethally taken through mortality associated with transplantation. The proposed action will result in the collection of small tissue fragments from each of the 31 transplanted coral colonies and transfer of these fragments to a permitted *Acropora* nursery within the sub-region.

10.2 Effect of the Take

NMFS has determined the anticipated incidental take specified in Section 9.1 is not likely to jeopardize the continued existence of staghorn coral nor result in the destruction or adverse modification of critical habitat if the project is developed as proposed.

11 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 COE or the contractor in order for the protection of Section 7(o)(2) to apply. The COE has a continuing duty to regulate the activity covered by this ITS. If the COE 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 COE 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 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. Relocation of *Acropora cervicornis:* Since transplantation can be stressful 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 A). The COE must ensure the 31 colonies of *A. cervicornis* are relocated outside of the project footprint prior to beginning construction. The COE must develop a transplantation monitoring plan in coordination with NMFS prior to commencing any construction.

2. Preservation of genetic material of transplanted coral colonies.

3. An environmental monitoring program and best management practices shall be established in order to determine whether technologies employed to reduce sedimentation and turbidity during all phases of construction are successful.

The COE 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, COE, 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.

12 TERMS AND CONDITIONS

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

The following terms and conditions implement the above RPMs:

1. COE must ensure that all 31 known *A. cervicornis* colonies within the project area are transplanted. Qualified individuals following the protocols in Appendix A must conduct transplantation. The COE must ensure that all transplanted colonies are re-located to

suitable habitat near their original location, but no closer than 400 feet from the edge of the channel but not further than 2,500 feet away. 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 1)

2. COE must record the original location of each transplanted colony, as well as the location of each colony after transplantation. These data must be submitted to the central acroporid geodatabase maintained by the Florida Fish and Wildlife Conservation Commission (FFWCC). COE must contact David Palandro, Ph.D., of FFWCC at (727) 896-8626, ext. 3056, prior to transplantation to discuss data collection and reporting requirements. (RPM 1)

3. The transplant monitoring plan shall include the monitoring of all the corals transplanted from the dredging footprint. The monitoring plan shall also include monitoring of corals already at the transplant site to compare the health and survivorship of transplants with corals naturally occurring at the transplant site. (RPM 1)

4. COE must submit any changes to transplantation protocols, and ensure that the qualifications of any persons conducting transplantation are submitted to NMFS, Protected Resources Division, Southeast Regional Office, Protected Resources Division, 263 13th Avenue South, St. Petersburg, Florida 33701. (RPM 1)

5. COE must ensure a 3-cm fragment is collected from each transplanted colony. The fragment must be collected from the axial tip of healthy branches (i.e., apparently free of disease, algae, or boring sponge infestations), using hand tools (e.g, clipper). Should colonies being transplanted fragment during handling, all fragments shall be collected in lieu of collecting an axial tip. Any fragments larger than 3-cm. shall be relocated according to transplantation protocols, fragments 3-cm or less shall be transplanted to the nursery. All fragments must remain in seawater until transfer to the custody of the *Acropora* nursery within the sub-region. COE will coordinate with NMFS to determine the appropriate nursery to receive the fragments. (RPM 2)

6. COE must ensure that only persons with an appropriate background conduct sedimentation/turbidity monitoring. (RPM 3)

7. The plan for the sedimentation/turbidity monitoring shall be developed in coordination with NMFS prior to commencing any construction. (RPM 3)

8. COE must ensure that best management practices are used, including a minimum 400-ft buffer between dredges and hard bottom resources (PBS&J 2008), except for dredging in construction of the channel. (RPM 3)

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The COE must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the reasonable and prudent measures.

13 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) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, project activities may only continue if the COE establishes that such continuation will not violate sections 7(a)(2) and 7(d) of the ESA. Please note that NMFS is currently conducting a status review of seven species of corals that occur in the Atlantic and Caribbean, including in the project area. Should any of these species be listed, consultation must be reinitiated.

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 *Acropora cervicornis*. 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 COE provide NMFS' Southeast Region, Protected Resource Division (PRD), with the collected data submitted for all projects permitted concerning staghorn coral.

2. NMFS strongly recommends that the COE, in consultation with PRD, utilize its authority to carry out programs for the conservation of *Acropora* corals. Pursuant to ESA Section 7(a)(1), the COE 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.

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16 APPENDIX A

***Acropora cervicornis* Transplantation Protocols for Miami Harbor Expansion Project.**

All *A. cervicornis* relocation field activities, data collection, analysis and reporting will be supervised by a marine biologist (M.S. in related field, minimum, 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.

Prior to colony collection, a 3-cm fragment must be collected from each parent colony. The fragment must be collected from the axial tip of healthy branches using hand tools (e.g., clipper). Fragments must remain in seawater until transfer to the custody of the *Acropora* nursery within the sub-region. Samples must be submitted to a permitted *A. cervicornis* coral nursery within the same eco-region. The eco-region of this project is Miami-Dade County. Applicant would be responsible for all costs of transfer of the colonies to the nursery. COE must coordinate with the appropriate *Acropora* nursery prior to collecting these samples to ensure safe transfer. If, for some reason, the *Acropora* nursery within Miami-Dade County is unable to accept the fragments, then the COE will transport them to the permitted *Acropora* nursery within Broward or Monroe County as soon as operationally feasible and no more than 24 hours after collection. COE will immediately notify NMFS of the change in nursery location.

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 COE 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 ft from the project area (550 ft from the edge of channel), and no further away than 2,500 ft 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 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 feet); 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 All Fill Epoxy. Before applying the epoxy to the substrate, it must be cleaned of any sediment or algae. The epoxy 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 epoxy 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.