12/06/01

Vicente Quevedo
Natural Heritage Division
DNER
P.O. Box 9066600
Pta. De Tierra Station
San Juan, P.R. 00906-6600

Dear Mr. Quevedo,

I was recently informed that Puerto Rico's Department of Natural and Environmental Resources (DNER) is considering the establishment of a marine natural reserve for Steps Beach and surrounding reefs off the west coast to offer protection for the benefit of the elkhorn reef system in Rincon. I would recommend implementing additional conservation measures for the coastal habitats near Steps and Tres Palmas, particularly because these areas support endangered and threatened wildlife, and also contains one of the few remaining healthy stands of elkhorn coral (*Acropora palmata*) left in the Caribbean. A large-scale development project in the cattle field immediately fronting Steps Reef is likely to cause substantial run-off during construction, and elevated nutrients and pollutants once the establishment is operational (as a result of increased sewage production and pesticides and fertilizers used on the surrounding grounds). Coral reefs are negatively affected by sediments, excessive nutrients and pollutants, and elkhorn corals are particularly sensitive to these types of stressors. A development project in this area may accelerate the decline in the health and productivity of the nearshore reefs, and possibly threaten the survival of elkhorn coral populations due to their limited tolerance to sedimentation and nutrient loading.

In support of further protection for Steps and Tres Palmas as a marine natural reserve, I am providing this information on the diversity, health and importance of two coral reefs located off the west coast of Puerto Rico near Rincon, Steps Reef and Tres Palmas. I conducted monthly surveys on Steps and Tres Palmas between 1994-1997, and annual surveys in 1998-2000. I am coral reef ecologist with the National Marine Fisheries Service. I received my Ph.D. from the University of Puerto Rico, Department of Marine Sciences in La Parguera, where I lived from 1994-1998. During the five years I lived in Puerto Rico, I spent 4-5 days per week diving on reefs off the northwest, west and south coast of Puerto Rico, and have continued to revisit these sites two times each year. For my research and dissertation I examined the effect of coral diseases and predators on important reef building corals. I collected information on different measures of coral reef health from the west and south coast near Aguadilla, Rincon, Desecheo, Mayaguez, Boqueron, La Parguera, Guayanilla, Guanica, and Ponce. I also established permanent study sites on the northwest coast (Aguadilla), southwest coast (off Parguera), the west coast at Steps and Tres Palmas (Rincon), and Mona Island, to conduct a detailed study of coral disease processes, long-term impacts, and synergistic effects of human activities. I have continued my research in Puerto Rico over the last three years under a study sponsored by Earthwatch ASaving Puerto Rico's Reefs@. My studies focus on the effects of disease, predation and storm damage

on the dominant and most important corals, including elkhorn coral, star coral and brain coral. I take a holistic approach to my research to obtain a snapshot of the health of the reef ecosystem using a modification of the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol (I examine corals as well as other indicators of reef health like fish abundance and size, type and biomass of algae, and present of key indicator organisms including commercially important species and keystone species). I also examine the long-term effect of these processes on coral survival, growth and new recruitment.

In the following document, I have provided a summary of the importance and role of elkhorn corals, their status throughout the region including Puerto Rico, threats that are impacting elkhorn coral populations, and measures that are needed to protect these corals. I am providing specific information on the elkhorn coral reef at Steps and Tres Palmas, based on my study between 1994-2000. I was unable to reexamine these sites in 2001 due to weather. It is important that these sites continue to be monitored to detect change in reef health. A detailed synoptic examination of the site in 2002 is recommended to quantify the extent, abundance and condition of the elkhorn population. I would be interested in conducting these studies but would need minimal support to conduct the work. If you have any questions about the following document, please contact me at andy.bruckner@noaa.gov.

Best of luck in obtaining protection for the marine environment off Steps and associated reefs.

