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**ABSTRACT**

There has been a marked increase in government funding for the U.S. Caribbean over the last 2 years. This has resulted in vastly improved regional mapping, monitoring, and management of coral reef ecosystems of Florida, Texas, Puerto Rico, U.S. Virgin Islands and Navassa. These improvements have resulted in significant advances in our understanding of the condition and functioning of these coral reefs. Digital maps of the U.S. Caribbean, including photo-mosaics, individual aerial photographs, classified habitat maps, a mapping ArcView extension classification scheme, and methods manual, were completed and are available on CD-ROM and the web (www.biogeo.nos.noaa.gov). Maps of benthic habitats of the Florida Keys National Marine Sanctuary (FKNMS) were completed in 1998 and are also available. The NOAA (National Oceanic and Atmospheric Administration) National Coral Reef Monitoring Program has been expanded from US$0.6 to 0.9 million and now supports monitoring of water quality, reef fish populations, and the habitat in Florida as well as in Puerto Rico and the U.S. Virgin Islands. A comprehensive monitoring program in the FKNMS was expanded, and shows that fishes in no-take reserves are larger and more abundant than in fished reference areas. Databases have been improved to allow easier data entry from the field and many are now available on-line. Monitoring data are published in peer-reviewed literature and in the first National Report on the Status and Health of U.S. Coral Reef Ecosystems.

A major 5-year research program started in 2002 to examine the links between natural and human stresses, reef processes, socio-economic factors, and the use of MPAs as a management tool. Biological and physical data are being integrated into GIS programs to allow managers to visualise and predict the impacts of their decisions. The National Coral Reef Initiative (NCRI) received US$1M in 2001 and 2002 to support cooperative grants for coral reef research and monitoring. The research projects and collaborations include: innovative methods and programs to assess, monitor, and restore reefs; investigations of ecological, environmental, and genetic responses to coral reef restoration; mapping and biological inventories; and risk assessment and categorisation. A new Coral Reef Institute was established in Puerto Rico to strengthen monitoring and develop improved monitoring technologies. In response to increasing coral diseases in the Caribbean, the Coral Disease and Health Consortium has brought together many experts who have: identified information needs; prioritised strategic research; identified technology...
requirements and risk management options; and determined prevention, mitigation or remediation strategies. Major needs identified are to: standardise the terms, procedures and protocols; clarify the basic research and technology developments; and improve the mechanisms for technology transfer, scientific training, and public education. The Coral Disease and Health: A National Research Plan is scheduled for release in late 2002.

Hopefully this improved attention to coral reef issues in this region will continue, and improve our understanding of how these ecosystems respond to anthropogenic stresses and how to develop management plans that protect the resources by minimising the stresses. It is recognised that a multi-disciplinary and cooperative approach is needed for better management of coral reef areas.

INTRODUCTION AND GEOGRAPHIC CONTEXT

This report on the status of U.S. Caribbean coral reef ecosystems has been summarised from more detailed reports in ‘The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002.’ That report was authored by 38 recognised technical experts and supported by 79 contributors from government agencies and NGOs. The report is available at www.nccos.nos.noaa.gov.

Florida East Coast

The reefs in northern Monroe County to Vero Beach are a series of 3 discontinuous reef rows parallel to the shore: First Reef rises to 3–5m of the surface with very low profile cover of algae and small octocorals; Second Reef at 6–8m depth has more complex relief that includes dissecting channels and conspicuous octocorals often in high density; and Third Reef is at 15-22m with the most diversity and abundant hard corals, that include Diploria clivosa, Dichocoenia stokesii, Montastraea cavernosa, and Solenastrea bournoni. There has been strong recruitment of Acropora cervicornis in the past 3 years and clumps of staghorn coral are common, especially in Broward County, along with large barrel sponges (Xestospongia muta). The hard corals are larger on the Third than the Second Reef and moderate sized colonies of Montastraea annularis are common. However, there has been no growth of the elkhorn coral (Acropora palmata) for more than 5,000 years.

Most reefs have been mapped and coral cover estimated for the first two rows, but less for the deeper Third Reef. These reefs are protected from some impacts by Florida State statutes and regulations e.g. fishing regulations, dredging permits, prohibition against harvest, sale, or destruction of corals etc. In addition, mooring buoys have been established.

