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NATIONAL MARINE FISHERIES SERVICE

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MEMORANDUM FOR: F/HC3 – Tom Moore

FROM: F/SE – Roy E. Crabtree, Ph.D.

SUBJECT: Biological Opinion for NOAA Restoration Center's American Recovery and Reinvestment Act Project: Threatened Coral Recovery in Florida and the US Virgin Islands; National Park Service Permits to Establish Acroporid Nursseries

The attached document is NOAA's National Marine Fisheries Service's (NMFS) opinion based on our review of the subject project, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This opinion is based on information provided by the NOAA Restoration Center.

The purpose of the project is to continue and expand existing elkhorn and staghorn coral nurseries to aid in the recovery of the species. NMFS has analyzed the proposed action's effects on listed species and designated critical habitat under our purview in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). It is NMFS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of elkhorn or staghorn corals.

This concludes formal consultation on the action outlined above. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) new information reveals effects of the action that may affect listed species or critical habitat (when designated) in a manner or to an extent not previously considered, (2) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the opinion, or (3) a new species is listed or critical habitat designated that may be affected by the identified action.

We look forward to further cooperation with you on other RC projects to ensure the conservation and recovery of our threatened and endangered marine species. If you have any questions regarding this consultation, please contact Jennifer Moore, natural resource specialist, at the number listed above, or by e-mail at jennifer.moore@noaa.gov.

Attachment

Ref: F/SER/2009/04427

Endangered Species Act - Section 7 Consultation
Biological Opinion

Lead Agency:	National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) Restoration Center (RC)
Co-action Agency:	National Park Service Biscayne National Park (BNP) Dry Tortugas National Park (DTNP)
Activity:	NOAA American Recovery and Reinvestment Act Project: Threatened Coral Recovery in Florida and the US Virgin Islands (F/SER/2009/04427)
Consulting Agency:	National Marine Fisheries Service (NMFS) Southeast Regional Office Protected Resources Division
Date Issued:	10/2/09
Approved By:	Roy E. Crabtree, Ph.D. Regional Administrator

Background

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §1531 *et seq*.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of those species. When the action of a federal agency may affect a protected species or its critical habitat, that agency is required to consult with either NMFS or the U.S. Fish and Wildlife Service (USFWS), depending upon the protected species that may be affected.

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

This constitutes NMFS' biological opinion (opinion) based on our review of the effects on elkhorn (*Acropora palmata*) and staghorn corals (*A. cervicornis*) that would result from the RC's cooperative agreement with The Nature Conservancy to conduct large-scale regional restoration activities directed at *Acropora* spp. in Florida and the US Virgin Islands (USVI). Additionally, this constitutes our opinion on the effects on elkhorn and staghorn corals that would result from the NPS permitting collection and nursery site establishment in BNP and DTNP. The project duration is three years from start date. NMFS has analyzed the activities' effects on listed species and designated critical habitat under our purview in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.). It is NMFS' biological opinion that the action, as proposed, may adversely affect but is not likely to jeopardize the continued existence of elkhorn or staghorn corals.

BIOLOGICAL OPINION

1.0 Consultation History

On August 6, 2009, we received a request for consultation from the RC on their project to continue and expand nurseries for elkhorn and staghorn corals in Florida and the USVI. The RC determined that their activities may affect *Acropora* spp. Because the project requires permits from several resource management agencies, of which two are federal, PRD staff identified the potential to include those agencies in this opinion. The Florida Keys National Marine Sanctuary (FKNMS) completed consultation on their research and enhancement permitting program through a programmatic biological opinion (NMFS 2009). The effects of this action have been analyzed in that opinion; thus, their consultation requirements on this action are complete. The National Park Service proposes to permit collection and nursery site establishment within two of their parks - Biscayne National Park (BNP) and Dry Tortugas National Park (DTNP). Therefore, PRD staff contacted staff from each of those parks via email on August 27, 2009. Both staff members requested to be included in the consultation and determined that their actions may affect elkhorn and staghorn corals. The RC is the lead action agency, with the NPS being a co-action agency. We initiated consultation on August 27, 2009.

2.0 Description of the Proposed Action

The NOAA Office of Habitat Conservation's Community-based Restoration Program under the authority of the Fish and Wildlife Coordination Act (16 U.S.C. 661, as amended) and the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, will administer 50 projects to restore coastal and marine habitats through activities conducted under the American Recovery and Reinvestment Act of 2009 (ARRA). The proposed action is one of these 50 projects; the RC has entered into a Cooperative Agreement with The Nature Conservancy (TNC) and its partners (e.g., Coral Restoration Foundation, Florida Fish and Wildlife Conservation Commission, Mote marine Laboratory, Nautical Farms, Inc., Nova Southeastern University, Penn State University, University of the Virgin Islands, and University of Miami) to carry-out the proposed action. The Federal Grant and Cooperative Agreement Act states "substantial involvement is expected between the executive agency and the State, local government, or other recipient when carrying out the activity contemplated in the [cooperative] agreement (31 U.S.C. 6301–08)." Per the Cooperative Agreement's Special Award Conditions, the RC will have substantial involvement in the carrying out of the proposed action; however, TNC is the main administer of the proposed action. Their partners will carry-out the project at each of the individual nursery sites.

> This project is a regional effort aimed at aiding in the recovery of populations of threatened acroporid coral through the maintenance and establishment of nurseries on reefs in Florida and the U.S.V.I. Nurseries will be maintained or established within eight distinct sub-regions: (1) Broward County, Florida; (2) BNP; (3) Upper Florida Keys; (4) Middle Florida Keys; (5) Lower Florida Keys;

(6) DTNP; (7) St. Thomas, USVI; and (8) St. Croix, USVI. All of the proposed restoration activities will operate under the appropriate permitting program for each collection and nursery site. All collections and nursery activities will be done consistent with the requirements of those permits. The duration of the project is three years from the start date. The purpose of the nurseries is to propagate the species, creating as many new colonies of the species as feasible given limits on resources.

2.0.1 Nursery Operations Plan

In the first quarter, a detailed Site Nursery Operations Plan for each nursery site will be developed in accordance with American Recovery and Reinvestment Act (ARRA) milestone reporting requirements and NOAA RC Special Award Conditions and technical requirements. A draft of each plan will be submitted to RC for review to ensure consistency with the requirements of this opinion. The sections below outline the broad principals that will be included in detailed nursery operations plan.