Sincerely,

Andrew Bruckner, Ph.D.
15212 Aylesbury St.
Silver Spring, MD 20905

cc: Craig Lileystrom
Michael Nemith
Leslie Cruz
Ken Lindeman

Attachments:
1. Information on *A. palmata* and Steps Reef compiled by A. Bruckner
2. Five figures illustrating elkhorn coral. Sexual reproduction, fragmentation, healthy population and single colony, white-band disease, patchy necrosis, snail predation, damselfish algal lawns.
3. Paper in press in the Proceedings of the 9th International Coral reef Symposium on the potential benefits of an ESA Listing for elkhorn coral and staghorn coral
4. Information on *Acropora palmata* and the candidate species listing for the ESA from NOAA/National Marine Fisheries Service Office of Protected Resources web page

Rincon's unusual elkhorn coral *Acropora palmata* thickets:

Steps and Tres Palmas reefs are some of the best developed fringing coral reefs found off the west coast of Puerto Rico. The coastline at Rincon is fringed by a narrow sandy beach, with beach rock at the waters edge. Tres Palmas and Steps Reefs are two hardground areas, separated by a channel 50-150 m wide. The reefs start immediately seaward of the beach rock and slope from 0.5m to 8-10 m depth. The reef extends out for less than 200 m before terminating in a shallow sand flat (8-10 m depth). In shallow water (0.5-3 m depth) the reef is dominated by *Acropora palmata* with isolated brain, star and mustard hill corals. Elkhorn colonies form a dense stand that begins about 5 m offshore and extends seaward 20-30 m. The densest areas of elkhorn growth are near Steps and Tres Palmas, and colonies also occur at a lower density from just north of the marina to the dome. The deeper portion of the reefs (from 2-8 m) is dominated by *Diploria strigosa*, but many other massive and branching corals, sea fans, soft corals and other invertebrates also occur here.[1]

A second reef begins from 250-400 m offshore. This reef is completely submerged, and slopes gradually seaward to about 70 feet. It is shallowest at the landward edge (0.5-2m) where the reef is colonized by isolated *A. palmata* colonies, and massive and plating corals dispersed over the remainder of the hardground areas. There is relatively high cover (25-40%) in moderate depths (15-20 m) and several large massive boulder corals and plating corals.

Background information on *Acropora palmata*

Life history: *Acropora palmata* is a fast-growing (5-10 cm/year linear branch extension) branching coral that forms dense thickets (stands) from 0.5-6 m depth in exposed fore reef environments. Colonies are also found in exposed back reef and deeper fore reef zones (to 18 m depth) at a lower abundance**,** provided that there is good circulation, high light, and low levels of sedimentation. Colonies are large and tree-like with exceptionally thick and sturdy branches up to 3 m in diameter. Elkhorn coral is an annual broadcast spawner (individual colonies release eggs and sperm bundles in August/September) that produces millions of gametes, but this species exhibits very low rates of sexual recruitment. The main mode reproduction is believed to be asexual - colonies produce long branches that become very fragile and are easily dislodged during storms. These detached branches reattach to substrate and continue to grow, and damaged adult colonies regenerate injuries.

[1]Stony corals recorded in study area at Steps and Tres Palmas reefs: *Acropora cervicornis, A. palmata, Montastraea faveolata, M. cavernosa, Porites astreoides, P. porites, Favia fragum, Agaricia agaricites, Diploria strigosa, D. clivosa, D. labyrinthiformis, Siderastrea siderea, Dendrogyra cylindricus, Colpophyllia natans, Dichocoenia stokesi, Meandrina meandrites*

At Steps, Tres Palmas and other surrounding fringing reefs, sea conditions are generally calm from April through September, with periods of high wave action in winter. Colonies are often fragmented, and the reef substrate may be littered with branches, but these rapidly fuse to the substrate and begin sending up new branches (protobranches). This has allowed elkhorn populations to rapidly recover from storms; elkhorn coral populations have remained very dense, with colonies slowly expanding into deeper water and to neighboring areas.