Florida Keys

The Florida Keys coral reefs extend from just south of Miami to the Dry Tortugas and include the only emergent reefs off the continental USA. The Florida Keys National Marine Sanctuary (FKNMS) was designated in 1990 to protect and conserve the nationally significant biological and cultural marine resources of the area, including critical coral reef habitats. The Sanctuary covers 9850 km² with 1400km² of coral reef and hard bottom habitat (42% in Florida State territorial waters; and 58% in Federal waters i.e. more than 3 nautical miles offshore). The reefs comprise a bank reef system of almost continuous reef communities in lines that run parallel to each another. There are several distinct habitats
including offshore patch reefs, seagrass beds, back reefs and reef flats, bank or transitional reefs, intermediate reefs, deep reefs, outlier reefs, and sand and soft bottom areas.

**Texas Flower Garden Banks**

These are two prominent geological features on the edge of the continental shelf in the northwest Gulf of Mexico, approximately 190km southeast of Galveston, Texas. The Banks are uplifted Jurassic salt domes, rising from 100m depth to within 17m of the surface and have about 1.4km² of luxurious bank reefs on the shallowest portions of the East and West Flower Garden Banks. These are the most northerly coral reefs on the continental shelf of North America (27°52’ to 27°56’ North) and also some of the most isolated reefs of the Caribbean, being over 690km from the nearest reefs of Campeche Bank off Yucatan, Mexico.

The East Flower Garden Bank (27°54’N; 93°36’W) contains about 70% of the coral area, with the rest on West Flower Garden Bank (27°52’N; 93°49’W) about 22km away. These reefs have only 21 coral species probably because they are so isolated, but coral cover is high (~50%) with crustose, coralline and calcareous green algae also common. The Flower Garden Banks are composed of large, closely spaced coral heads up to 3m in diameter and height, which are hollow in places due to bioerosion and separated by sand patches and channels. These corals grow from the top near 17m down to about 50m.

The reefs were designated as the Flower Garden Banks National Marine Sanctuary (FGBNMS) in 1992, and Stetson Bank was added in 1996. The Sanctuary covers 143km² and includes all the coral reef areas. Regulations protect the corals with prohibitions on: oil and gas exploration; anchoring or mooring of vessels over 30m; anchoring of smaller vessels near mooring buoys; injuring or taking coral and other marine organisms; use of fishing gear other than hook and line; discharging or depositing any substances or materials; altering the seabed; building or abandoning any structures; and using explosives or electrical charges.
Puerto Rico
Along with the main island, there are 2 inhabited small islands off the east coast (Culebra and Vieques), and 3 uninhabited islands (Mona, Monito, Desecheo) off the west coast. Most coral reefs occur on the east, south and west coasts, with fringing reefs being the most common type. The western two-thirds of the north coast consists of mainly hard ground and reef rock with low to very low coral cover and some small, sparse, low coral colonies. Coral reefs cover approximately 3,370km² within 3 nautical miles of the coasts, which are about 3% of the total coral reef area under U.S. jurisdiction (Hawaiian Islands are first with 85%). The main islands of Puerto Rico, including Culebra and Vieques, are almost completely encircled by reefs, although coral reef abundance is highly variable, depending on the local conditions.

U.S. Virgin Islands (USVI)
Coral reefs occur around all the major islands of St. Croix, St. John, and St. Thomas, as well as the offshore cays. Fringing reefs, deep reefs (wall and shelf-edge), patch reefs, and spur and groove formations are present, although only St. Croix has barrier reefs. Bank reefs and scattered patch reefs with high coral diversity occur deeper offshore. The U.S. Departments of Interior, and Commerce, and the Virgin Islands Government have jurisdiction over submerged lands with coral reefs within the USVI. In 2001, NOAA completed maps of USVI coral reefs and associated ecosystems to a depth of 20m. Of the 485km², 61% consisted of coral reefs and hard-bottom habitats, 33% were seagrass beds; submerged and the rest was sand or rock.