2.0.2 Nursery Site Selection

Four of the eight nursery sites are already in existence and fully permitted; the remaining four are being identified in conjunction with NOAA RC, PRD, and the local permitting agencies as part of the local permitting process. Sites will be selected based on several factors including: (1) avoiding impacts to the reef; (2) absence of acroporid predators; (3) appropriate water quality and substrate conditions; and (4) logistics. Once permits are obtained from the local permitting agencies, copies will be submitted to RC. Once sites are selected, locations will be reported to RC and submitted to the central acroporid geodatabase at FWC.[1]

2.0.3 Coral Collection

Collection of corals to serve as nursery donor stock will be necessary. To support the scientific design of the nursery program, each nursery site, whether existing or new, will require bringing approximately 150 new 3-cm staghorn fragments into nursery. In Florida, staghorn fragments will be collected from wild parent colonies. Three 10-cm or smaller staghorn fragments will be clipped from 20 isolated wild colonies (totaling 60 fragments) within each of the six project sub-regions (six in Florida) and relocated to the established nursery in each sub-region. Due to local permitting requirements, the USVI sites will only utilize fragments of opportunity (loose, living coral fragments apparently free of disease, algae, or boring sponge infestation) to populate their nurseries; however, they will ultimately create the same number of fragments in their sites to be comparable with the Florida sites. Only the nursery sites in the Upper Keys and St. Croix will have both elkhorn and staghorn corals; all other sites will have only staghorn corals in nursery. See Table 1 for a summary of wild collections. The location of each parent colony will be recorded and reported to the central acroporid geodatabase at FWC[1].

[1] Prior to or immediately upon conducting collections from wild parents, the RC or designee shall contact David Palandro, Ph.D. of FWC at (727) 896-8626, ext. 3056 for information on reporting appropriate data to the central acroporid geodatabase.

To minimize the impact of the harvesting, collections will take place from October through May when water temperatures are lower, causing the least stress to the coral colonies. No movement of fragments will occur between sub-regions in order to prevent mixing of potentially different metapopulations of corals. Each parent donor will be sampled for genotypic identification (see Section 2.0.5). The total maximum number of fragments collected from wild colonies in all sub-regions will be 60 and 360, elkhorn and staghorn, respectively (see Table 1 for a summary of number of fragments of each species from each sub-region).

Table 1. Summary of collections from wild parent donors by species.

Nursery Site	Elkhorn Collections	Staghorn Collection
Broward	None	60 wild fragments
BNP	None	60 wild fragments
Upper Keys	60 wild fragments	60 wild fragments
Middle Keys	None	60 wild fragments
Lower Keys	None	60 wild fragments
DTNP	None	60 wild fragments
St. Thomas	None	None
St. Croix	None	None

In addition to the corals collected under the scientific design protocols described above, the nurseries will have the capability to manage additional corals within each site. These corals will not be collected from wild parent donors; rather the following hierarchical approach will be utilized : (1) Corals of opportunity - loose, living coral fragments apparently free of disease, algae, or boring sponge infestation; (2) Corals of opportunity - harvest of fragments from areas where corals are predicted to be lost due to permitted coastal construction activities; (3) Nursery corals – corals that are already in a nursery setting; and (4) Artificial substrate – corals that are attached to artificial substrates (i.e., sea walls, docks, unpermitted artificial reef sites, etc.; does not include permitted artificial reef sites). There is no established maximum number of fragments of this nature that can be collected; the only limit is appropriate space and care within the nursery. These corals will be maintained in a separate portion of the nursery apart from those being maintained as part of the scientific design and will be tracked separately.

2.0.4 Nursery

Once brought into nursery each of the collected corals is fragmented into multiple fragments (between 3-cm and 5-cm). Each fragment is given a unique identifier that will allow it to be tracked back to its parent colony and allow accurate genetic tracking. The fragment will then be secured to a small concrete disc, a restoration module, or a line, depending on the species and methodology being employed (see Image 1). Each coral fragment will then receive maintenance as necessary to remove algae and predators. After 6-12 months (depending on growth), each coral will be re-fragmented into multiple 3-cm to 5-cm fragments in order produce 2nd generation corals, which are clones of the parent. Each 2nd generation coral will receive a unique identifier to facilitate ongoing tracking. Maintenance activities will be ongoing for the duration of the project (i.e., fragmentation events will occur every 6-12 months for 3 years). These methods have

proven to be highly successful (i.e., little to no mortality) in pilot nurseries that have been operating for several years (Herlan and Lirman 2008).

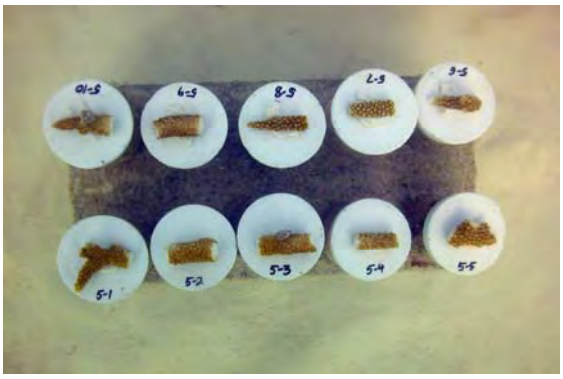

Image 1. Typical nursery fragment array with small fragments attached to concrete disks. Photo credit K. Nedimyer.

2.0.5 Tissue Sampling for Genotyping

The genotype of each wild parent donor will be determined during the first six months of the project and reported to FWC (see footnote 1). A small (approximately 1 cm^2) tissue sample will be taken from each collected fragment or parent colony for genotyping. This genetic marker is a tool that allows long-term tracking of recruitment and proliferation resulting from these nursery sites across Florida and the USVI. This information will be added into the existing library for the species to help determine the genetic relationships across Florida and Caribbean sub-regions. All genotyping will be carried out by Penn State University (Dr. Iliana Baums or her designee) using the same techniques and biomarkers that have been used on most existing studies of *Acropora* (Baums et al. 2005).

2.0.6 Monitoring

On a quarterly basis, trained staff and volunteers from each project location will assist with the monitoring of nursery coral colonies. Specifics on the monitoring plans and protocols will be developed in the first quarter in close consultation with NOAA RC and PRD staff. However, general nursery monitoring activities include:

- Monitor all fragments monthly for presence/absence of disease, bleaching, breakage, predation, and survivorship. Should any of these conditions arise, they will be reported immediately to RC and response will be coordinated with RC.
- Measure all fragments. Total linear growth and number of branches recorded for each coral.
- Photographs of all fragments.
- Monitor parent for survivorship and condition (presence/absence of disease, bleaching, breakage and predation). Should any of these conditions arise, they will be reported immediately to RC and response will be coordinated with RC.
- Clean all coral disks on an as needed basis.