Distribution and abundance: This species was formerly the dominant species on the shallow fore reef in the Florida Reef Tract, the Bahamas and throughout the Caribbean[2], forming extensive, densely aggregated, monospecific thickets between low water level and 5-6 m depth, in wave-exposed and high surge reef zones.

Colonies of *A. palmata* occur throughout shallow nearshore reef environments of Puerto Rico, except for 1) locations on much of the north coast; 2) reef environments adjacent to major cities; and 3) reefs affected by discharge from large rivers. Elkhorn populations were formerly most abundant on the northwest coast near Jobos and Isabela; on the west coast near Rincon; south of Mayaguez to Boqueron; on reefs near La Parguera; fringing reefs near Guayanilla, Guanica, Ponce; isolated reefs near Punta Tuna; Fajardo and offshore emergent reefs, and the islands of Mona, Culebra and Vieques. Possibly the largest remaining stand of elkhorn coral in Puerto Rico is located at depths of 3-5 m on a submerged reef 15-20 km off Boqueron (Bajo Gullardo). During the 1970s and 1980s Goenaga conducted island-wide surveys of reefs; and his reports provide extensive information on known locations of *A. palmata* throughout Puerto Rico.

Success and limitations of life history and population recovery: The success this species has achieved is a result of its fast rate of growth, persistence of injured adults by rapid wound healing, and high rate of asexual recruitment of fragments (Gladfelter et al., 1978; Bak and Criens, 1981, Highsmith, 1982). *A. palmata* has adaptations for survival in shallow, high energy reef environments occupied by few other stony corals, but colonies are susceptible to breakage from physical forces associated with storms and high wave action. Branches that break off standing colonies fuse to the substrate and continue growing. This has allowed *A. palmata* to rapidly recolonize an area after a major disturbance and spread into new areas, especially habitats not suitable for settlement by sexually-produced larvae (Fong and Lirman, 1997). However, this mode of reproduction also limits the extent of spread of populations. Unlike A. palamata, colonies that reproduce sexually and have a high success of settlement and recruitment of planula larvae benefit from the ability to disperse to surrounding and distant reefs, as the larvae are

[2]Florida and throughout the Caribbean including the Antilles, the West Indies, Central and South America, including Mexico, Belize, Honduras, Nicaragua, Costa Rica, Panama and Columbia. Isolated populations occur in the southern portion of the Gulf of Mexico, near Veracruz, Mexico; The northern limit in 1992 was the Tuxpan Reef System, approx 29EN latitude; northern limit off the east coast of Florida is Biscayne National Park; The species is absent from Bermuda, the east coast of Florida, Florida Middle Grounds and Flower Garden Banks; The southern limit is Venezuela, in areas without freshwater runoff.

carried by water currents. Because *A. palmata* exhibits limited ability to recruit sexually, damaged populations are unlikely to recover unless a local source of branches remains following the disturbance.

While storms may enhance the spread of *A. palmata* populations, recent observations indicate that initial mortality to colonies and fragments may be quite high, injured colonies and fragments exhibit reduced growth rates and declines in reproductive output, and damaged populations are susceptible to subsequent disturbances (Bruckner, unpubl. Data; Lirman, 1998). If populations of *A. palmata* were seriously damaged near Rincon, there is no other site within close proximity that could serve as a site for new recruits. Populations of elkhorn coral formerly existed on reefs surrounding the Mayaguez Bay, but these have largely disappeared as a result of poor water quality.

Importance of *Acropora palmata*

A. Storm damage: Elkhorn coral thickets reduce incoming wave energy, offering critical protection to coastlines. Loss of this species may negatively affect shorelines with mangrove and grass bed habitats which rely on calm water provided by these effective reef barriers. Fringing reefs with elkhorn thickets, like those found in Rincon, are also particularly important to coastal communities and the beach as they form a buffer that protects shorelines from erosion during storms. The loss of elkhorn thickets results in higher wave action reaching coastal environments, and this can lead to erosion and loss of nearshore grassbeds and mangroves. In Rincon, the elkhorn thickets front a narrow sandy beach. There is high wave action during winter. This is associated with offshore transport of sand, which accumulates among the corals on fringing reefs and in the surrounding area. Without the presence of a large stand of elkhorn coral, it is likely that much more sand will be carried offshore during periods of high wave action, and the beaches may eventually disappear.