Navassa
This tiny (5km²) uninhabited U.S. protectorate between Jamaica and Haiti, is under the jurisdiction of the U.S. Fish and Wildlife Service. Knowledge about the status of the reefs is extremely limited and based on several expeditions over the past 2 years sponsored by The Ocean Conservancy.

Status of the Coral Reefs
Florida
The level of research and monitoring in the Florida Keys increased markedly after the declaration of the FKNMS. Seven years of data on water quality, seagrasses, and coral reef and hard bottom communities provided Sanctuary managers with trend information on the health of the coral reef ecosystem. In addition, there are 5 years of data on ecological changes associated with the implementation of the first network of marine reserves in the U.S. Those on the southeast coast of Florida and the Middle Grounds are not as well studied, but are being mapped and given some monitoring. Most of the information on these areas, however, continues to be anecdotal with some reefs appearing healthy although there was some bleaching similar to levels seen in the Florida Keys during the massive 1997-1998 event. There is little information on the status of benthic communities at the Florida Middle Grounds.

There are 64 hard coral species, 2 fire corals, and 55 species of octocoral on the Florida Keys. Coral cover is highly variable depending on the habitat type and previous history, with patch reef habitats showing the fewest losses and highest average cover over time.
Hard coral cover in the FKNMS has decreased from an average of 10.3% in 1996 to 6.4% in 1999 at 160 stations, and species richness at first declined from 1996-1999, but rose slightly in 2000. The type, distribution, and frequency of coral diseases are increasing, and so far 3 pathogens have been identified. Coral bleaching also remains a problem, and has been responsible for some of the dramatic declines in coral cover in the Sanctuary since 1997, but fortunately there has been no repeat of that severity of bleaching.

Algae continue to dominate all sites, with average cover generally above 75% in the Keys and above 50% in the Dry Tortugas. Scientists have identified 90 species of marine macroalgae and 7 seagrasses, along with 3 species of mangroves in Florida. Seagrasses are present at over 80% of the FKNMS stations, and cover approximately 12,800km² in the 17,000km² study area. The algae and many invertebrates fluctuate widely between years e.g. algal cover increased between 1996 and 2000, while sponge and soft coral cover decreased. Similarly, algae dominate at deeper sites.

There is still considerable concern about water quality, with continued pollution by agricultural chemicals, sediments, and nutrients from agriculture and industry throughout Southeast Florida and the Keys. Total phosphorus concentrations are increasing as far as the Dry Tortugas, and the increases in nitrates appear to be mostly closer to shore on the shelf of the Lower and Upper Keys. By contrast, organic nitrogen is decreasing slightly at many sites around Florida. These trends may be driven by regional circulation of the Loop and Florida Currents.

Flower Garden Banks
These remain amongst the least disturbed coral reefs in the Caribbean and can be considered nearly pristine. The ocean water around the reefs is clear with visibility up to 30m, and no major variations in salinity and temperature. The coral communities have remained stable and healthy since they were first studied in the early 1970s. There has been some minor damage from anchors, illegal fishing gear, tow cables, and seismic arrays.
Coral cover has not significantly changed since 1972; it averaged 47% in 1995, and 52% in 1997. Coralline algae cover is 45.4%, algal cover is low at 2.7%, and there are some sponges (1.5%), and sand patches (<0.1%). The dominant coral species are *Montastrea annularis* and *Diploria strigosa*, but there are no branching *Acropora palmata* or *A. cervicornis*, and no sea whips or sea fans (gorgonians), which are common elsewhere in the Caribbean. Slight coral bleaching was observed when water temperatures exceeded 30°C, but there was no significant mortality. Coral disease is rare, with 23 only diseased colonies among 3700 observed. The most common algae were crustose coralline and calcareous greens among at least 44 species. Below 50m is the ‘algal-sponge zone’. Fleshy algae are rare with cover usually below 5%, but increased to over 13% after the sea urchin die-off in 1983. They dropped again when herbivore populations picked up. There was an increase in turf algae in 1999 to 27.6% on the East Bank and 20.7% on the West Bank (usually 3 to 5% cover) which may signal a change to the benign conditions for corals.