2.0.7 Annual Comprehensive Review of Operation of Acroporid Nurseries

PRD and RC will conduct a review of the operation of the acroporid nurseries annually. This review will evaluate, among other things, whether the performance measures (e.g., monitoring, fragmenting events) and data reporting requirements are being met.

2.1 Outplanting of Nursery-reared Corals

The ultimate goal of engaging in controlled propagation of the species within these nurseries is for enhancement of wild populations, to support recovery of the species. Previous efforts at nursery operations and outplanting have been at a pilot scale. Because the proposed action will significantly increase the number of corals available for outplanting, a comprehensive plan must be developed to identify the methods and practices necessary to conduct wild population enhancement appropriately. This plan will be developed by PRD in close coordination with the RC and its partners and will address NMFS' "*Policy Regarding Controlled Propagation of Species Listed Under the ESA*" (65 FR 56916). No outplanting (with one exception) will be conducted prior to re-initiation of consultation on this opinion. Currently, no permits are held for outplanting (with one exception). Further, Special Award Conditions (SAC)3 and 4 of the Cooperative Agreement state:

> "3) *Adhere to Applicable Federal, State, and Local Laws*
> The grantee will ensure that implementation of the project will meet all federal, state, and local laws and regulations by obtaining all applicable permits and consultations prior to expenditure of federal funds or award match for those activities requiring permits. This includes, but is not restricted to, consultations required under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat), National Historic Preservation Act, and Coastal Zone Management Act. The grantee will be cognizant of all conditions and restrictions required by their permits and consultations, and will immediately halt activities and contact their NOAA Technical Monitor if events occur that threaten to violate the conditions or restrictions required by their permits and consultations.
>
> 4) *Verify Receipt of Permits and Consultations*
> Grantees should provide the NOAA Technical Monitor with a list of required permits prior to receipt, including estimated dates of completion, to assist with the NEPA evaluation process. The grantee must notify the NOAA Technical Monitor [RC] via email with the date that each required Federal and state permit or compliance document is obtained or approved, and present verification that the permit or other requirement has been satisfied."

These SACs will ensure that outplanting (with one exception) will not occur prior to re-initiation of consultation on this opinion.

2.1.1 Exception to the Outplanting Restriction

One nursery site, the Upper Key operated by the Coral Restoration Foundation (CRF), has been in existence since 1999, when three individual (unique genotype) colonies of staghorn coral settled naturally in a live rock farm. Those initial three genotypes have been propagated in the nursery and now number close to 1,000 fragments. CRF, one of the proposed action's partners, currently holds a permit from the Florida Keys National Marine Sanctuary to outplant a total of 384 colonies (128 of each genotype) to 16 reefs within the Upper Keys. A total of 24 colonies (8 of each genotype) will be outplanted to each reef. The purpose of this pilot outplanting project is to gather data that is necessary to assist in the development of the large-scale outplanting plan discussed above. The outplanting project utilizes an experimental design to test different management regimes and compare growth, survival, incidence of disease, and incidence of bleaching between multiple habitat types in offshore and mid channel reef sites and the different genotypes.

3.0 Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The proposed action area is the Florida Reef Tract and the reefs surrounding St. Thomas and St. Croix, USVI. Individual nurseries are usually focused on small sites; four nursery sites are existing (Broward, BNP, Upper Keys, and Lower Keys) and four will be established (Middle Keys, DTNP, St. Thomas, and St. Croix) according the site selection criteria described above (see section 2.0.2) and through the local permitting process. Collections of fragments will be from throughout the entire action area, based on availability of sources.

4.0 Status of Listed Species and Critical Habitat

Much of the information for this section, as well as additional detailed information relating to the species' biology, habitat requirements, threats, and recovery objectives, can be found in the status review and recovery plan for each species (see www.nmfs.noaa.gov/prot_res/PR3/recovery.html). Table 1 lists the endangered (E) and threatened (T) sea turtle and fish species under the jurisdiction of NMFS, which occur in or near the action area.

4.1 Species in the Action Area

There are five species of sea turtles (green, hawksbill, Kemp's ridley, leatherback, and loggerhead) and the smalltooth sawfish that can possibly be found in or near the action area. Although these species may be present in the action area, there are no potential routes of effects to these species from the proposed action. The action area is not within designated critical habitat for sea turtles or smalltooth sawfish.

Table 2. Listed species in Florida likely to occur in or near the project area.

Common Name	Scientific Name	Status
Turtles		
green sea turtle	*Chelonia mydas*	E/T
hawksbill sea turtle	*Eretmochelys imbricata*	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
leatherback sea turtle	*Dermochelys coriacea*	E
loggerhead sea turtle	*Caretta caretta*	T
Fish		
smalltooth sawfish	*Pristis pectinata*	E
Invertebrates		
elkhorn coral	*Acropora palmata*	T
staghorn coral	*Acropora cervicornis*	T

The action is within critical habitat for elkhorn and staghorn corals (73 FR 72210; November 26, 2008). However, there are no adverse effects of the action. The nursery sites are or will be established primarily in sandy substrates. For those few sites that are on hard substrate (i.e., the essential feature), the effect of the action is solely beneficial. The final critical habitat designation identified the key conservation objective for the corals as facilitating increased incidence of successful sexual and asexual reproduction. So while an extremely small portion of the essential feature will be covered with coral fragments in the nursery sites temporarily, the purpose of the project is to increase asexual reproduction for the species. Thus, the project is meeting the conservation goal for designated critical habitat and will not result in any adverse effects.

For the reasons given above, NMFS has determined sea turtles and smalltooth sawfish, will not be affected by the proposed action. Acroporid critical habitat is not likely to be adversely affected. Therefore, these species and critical habitat will not be considered further in this opinion.

4.2 Species Likely to be Adversely Affected: Elkhorn and Staghorn Corals

Elkhorn and staghorn corals were listed as threatened under the ESA on May 9, 2006 (71 FR 266852), based on a status review initiated in 2004. Elkhorn and staghorn corals are the only two corals listed under the ESA. The Atlantic *Acropora* Status Review (Atlantic *Acropora* Biological Review Team (BRT) 2005) presents a summary of published literature and other currently available scientific information regarding the biology and status of both elkhorn and staghorn corals. The following discussion summarizes those findings relevant to our evaluation of the proposed action.