B. Fisheries habitat: The high structural complexity produced by the interdigitated branches of *A. palmata* colonies provide essential fish habitat. Studies from Florida and the Virgin islands have shown that a higher number of lobsters, snappers, grunts, parrotfish and other large reef fish occur in areas with live stands of elkhorn coral. In many locations elkhorn populations have died, but erect skeletons (standing in place) may remain for 10-20 years. Dead colonies continue to provide high relief habitat utilized by a number of organisms. The skeletons are rapidly overgrown with algae and benthic invertebrates, and fish communities become dominated by schools of herbivorous fish like surgeonfish due to increased biomass of algae. Over time, however, the skeletons eventually collapse, eliminating high-relief topography and habitat for predatory fish and motile invertebrates.

C. Reef growth: Coral reefs were formerly dominated (prior to 1980s) by three species of coral - elkhorn coral, staghorn coral (*Acropora cervicornis*) and star coral (*Montastrea annularis* complex). *A. palmata* formed characteristic thickets in the shallowest, exposed areas, on fringing reefs and the outer portions of offshore reefs. These often extended along the coastline or the

crest of the reef for several kilometers. *A. cervicornis* also forms thickets, but it occurs in intermediate depths (5-25 m) on the fore reef in areas with moderate to low amounts of wave action, and shallow calm back reef environments. *M. annularis* is a complex of three species of massive corals that occurs throughout most reef environments (it is uncommon in areas dominated by elkhorn coral). *M. annularis* grows very slowly, and colonies may live for hundreds of years forming immense structures several meters tall.

The genus *Acropora* include the fastest growing scleractinian corals in the Indo-Pacific and Caribbean. Branch extension rates of 10-12 cm per year are common for the Caribbean species, which is approximately 10 times greater than massive reef-building corals. Gladfelter (1982) estimated a rate of reef accretion by elkhorn coral of 10.3 kg $CaCO_3/m^2/yr$; over 1000 years, shallow windward *A. palmata* reefs have grown upward close to 15 meters, keeping pace with rising sea level (Adey, 1975).

This growth results in a large accumulation of branches and rubble as a result of wave action that periodically prunes colonies. Some of these branches are carried to deep reef or soft bottom communities, where they accumulate and are cemented together. This creates additional habitat for fish, hard substrate for colonization by other corals, and also contributes to reef growth. In offshore populations of elkhorn coral, hurricanes will also break branches and carry these from the front of the reef to the back side, depositing them in a lower energy environment. These accumulate, and slowly build new islands. Recently Dr. Ernest Williams and colleagues excavated several of the outer islands off La Parguera (Turrumote; Media Luna) and found that the entire island consists of elkhorn coral.

Threats: *A. palmata* once was the dominant scleractinian coral on high-energy, windward reefs of the tropical western Atlantic (Goreau, 1959; Almy and Carrion-Torres, 1963). Over the past two decades the density of this species has been greatly reduced throughout its range as a result of various anthropogenic and natural disturbances[3], especially white-band disease (WBD) epizootics and storm damage (Gladfelter, 1982; Peters, *et al*.,1983; Rogers, *et al*., 1982; Peters, 1993). A number of studies have shown that elkhorn reefs rapidly recovered from periodic storms and other short-term disturbances through regrowth of colony stumps and branch fragments. However, in many cases elkhorn populations are being impacted by a number of different stresses at the same time which have may a synergistic effect, compounding losses or preventing recovery.

[3]White-band disease is the most significant source of mortality to *Acropora palmata* populations throughout the range over which this coral occurs, and populations have declined by as much as 90-95% as a result of disease. However, localized losses of *A. palmata* populations have also been associated with storm damage, ship groundings, predation, cold water events, flooding, bleaching, siltation, algal and invertebrate overgrowth.