There are no immediate concerns about water quality, however there are some warning signals. Dirty water at the Flower Garden Banks in mid-2002 was possibly associated with Mississippi and Atchafalaya River flood waters, and oxygen-depleted water masses seen in the northern Gulf of Mexico may be moving across the Continental Shelf towards the Banks. The direct threats include atmospheric pollution and effluent discharges from nearby oil and gas development, and transportation.

**Puerto Rico**

There are more coral species around Puerto Rico than further north. There are many ‘coral’ species, that include 117 hard corals, 99 soft corals and gorgonians, 13 corallimorphs, 3 fire corals, and 5 hydrocorals making the Puerto Rico reefs the richest in the U.S. Caribbean. It is now clear that reefs surrounding the main island are degraded, because of nearby coastal developments, whereas the reefs near Descheo Island are probably the best-developed and healthiest in Puerto Rico, with about 70% coral cover and very clean water; however there are few long-term monitoring data available. The main branching elkhorn and staghorn corals (*Acropora palmata* and *A. cervicornis*) have declined in most places over the last 25 years due to hurricane damage, white-band disease, and coral-eating molluscs. Hurricane Georges heavily damaged *A. palmata* on the outer reefs in 1998 such that only one thicket remains between Margarita and San Cristobel. *A. cervicornis* has recovered considerably since Hurricane Georges and flourishes in shallow back-reef sites off San Cristobel, despite the presence of white-band disease. However, up to 10% of the *A. palmata* near La Parguera is affected by white-band disease and has not recovered, nor have the *A. cervicornis* around Mona Island recovered after Hurricane Georges.

Most of the common coral diseases have been observed in Puerto Rico (yellow-blotch, black-band, white plagues I & II, and aspergillosis) and caused considerable damage down to 30m depth. White plague II struck after Hurricane Hortense (1996), and spread to more than 50% of the brain corals near La Parguera. Yellow-blotch disease was found on a few colonies in 1996, but by 1999, up to 50% of the *Montastrea annularis* off Mona Island were infected, as well as corals at almost all other sites. There was also massive coral bleaching and mortality in the late 1980s, however major coral bleaching in 1998, resulted in very little mortality.
There are extensive seagrass beds in the shallow water around Puerto Rico and mangroves fringe the southern coast. Massive macroalgal cover on the nearshore reefs, first observed in the 1970s, continues to kill corals. Such major cover by macroalgae is indicative of eutrophication from sewage and urban outfalls and low populations of algal grazing fishes.

There has been definite degradation of water quality around all reefs off the southern coast of Puerto Rico due to high sediment inputs and increased turbidity. There has been clear-cutting of the hillsides leading to increased sediment runoff during rainy periods, and sewage is discharged into the sea. Mangrove channels and reefs may be affected by sewage discharge from upstream sources (e.g. off Guayanilla, Guancia, and Ponce). Three rivers pour excessive sediments, sewage, and nutrients from agriculture and tuna canneries onto the near-shore reefs in the west. The fore-reefs off the Jobos Bay National Estuarine Research Reserve have been severely damaged by sediments from coastal erosion and long-shore transport from the towns of Guayama and Salinas.

The Environmental Quality Board reported that 97.7% of 88 sites around Puerto Rico can support aquatic life (e.g. 10% or less of the shore area violates health standards) and only 1.8% are more than 25% in violation of the standards, which measure turbidity, ammonia, dissolved oxygen problems linked to industrial and municipal, sewage disposal, urban runoff, land disposal, and marinas. The U.S. EPA cited the Bacardi Corporation for Clean Water Act Violations when in 2001 they discharged rum processing wastes that are toxic to mangroves and coral reefs.
U.S. Virgin Islands
Some of the best long-term datasets on Caribbean coral reefs come from St. John and Buck Island, St. Croix in the USVI. Live hard coral cover varies from a low of 5.8% on Buck Island, St. Croix to a high of 45.3% (Tektite, St. John), however 76% of randomly selected transects showed declines in coral cover between 1988 and 1991. For example, cover of the elkhorn coral (*Acropora palmata*) at Buck Island National Monument fell from 85% in 1976 to 5% in 1988 due to storms and disease. *A. palmata* is recovering and recruitment is increasing, however, the white-band disease that killed the corals is still occasionally observed. A similar plague appeared around St. John in 1997 affecting 14 coral species, and it is the most destructive of problems facing the corals in the USVI. Monthly surveys on one St. John reef have documented a new incidence of disease every month from 1997 to present, making this the most disease prone area on St. John. Some small patch reefs of *Porites porites* died from an unknown disease and have not recovered in 12 years. The large, dense seagrass beds observed in 1962 and 1983 on St. John no longer exist. The losses are most noticeable in areas within popular anchorages. Analysis of photographs shows a decrease in total seagrass area by 68,000m² from 1971 to 1991 in Great Lameshur Bay, and losses of 22,000m² in Little Lameshur Bay. Similarly in all the bays visited, seagrass area has fluctuated, but usually declined with direct correlations with the numbers of boats anchoring above.