Elkhorn and staghorn corals are two of the major reef-building corals in the wider Caribbean. Elkhorn colonies are flattened to near-round, with frond-like branches that typically radiate outward from a central trunk that is firmly attached to the sea floor. Staghorn colonies are staghorn-antler-like, with cylindrical, straight or slightly curved branches. The branching morphology of these species provides important habitat for other reef organisms. Historically, both acroporid 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 elkhorn and staghorn zones were described for many shallow-water reefs, based on the high coverage and colony density, and in some cases near exclusiveness, of these species (Figure 1) (Jaap 1984, Dustan 1985, Dustan and Halas 1987). In terms of accretion rates and the formation of structurally complex reefs, the structural and ecological roles of Atlantic *Acropora* spp. in the wider Caribbean are unique and cannot be filled by other reef-building corals (Bruckner et al. 2002).

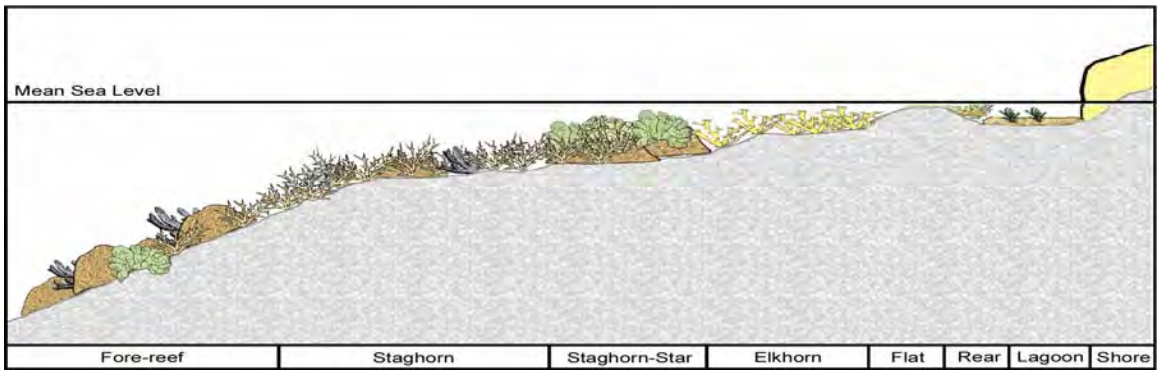

Figure 1: Reef zonation schematic example modified from several reef zonation-descriptive studies (Goreau 1959; Kinzie 1973; Bak 1977).

Life History

The maximum range in depth reported for elkhorn coral is <1 m to 30 m, but the optimal depth range for this coral is considered to be 1 to 5 m depth (Goreau and Wells 1967). Currently, the deepest known colonies of elkhorn coral occur at 21 m in the Flower Garden Banks National Marine Sanctuary (Hickerson pers. comm.) and at Navassa National Wildlife Refuge (Miller pers. comm.). The preferred habitat of elkhorn coral is the seaward face of a reef (turbulent shallow water), including the reef crest, and shallow spur-and-groove zone (Shinn 1963, Cairns 1982, Rogers et al. 1982). At low tide, colonies are sometimes exposed. Colonies of elkhorn coral often grow in nearly mono-specific, dense stands and form interlocking framework known as thickets in fringing and barrier reefs (Jaap 1984, Tomascik and Sander 1987, Wheaton and Jaap 1988). Storm-generated fragments are often found occupying back reef areas immediately landward of the reef flat/reef crest, while colonies are rare on lagoonal patch reefs (Dunne 1979). Elkhorn coral has formed extensive barrier-reef structures in Belize (Cairns 1982), the greater and lesser Corn Islands, Nicaragua (Gladfelter 1982, Lighty et al. 1982), and Roatan, Honduras, and built extensive fringing reef structures throughout much of the Caribbean (Adey 1978). Colonies generally do not form a thicket below 5 m depth, with

maximum water depths of framework construction ranging from 3 m to 12 m (see Table 1 in Lighty et al. 1982).

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 is currently observed at 5 to 15 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 hard-bottom (Davis 1982). Colonies have been common in back- and patch-reef habitats (Gilmore and Hall 1976, Cairns 1982). Although staghorn coral 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, staghorn coral 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), with these latter types of corals more dependent on zooplankton. Therefore, *Acropora* spp. 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 photosynthetic to respiration ratio (P/R ratio).

Optimal water temperatures for elkhorn and staghorn corals range from 25° to 29°C, although colonies in the U.S.V.I. have been known to tolerate short-term temperatures around 30°C without obvious bleaching (loss of zooxanthellae). 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 both species. Additionally, major mortality of elkhorn and staghorn corals 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 staghorn coral was reported in Florida when temperatures dropped to less than 26°C (Shinn 1966).

Atlantic *Acropora* spp., like many stony coral species, employ both sexual and asexual reproductive propagation. Atlantic *Acropora* spp. reproduce sexually by broadcast spawning, meaning that coral larvae develop externally to the parental colonies (Szmant 1986), and both species are simultaneous hermaphrodites, meaning that a given colony will contain both female and male reproductive parts during the spawning season. Gametes (eggs and sperm) are located in different layers of the same polyp (Soong 1991). The spawning season for elkhorn and staghorn corals is relatively short, with gametes

released only a few nights during July, August, and/or September. In some populations, spawning is synchronous after the full moon during any of these three months. Annual egg production in elkhorn and staghorn populations studied in Puerto Rico was estimated to be 600 to 800 eggs per cm^2 of living coral tissue (Szmant 1986).

In *Acropora* spp., fertilization and development are exclusively external. Embryonic development culminates with the development of planktonic larvae called planulae. Little is known concerning the settlement patterns (Bak et al. 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 elkhorn and staghorn corals on the Caribbean coast of Panama indicated that larger colonies of both species (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). For elkhorn coral, the larger the colony, the higher the fecundity rate; over 80 percent of the colonies larger than 4000 cm^2 were fertile. The estimated size at puberty for elkhorn coral was 1600 cm^2 and the smallest reproductive colony observed was 16 x 8 cm^2. 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).

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.

The growth rate of elkhorn coral, expressed as the linear extension of branches, is reported to range from 4 to 11 cm annually (Vaughan 1915, Jaap 1974). The growth rate for staghorn coral has been reported to range from 3 to 11.5 cm/yr. These growth rates are 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 of elkhorn and staghorn corals 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 elkhorn and staghorn corals relative to other corals and other benthic organisms (Shinn 1976, Neigel and Advise 1983, Jaap et al. 1989).