Acropora palmata populations on the southwest coast of Puerto Rico have suffered similar losses to that reported from other parts of the Caribbean. These reefs have been impacted by relatively few hurricanes since the 1960's, the most severe of which were Hurricanes Edith (1963), David and Frederick (1979), Hortense (1996) and Georges (1998). While Hurricane Edith caused extensive destruction to *A. palmata* thickets, Glynn et al. (1964) observed high survivorship and continued growth among damaged colonies and fragments. Hurricanes David and Frederick also damaged *A. palmata* populations (Armstrong, 1983), however information on patterns of recovery is unavailable. I followed the fates of hurricane generated fragments on reefs near La Parguera after Tropical Storm Debbie (1994), Hurricane Hortense and Hurricane Georges (Bruckner, unpubl. Data). In my study area a high incidence of disease affected fragments after Debbie with mortality that exceeded 50% of the branches, and Hortense dislodged and overturned many of the remaining fragments. However, new fragments produced during Hortense exhibited fairly good survival until Hurricane Georges, which removed most remaining standing colonies and fragments generated by Hortense. Some sites in La Parguera have shown little recovery after 3 years. Although La Parguera has some of the best deep reef environments (e.g., shelf edge reefs) found in Puerto Rico (and these rival reefs found throughout the Caribbean), there is only one reef in the entire Parguera reef system that still has an extensive thicket of *A. palmata* (Morelock, pers. Comm.Bruckner, unpubl. data). in areas off La Parguera where this species once formed large thickets (shallow reef crest/ fore reef), only isolated colonies or small groups of colonies remain and many of these are affected by disease, Cliona overgrowth and snail predation.

In Rincon, a number of broken colonies were observed after Hurricane Georges. Unlike La Parguera, most fragments remained near mother colonies and these did not die. One year later the fragments were firmly attached to the reef and had produced numerous small protobranches.

Like other Caribbean locations, observations from Puerto Rico suggest that coral disease has impacted this species in the past. On one reef near La Parguera, C. Goenaga observed an incidence of WBD which affected 20-33% of the *A. palmata* colonies in 1984 (Davis, *et al*.,1986). During the 1990's I have documented a slow, steady decline of remaining *A. palmata* thickets in La Parguera due to a combination of factors including disease and predation (Bruckner *et al*., 1997, unpubl. data). On the east coast of Puerto Rico, vast stretches of living *A. palmata* colonies were observed in 1979 in Fajardo, Culebra and Vieques. Populations near Fajardo were decimated by WBD in the 1980s, and Hurricane Hugo in 1989 caused almost total destruction to *A. palmata* thickets in eastern Culebro (Goenaga and Boulon, 1992). On 85 reefs off the east coast and associated islands, populations of elkhorn coral have continued to decline from disease, sedimentation and algal overgrowth (Hernandez-Degado, pers. Comm).

Tolerance to terrestrial impacts: Elkhorn coral is an environmentally sensitive species that requires clear, high saline, well circulated water with moderate temperatures (25-29EC). *A. palmata* is intolerant of prolonged periods of high sedimentation; this species lacks a well developed ciliary mucus system found in sediment-tolerant species like *Porites astreoides* and *Montastraea cavernosa*. It can only tolerate short periods of increased water turbidity if the site

is exposed regularly to moderate to high levels of wave action. Rogers (1983) found that even low doses of sediment accumulate on the flattened branch surfaces, resulting in rapid tissue necrosis; in addition, injuries regenerate more slowly at elevated sedimentation levels (Meesters and Bak, 1995). Rincon's reefs are affected by poor water quality conditions during the rainy season in summer due to run-off, but murky conditions generally persist for short periods and water clarity improving after a few days. In winter high wave action prevents accumulation of sediment on branches. Clearing of the land adjacent to Steps reef would cause a significant increase in run-off, which is likely to have a significant impact on nearshore elkhorn coral populations.