Status and Distribution

Throughout much of the wider Caribbean, *A. palmata* coral historically comprised the elkhorn zone (Figure 1) at 1 to 8 m depth (reef flat, wave zone, reef crest) in diverse areas including Jamaica (Goreau 1959), Alacran Reef, Yucatan peninsula (Kornicker and Boyd 1962), Abaco Island, Bahamas (Storr 1964), the southwestern Gulf of Mexico, Bonaire (Scatterday 1974), and the Florida Keys (Jaap 1984, Dustan and Halas 1987). The predominance of elkhorn coral in shallow reef zones is related to the degree of wave energy; in areas with strong wave energy conditions only isolated colonies may occur, while thickets may develop at intermediate wave energy conditions (Geister 1977). Although considered a turbulent water species, elkhorn coral is sensitive to breakage by wave action, and is thus replaced by coralline algae in heavy surf zones throughout the province (Adey 1977).

Historically, throughout much of the wider Caribbean, staghorn coral 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), staghorn coral was a major mid-depth (10 to 25 m) reef-builder. Principally due to wind conditions and rough seas, staghorn coral has not been known to build extensive reef structures in the Lesser Antilles and southwestern Caribbean.

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). Few data are present before the 1980 baseline, likely due in part to researchers' tendencies to neglect careful measurement of abundance of species that are ubiquitous.

Both acroporid species underwent precipitous declines in the early 1980s throughout their ranges and this decline has continued. Although quantitative data on former distribution and abundance are scarce, in the few locations where quantitative data are available (e.g., Florida Keys, Dry Tortugas, Belize, Jamaica, and the U.S.V.I.), declines in abundance (coverage and colony numbers) are estimated at >97 percent. Although this downward (decline) trend 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.

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).

Threats and Outlook

Elkhorn and 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 elkhorn and 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, divers/snorkelers), coastal development, competition, and predation are deemed to be moderate.
Table **3** summarizes the factors affecting the status of elkhorn and staghorn corals and the identified sources of those stressors.

Many factors, including both intrinsic life history characteristics, as well as external threats, are important to consider in assessing the status and vulnerability of elkhorn and staghorn corals. Recovery of the two corals from their current level of decreased abundance depends upon rates of recruitment and growth outpacing rates of mortality. These species have rapid growth rates 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.

Thus, it is anticipated that successful sexual reproduction will need to play a major role in Atlantic *Acropora* spp. recovery (Bruckner 2002). Meanwhile, there is substantial evidence to suggest that sexual recruitment of both elkhorn and staghorn corals is currently compromised. Reduced colony density in these 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. In addition, appropriate substrate available for fragments to attach to is likely reduced due to changes in benthic community structure on many Caribbean reefs. Coupled with impacts from coastal development (i.e., dominance by macroalgal, turf, and/or sediment-coated substrates), these factors are expected to further reduce successful larval recruitment below an appropriate scale that can compensate for observed rates of ongoing mortality.

Species at reduced abundance are at a greater risk of extinction due to stochastic environmental and demographic factors (e.g., episodic recruitment factors). Both acroporids have 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.

The major threats (e.g., disease, elevated sea surface temperature, and hurricanes) to elkhorn and 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 elkhorn and staghorn corals' decline by enhancing coral condition and decreasing synergistic stress effects.

The impacts on elkhorn and staghorn corals from all of the above mentioned stressors could be exacerbated by reduced genetic diversity, which often results when species undergo rapid decline like *Acropora* spp. have 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 remain 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 elkhorn and staghorn corals, it is plausible that these species have suffered a loss of genetic diversity that could compromise their ability to adapt to future changes in environmental conditions. No quantitative information is available regarding genetic diversity for either species.

Table 3. 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

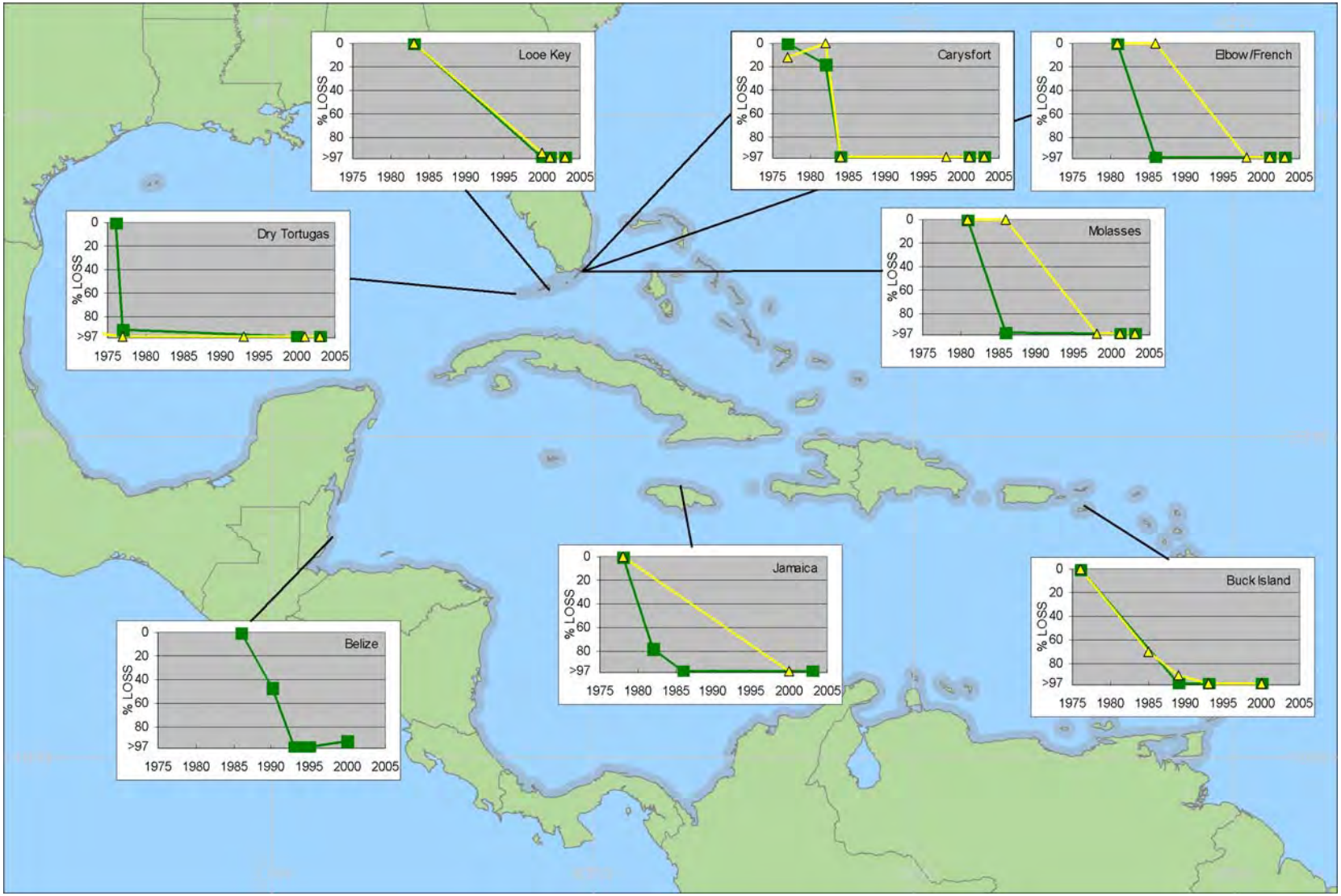

Figure 2. Percent loss of staghorn coral (green squares) and elkhorn coral (yellow triangles) throughout the Caribbean for all locations (n=8) where quantitative trend data exist. Shaded areas on map illustrate the general range of elkhorn and staghorn corals (*Acropora* BRT 2005).

5.0 Environmental Baseline

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

The environmental baseline for this opinion includes the effects of several activities that affect the survival and recovery of elkhorn and staghorn corals in the action area.

5.1 Status of Elkhorn and Staghorn Coral Within the Action Area

The action area includes the Florida Reef Tract and reefs surrounding St. Thomas and St. Croix, USVI. Elkhorn and staghorn coral are found in varying densities throughout the action area. A 2007 synoptic survey conducted by the University of North Carolina – Wilmington reports that elkhorn and staghorn coral were observed in the general survey area at approximately 10 percent and 23 percent, respectively, of the 235 reef sites surveyed throughout most of the Florida Reef Tract (minus the Marquesas Keys and the Dry Tortugas further west). The survey included sites in all of the FKNMS zones except for Newfound Harbor Sanctuary Preservation Area (SPA) (Miller et al. 2007). Similar comprehensive data do not exist for the USVI.

5.2 Factors Affecting the Species' Environment Within the Action Area

Numerous activities funded, authorized, or carried out by federal agencies have been identified as threats and may affect elkhorn and staghorn corals in the action area. Few other biological opinions have been conducted that can be referenced and the following identified activities are based on agency knowledge of ongoing actions that may require re-initiation of ESA consultation or new consultations based on the listing.

- The U.S. Army Corps of Engineers (COE) authorizes and carries out construction and dredge and fill activities that may result in direct mortality, injure elkhorn or staghorn coral, or eliminate or impede an elkhorn or staghorn coral's access to habitat.
- The U.S. Environmental Protection Agency (EPA) regulates the 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.
- NMFS develops fishery management plans and fishery regulations that govern fishing activities that may physically interact with the species and its habitat.
- The National Park Service (DOI) and the National Marine Sanctuary Program (NOAA) regulate activities within the boundaries of their designated parks and marine sanctuaries that are conducted in shallow water coral reef areas including collection of coral,

alteration of the seabed, discharges, boating, anchoring, fishing, recreational SCUBA diving, snorkeling, and scientific research.

- The COE and EPA permit 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 run-off, and dredging and disposal activities, result in direct deposition of sediment on corals, shading, and lost substrate for fragment reattachment or larval settlement).

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

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

Although many regulations exist to protect corals, including elkhorn and staghorn corals, many of the activities identified as threats still adversely affect the species. Poor boating and anchoring practices, poor snorkeling and diving techniques, and destructive fishing practices cause abrasion and breakage to elkhorn and staghorn corals. 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.

Diseases have been identified as the major cause of elkhorn coral and staghorn coral decline. Although the most severe mortality resulted from an outbreak in the early 1980s, diseases are still present in elkhorn and staghorn coral populations and continue to cause mortality.

Hurricanes and large coastal storms could also significantly harm elkhorn and staghorn corals. Due to their branching morphologies, they are especially susceptible to breakage from extreme wave action and storm surges. Historically, large storms potentially resulted in asexual reproductive events, if the fragments encountered suitable substrate, attached, and grew into new colonies. However, in the recent past, the amount of suitable substrate is significantly reduced; therefore, many fragments created by storms die.

5.3 Summary and Synthesis of Environmental Baseline

In summary, several factors are presently adversely affecting elkhorn and staghorn corals in 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 will continue to degrade water quality and decrease water clarity necessary for coral growth;
- Dredge-and-fill activities;
- Interaction with fishing gear;
- Vessel traffic will continue to result in abrasion and breakage due to accidental groundings and poor anchoring techniques; and
- Poor diving and snorkeling techniques will continue to abrade and break corals.

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

6.0 Effects of the Action

As described below, the collection of coral fragments constitutes take under the ESA. However, the purpose of the acroporid nurseries is to aid the recovery of the species. On October 29, 2008, NMFS finalized an ESA section 4(d) rule that prohibited most forms of take of these species (50 CFR 223.208). The rule provides an exception from the ESA section 9 take prohibitions for research and enhancement activities permitted under six specific governmental research permitting programs. All activities under the proposed action constitute enhancement activities covered by the take exception, and require a permit from one of the six identified and excepted programs (i.e., NPS, state of Florida, FKNMS, and Territory of the USVI). Therefore, take resulting from this proposed action is not legally prohibited, provided all appropriate permits are obtained, and no incidental take statement or reasonable and prudent measures will be issued in this opinion. However, because take will result from the proposed action, we must evaluate whether the action is likely to jeopardize the continued existence of either species.

The proposed action is the continuation (i.e., maintenance of existing nursery sites) and expansion (i.e., establishment of new nursery sites) of acroporid nurseries in eight specific locations in the Florida Reef Tract and reefs surrounding St. Thomas and St. Croix, USVI. Collection and nursery activities include tissue sampling; fragment breakage, handling, or collection; coral branch or colony reattachment in the nursery; coral branch or colony marking; removal of predatory organisms and algae; measuring; and/or video monitoring of colonies. Take of *Acropora* spp. will result from some of these activities; however, the purpose of the nursery program is to increase reproduction and recovery potential for the species. The RC has developed this program in close coordination with local resource managers and PRD. The techniques that will be utilized have been tested and proven through previous successful pilot nursery projects (Herlan and Lirman 2008). Tissue sampling typically involves the collection of polyps (approximately 1 cm^2 tissue) or small branch tips (approximately 2-10 cm in length) for

genotyping using hand tools, such as syringes or pliers. Reattachment of branches or colonies involves the use of epoxy or cement, with mechanical devices such as cable ties being used less often. Markers on coral branches or colonies are placed adjacent to colonies or impact a small area of the coral tissue (~1 cm^2). Measuring and video monitoring of corals involves the temporary hand placement of flexible transect tapes on corals. Lastly, as discussed above (see section 2.0.3), whenever possible collection of nursery stock will be limited to coral fragments produced naturally via fragmentation; where wild collections occur, monitoring of parent colonies will track lesion healing and new growth over time.