Natural disturbances: Coral disease is a major factor that has impacted this species since the 1970s (first reported in 1977 from St. Croix, USVI). White-band disease (WBD) spread throughout the Caribbean, with concurrent losses of 90-95% reported during the 1980s and early 1990s. White-band disease still affects *A. palmata* throughout its range, and other new, white-type diseases (white pox; patchy necrosis) have been reported on this species in the 1990s. Elkhorn coral is one of only two coral species (other species is *A. cervicornis*) known to have experienced mass mortalities from disease.

Throughout its range, Caribbean-wide losses of *A. palmata* have been attributed primarily to WBD, with compounding (localized) effects from hurricanes, increased predation pressure, hypothermic stress, bleaching events, physical damage from ship groundings, and problems associated with increased nutrient and sediment loading**.** Two predators in particular, include the fireworm, *Hermodice carunculata* and the corallivorous gastropod, *Coralliophila abbreviata* are a significant threat to elkhorn populations. While worms generally consume parts of individual branches, the gastropods are capable of denuding entire colonies of *A. palmata*. The pressure on remaining populations from coral predators may be increasing in many locations, because, even if snail and fireworm densities have not increased, they may occur at higher densities on individual corals because there are fewer corals remaining. However, recent work suggests that coral eating gastropods have become more prevalent and more voracious on reefs in Puerto Rico and the Florida Keys possibly as a result of overfishing of their predators, the octopus and spiny lobster (Bruckner et al., 1996; Szmant, pers. comm). Work by Bruckner et al., (1997) examined the population dynamics of snails on reefs in La Parguera, and the relative affect of snails on remaining populations. This study showed that individual snails will consume 5-25 square centimeters of tissue in one day and aggregates of snails eat entire colonies in as little as one month. It is interesting to note that the snails were much larger (30-50 mm) than those found on massive corals, and these were predominantly female (the snails change sex from male to female once they reach a certain size) suggesting that populations may continue to increase in abundance (larger females producea higher number of offspring) and contribute to the loss of remaining coral thickets near la Parguera.

Fortunately, Rincon populations of elkhorn coral currently do not face a substantial threat from coral diseases or predators at this time. Snails have been observed at high densities (2-25 snails per coral) on massive brain and star corals on these reefs, but the snails are very small (less than

1 cm). Over the duration of the study (1994-1997), only six standing elkhorn colonies have been affected by groups of snails, and associated predation was minimal.

A low incidence of disease has been observed at Steps and Tres Palmas. Isolated colonies are periodically observed with white band, and patchy necrosis may be relatively common after extended periods of terrestrial runoff (May-July, during the rainy season water visibility may drop below 1 m and remain this way for several days). However, patchy necrosis most frequently affects fragments, colonies are not entirely killed, and branches begin to regenerate tissue off areas that were formerly affected by disease.

An outbreak of disease (patchy necrosis) was recorded on *Acropora palmata* at **Steps Reef** during 1996. The occurrence of the disease may be associated with high sediment loads that affected corals at the time of construction of a residential structure across the street from Steps. The construction project involved removal of all trees, and the land was bulldozed, exposing the underlying sediment. Unfortunately, this occurred during the rainy period in summer, and run-off was exacerbated. Fortunately, the amount of sediment run-off declined within a few weeks, and the disease outbreak subsided. However, this indicates that coral populations are very vulnerable in this location, and development of the land immediately in front of Steps may seriously compromise elkhorn coral populations, especially if construction coincides with the rainy season.

Conservation Measures: *A. palmata* is offered limited **protection by existing legislation** in U.S. waters: The Fishery Management Plan for Coral and Coral Reefs, developed in 1982 by the Gulf of Mexico and the South Atlantic Fisheries Management Councils, provides direct protection in federal waters for acroporid corals (and other species). The FMP 1) prohibits the taking of stony coral or destruction of coral; 2) establishes a permit system for taking corals for scientific or educational purposes; 3) requires the return of stony corals taken incidently in other fisheries; and 4) prohibits the use of toxic chemicals in taking fish or other marine organisms. Other protected areas include National Parks (Florida: Dry Tortugas; Biscayne National Park and the U.S. Virgin Islands: Buck Island; St. John) and in the Florida Keys National Marine Sanctuary. It is illegal to damage, remove, collect, or sell *Acropora palmata* and other stony corals In State waters of Florida (State statute, in effect since the mid 1970s).