NMFS believes that, overall, the take of the species that would occur will have temporary effects to these species. In our evaluation of scientific research permitting programs eligible for the take exemptions from the ESA section 9 prohibitions extended by the ESA 4(d) regulations for elkhorn and staghorn corals, NMFS found that the coral research (e.g., gene flow, disease etiology) and enhancement activities (e.g., coral nurseries, restoration) permitted by the six excepted programs provide for the conservation of these species. Additionally, a comparison of permitting requirements for research and enhancement activities permitted under these programs indicates that the permit procedures are as protective as the requirements for an ESA section 10(a)(1)(A) scientific research permit. All activities conducted under this nursery program will require a permit under the aforementioned programs. The specific effects of nursery activities on coral colonies, and on reproductive units of elkhorn and staghorn corals (e.g., gametes and asexual fragments), are discussed below.

6.1 Effects of the Action on Elkhorn or Staghorn Coral Colonies

Permitted collection of naturally-available fragments and/or collection of fragments using hand tools will have positive and negative effects on the species. As identified in Section 3.2 (Life History) of this opinion, these species have rapid growth rates and high potential for propagation via asexual fragmentation. Asexual fragmentation of wild elkhorn and staghorn coral colonies is the dominant mode of reproduction, and results naturally from storm events (i.e., tropical storms and hurricanes). Highsmith (1982) describes fragmentation as an adaptive process for several reasons, including increased survival due to large size of offspring compared to a sexually produced offspring. In order for these fragments to survive, though, they must reattach to the substrate. The likelihood of successful reattachment and subsequent growth into a coral colony is low because of the limited availability of appropriate quality reattachment substrate (i.e., consolidated hard substrate free from algae or sediment). Fragments that do not reattach shortly after breaking off of coral colonies are highly susceptible to abrasion and further breakage. Thus, many asexual fragments that result from natural disturbances (e.g., hurricanes) experience mortality. For this reason, the nursery program has identified collection of naturally-occurring fragments as the main source of nursery stock. Lindahl (2003) conducted a study on the effects of artificial stabilization and mechanical damages and found that coral fragments were not significantly affected by skilled handling. Furthermore, artificial reattachment and stabilization of fragments increases the likelihood of fragment survival by reducing mortality due to abrasion and additional breakage. Once an outplanting strategy has been developed, the nursery-reared fragments will be outplanted to the wild within their native sub-region to increase the wild population and distribution. Remarkably, during the 2009 acroporid spawning event, three nursery-reared staghorn colonies, which were outplanted to Florida Key's Molasses Reef two years ago, were observed releasing gametes (Palandro pers. comm.). This is the first observation

of spawning in nursery-reared colonies, proving that they can contribute to reproduction of the species. Thus, nursery-rearing of the species will contribute to an increase in numbers and reproduction of elkhorn and staghorn coral colonies; eventually it will contribute to an increase in distribution.

NMFS believes that the permitted collection of fragments of opportunity (discussed in section 6.2) or small tissue samples (i.e., polyps and/or branch tip fragments) using hand tools such as a syringe, shears, or pliers will have temporary effects on the coral colonies from which samples are collected. Prior to permitting collection of small tissue samples, local resource managers will consult with permit applicants (i.e., TNC) to ensure these collections are minimized in quantity and sample dimension, and dispersed geographically. Only one small tissue sample for genotypic identification is collected from a single parent. Donor stock will be comprised of up to three 10-cm or smaller fragments from approximately 20 isolated wild staghorn colonies within each of the eight sub-regions. Thus, the "sample collection load" is dispersed across several coral colonies at several locations, and no one coral colony is relied upon to provide a single large tissue sample. Given the limits placed on tissue sample collection by local permits, the effect of this activity on elkhorn or staghorn coral colonies is a small reduction in biomass. This reduction in coral biomass caused by the collection of small tissue samples, however, is expected to be temporary, with recovery through tissue replacement and/or coral colony growth. In elkhorn coral, lesions at the point of fragment detachment have been shown to begin regeneration within two weeks (Lirman 2000) of fragmentation, with regeneration rates being positively correlated with decreasing size of lesion and proximity to growing tip. Lirman (2000) showed that a 3-cm^2 lesion regenerated completely within 100 days. Additionally, the collection of small tissue samples almost always occurs at the outermost portion of the branch tip. Soong and Lang (1992) observed that, in *A. cervicornis*, large polyps and basal tissues located 1.0 to 4.5 cm (0.4 to 1.8 inches) 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 (0.8 to 2.4 inches) of the colony's branch tips always had smaller eggs than those in the mid-region (Soong and Lang 1992). In *A. palmata*, small eggs were found in the whole colony, while infertile areas were observed in the encrusting base and along the growing edges of branches (Soong and Lang 1992). Additionally, larger colonies of both species (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). Thus, the collection of small tissue samples is not expected to have a significant effect on coral colonies' sexual reproduction. In summary, given that collected tissue samples are small in size (anywhere from 1 polyp to a 10-cm branch tip) relative to coral colony size, that the effects of collecting tissue samples are temporary, and that tissue samples are almost always collected from the outermost portion of the coral branch or branch tip where smaller eggs are found, it is not likely that the natural survival or reproductive output of elkhorn or staghorn coral colonies will be measurably reduced by the collections.

NMFS believes that the permitted marking of coral colonies, removal of predatory organisms or algae from coral colonies, measurement of coral colonies, or video monitoring of coral colonies will have insignificant effects on coral colonies. None of the tools or methods used during these activities requires the permanent removal of tissues (i.e., polyps and/or branch tip fragments) or permanent attachment of materials to coral colonies, except for some coral colony markers. Markers attached directly to coral colonies are rarely used, and in the past, coral colonies have

shown rapid tissue overgrowth of the marker. Additionally, hand-placed calipers or flexible transect tapes, used for measuring and video monitoring purposes, remain in contact with small portions of coral colonies for brief periods lasting 30 minutes or less. Given the temporary and superficial nature of these activities, it is not likely that elkhorn or staghorn coral colonies will be injured or killed by the collection, monitoring, and measuring activities mentioned above.