The Fishery Management Plan for Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the USVI, July 1994, Caribbean Fishery Management Council regulates take of stony corals in federal waters around Puerto Rico: Harvest and possession of stony corals, octocorals, and live rock, whether dead or alive, are prohibited, except for the purpose of scientific research, education and restoration. In territorial waters of Puerto Rico, DNER prohibits the harvest or take of corals (Law No. 83) for commercial purposes, except under permit.

The U.S. Endangered Species Act: In the U.S. Federal Register Notice (FR Doc. 99-1011, 1/15/99; Vol. 64, no. 10) the National Marine Fishery Service (NMFS) has proposed to add two coral species, elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*) as candidates for possible addition to the List of Endangered and Threatened species under the

Endangered Species Act. These species are fast-growing, branching corals that form dense, high profile, monospecific stands at shallow and intermediate depths. Formerly, these were two of the three most important corals in the tropical western Atlantic, contributing significantly to reef growth and providing essential fishery habitat. During the last two decades, disease outbreaks and compounding (localized) factors such as hurricane damage, increased predation, hypothermia, boat groundings, sedimentation, and bleaching have resulted in widespread mortalities. Losses are well documented at several sites in the U.S. and throughout the Caribbean, where populations declined during the 1980s by up to 96%. To date, acroporid corals have not recovered to their former abundance. Low remaining population densities, a strong dependence on asexual recruitment by coral fragments, and limited potential for larval recruitment may hinder recovery of these species, given continuing losses from coral diseases, storms, and human impacts.

In this notice, NMFS is not proposing to list these corals as Threatened or Endangered species under the U.S. Endangered Species Act. The goals of the candidate species program are 1) to identify species that may qualify as candidates for possible addition to the List of Endangered and Threatened Species, 2) to assist in acquiring information needed to determine the status and trends of a species, and 3) to encourage voluntary efforts to help prevent listings. NMFS is seeking additional information on these species that would support or argue against inclusion on the candidate species list. This includes historic and current population abundances and distribution, assessments of threats, and existing and future protective measures that may assist in recovering these species.

Using information collected from an initial analysis of published information indicating that populations of *A. palmata* were in serious decline, and public comments generated from the Federal Register Notice proposing the candidate listing, NMFS added two coral species, elkhorn coral (*Acropora palmata*) and staghorn coral *(Acropora cervicornis*) to the candidate species list of the Endangered Species Act (Federal Register Vol. 64, No. 120, June 23, 1999 pp. 33466-33467).

Potential impacts associated with a loss of elkhorn coral populations in Rincon: The disappearance of these coral thickets may ultimately affect the diversity and abundance of reef organisms, the rate of carbonate deposition and reef growth, and the skeletal contribution to coral cayes and boulder ramparts (Hernandez-Avila *et al*., 1977; Gladfelter *et al*., 1978; Williams, pers. comm.).

Reduced Diversity. In addition to the loss of one of the most important reef builders in the Caribbean, many organisms that rely on A. palmata for habitat, feeding areas, and refuge will disappear.

Tourism. Steps reef is a very popular site for snorkeling, due to the shallow water and close proximity to land. Steps is one of the few reefs in Puerto Rico accessible immediately off the shore.

Beach erosion. Loss of elkhorn coral would result in stronger waves reaching the shoreline, which will subsequently cause substantial increase in erosion of sand. Increased erosion of

sediments will ultimately affect other benthic reefs invertebrates found slightly deeper than elkhorn coral and also those found on the outer reefs. In addition, increased erosion is likely to result in decreased water clarity which will affect the amount of light reaching photosynthetic reef organisms.

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