NMFS believes that the reattachment or stabilization of coral colonies using epoxy, cement, or mechanical devices (e.g., plastic cable ties) in the nursery will have positive effects on elkhorn and staghorn coral colonies. Coral colonies are typically dislodged or knocked over because of storms, hurricanes, boat groundings, or anchoring. Depending on the degree of damage and the availability of suitable reattachment substrate, a coral colony may reattach on its own. The likelihood of coral colony survival increases, however, with artificial stabilization by reducing coral colony mortality due to abrasion and additional breakage. Additionally, Lindahl (2003) showed that skilled handling does not significantly affect coral fragments or, by extension, coral colonies. Given that these activities increase the likelihood of coral colony survival, NMFS believes that the survival and reproductive output of elkhorn or staghorn coral colonies will be increased by reattachment or stabilization activities. Further, because the fragments will be brought into a nursery and cared for (i.e., grazer, predator, and algae removal), their survival is all but certain.

There are potential positive effects of proposed activities on elkhorn and staghorn coral colonies including potentially reduced coral colony tissue destruction caused by corallivorous grazers – and therefore increased survival and reproduction potential – and reduced coral colony mortality following natural or anthropogenic disturbances.

NMFS believes that the outplanting of 384 colonies of staghorn coral in the upper Keys will have no effect on the wild population. The number of outplants (384) is extremely small compared to the wild population in the Upper Keys (estimated at several million per Miller et al. 2008). Further, at each individual reef, only 8 colonies of each or three genotypes will be outplanted. Therefore there is no potential for any deleterious genetic effects (i.e., founder effect, inbreeding, genetic swamping) to occur.

Activities conducted through this project and take of the species that will occur will have solely temporary adverse effects on elkhorn and staghorn corals and will never result in mortality of whole coral colonies in the wild. The nursery activities will also result in positive effects to these species. Collection of fragments and tissue samples from elkhorn or staghorn coral colonies will result in a small reduction in coral biomass; however, this effect is expected to be temporary, with recovery through tissue replacement and/or coral colony growth. Removal of predatory organisms and algae, measuring, monitoring, or marking will have no detectable negative effect on coral colonies. These activities are not likely to result in injury or death of wild elkhorn or staghorn coral colonies; rather, predatory and algae removal will result in reduced injury and mortality. Only small samples collected for genotypic analysis (~1 cm^2) will be consumed in the laboratory and will thus not contribute to potential reproduction. However, nursery rearing, reattachment, stabilization, and transplantation of coral colonies or fragments will have positive effects on the species. Reattachment, stabilization, and transplantation of coral colonies or fragments into nurseries will reduce mortality due to abrasion and breakage, and these activities are likely to result in increased survival and reproductive output of elkhorn and

staghorn coral colonies and fragments. Nursery-reared fragments have a high probability for survivorship and for growing into coral colonies, which will contribute to an increase in numbers, reproduction, and distribution of elkhorn and staghorn coral colonies

7.0 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 in Sections 4.2 and 5.0 are expected in the action area. Activities affecting corals are highly regulated federally; therefore, any future activities within the action area will likely require ESA section 7 consultation.

8.0 Jeopardy Analysis

This section considers the likelihood that the proposed action will jeopardize the continued existence of elkhorn or staghorn corals in the wild. 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 5.0) describes the effects of the take resulting from the proposed action on elkhorn and staghorn corals. Sections 4.0 and 6.0 help 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 these listed species. The analysis next considers whether any such reduction would in turn result in an appreciable reduction in the likelihood of survival of each species in the wild and the likelihood of recovery of each species in the wild.

In the following analyses, we demonstrate that no reduction in numbers, reproduction, or distribution is expected; therefore, the proposed action's effects on elkhorn or staghorn corals will not appreciably reduce the likelihood that the species will survive and recover in the wild.

As discussed in Section 6.0 ("Effects of the Action"), collection and nursery activities directed at *Acropora* spp. in the Florida and USVI will not result in the mortality of any wild elkhorn and staghorn coral colonies. The proposed action will potentially result in an increased number of elkhorn and staghorn coral colonies because of the expected increased survival of rescued fragments. Thus, the proposed action does not constitute a reduction in numbers of the species in the wild; rather, it will contribute to an increase of numbers. Similarly, because the proposed action will not measurably reduce sexual and asexual reproductive output of elkhorn or staghorn coral colonies, and the net effect of the action on coral reproduction is likely to be positive, the proposed action will not result in a reduction in elkhorn and staghorn coral reproduction. Furthermore, given that the action will not result in mortality or complete removal of wild elkhorn or staghorn coral colonies, and that both species are present throughout their ranges, the proposed action will not result in a reduction in the distribution of elkhorn and staghorn corals.

Based on the above analysis, we have determined that the proposed action is not reasonably expected to cause an appreciable reduction in the likelihood of survival of these coral species in the wild.

The following analysis considers the effects of the this proposed action on the likelihood of recovery in the wild. Although a recovery plan has not been drafted at this time, we consider the recovery vision statement from the *Acropora* Recovery Outline (available at http://sero.nmfs.noaa.gov/pr/protres.htm) relevant to analyze the effects on recovery:

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

The above analysis on the effects of the action on the likelihood of the species' survival in the wild considered the current status of the species and effects of the amount of take anticipated for the species. We determined that no reduction in numbers, reproductive potential, or distribution will result from the proposed action. Further, the proposed action directly addresses and attempts to fulfill the first part of the recovery vision statement. Collection and nursery activities directed at *Acropora* spp. in the Florida and USVI will contribute to the identified recovery vision statement of increasing the number of individuals within the population by reducing mortality due to abrasion and breakage, through the transplantation and reattachment of fragments and coral colonies into the nursery, and by propagating the species. Therefore, we have determined that the proposed action is not expected to reduce appreciably the likelihood of recovery of these coral species in the wild; it will likely increase the likelihood of recovery.

9.0 Conclusion

The proposed action consists of a program to continue and establish elkhorn and staghorn coral nurseries in Florida and USVI. After reviewing the current statuses of elkhorn and staghorn corals, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of elkhorn or staghorn corals. Because the proposed action does not include any prohibited incidental take, no incidental take statement is provided; moreover, no reductions in numbers, reproduction, or distribution of either threatened coral species is expected to result from the action.

10.0 Reinitiation of Consultation

As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered, (2) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion, or (3) a new species is listed or critical habitat designated that may be affected by the identified action.

11.0 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 elkhorn and staghorn corals. NMFS strongly recommends that these measures be considered and implemented, and requests to be notified of their implementation.

NMFS recommends that the RC and NPS provide NMFS' Southeast Region PRD with the data collected and any resulting publications from all activities concerning elkhorn and staghorn corals.

12.0 Literature Cited

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