There is more sewage treatment in the USVI than most parts of the Caribbean e.g. 8 facilities on St. Thomas; a new secondary treatment plant on St. John; 1 primary treatment plant on St. Croix. However, the plants are not all maintained correctly and inshore pollution still occurs. Untreated rum-effluent from a St. Croix distillery results in a 8km benthic ‘dead zone’ caused by the high toxin levels, and raised temperatures, but the distillery is granted an exemption every year.

Accelerating development, 56km of unpaved roads, and poor land management on St. John result in increased sediment runoff onto the reefs. When the 1998 bleaching event struck, there were more bleached corals in sedimented areas (38% bleached in 14 mg/cm²/day) compared to cleaner zones (23% at 4-8 mg/cm²/day).

Navassa
There is no regular reef monitoring, nor research at Navassa, but the reefs were assessed in 2000. The island is uninhabited with no development nearby, therefore the water is clean and the reefs are not heavily exploited. Average live coral cover was 20 to 26% at 11-23m, with sponges (7-27%) and fleshy brown algae (10-23%). The reef areas with more reef structural complexity had more fish than the smoother areas. The elkhorn coral (*Acropora palmata*) appeared healthy with no white band disease or predation scars. The staghorn coral (*A. cervicornis*) was healthy but less abundant. The only disease seen was some white plague on 3 colonies of *Agaricia*, but many *Montastraea* colonies had suffered partial mortality in the past. There was no observed bleaching in 1998.
STATUS OF CORAL REEF FISHES AND INVERTEBRATES

Florida Keys
There have been 517 fish species identified on the Keys, including 389 reef fish, however, the highest abundance and biomass came from 10 species: bluehead wrasse (*Thalassoma bifasciatum*); bicolor damselfish (*Stegastes partitus*); tomtate (*Haemulon aurolineatum*); sergeant major (*Abudefduf saxatilis*); striped parrotfish (*Scarus croicensis*); yellowtail snapper (*Ocyurus chysurus*); bluestriped grunt (*Haemulon sciurus*); white grunt (*Haemulon plumieri*); masked goby (*Coryphopterus personatus*); and French grunt (*Haemulon flavolineatum*). The target reef fish are highly exploited e.g. 13 of 16 species of groupers, 7 of 13 snappers, 1 wrasse, and 2 of 5 grunts are over-fished in the Florida Keys. A good sign for reef managers is that average densities of the gray snapper (*Lutjanus griseus*), yellowtail snapper (*Ocyurus chrysurus*), and several grouper species are higher in the no-take zones than in fished reference sites.

The inventory of other animals includes: 117 sponge species; 89 polychaete worms; 1,400 mollusks; 371 crustaceans; and 82 echinoderms. Legal-sized spiny lobsters continue to be larger and more abundant in no-take zones than nearby fished areas, but Queen conch populations remain low, despite a ban on commercial and recreational fishing since the mid-1980s. Both are being monitored intensively, and attempts are now underway to improve reproductive output. The large long-spined sea urchin (*Diadema antillarum*) populations seen before the massive die-off in 1983 are only showing poor recovery.

Texas Flower Garden Banks
Fish diversity is lower (266 species) than on other Caribbean region reefs, with plankton and invertebrate feeders the most abundant groups. However, these reefs may be important spawning areas for grouper. Other commercial species, like grunts and snappers are much less common. There has been a significant increase in queen and stoplight parrotfish (*Scarus vetula* and *Sparisoma viride*), possibly due to a greater availability of algae after the loss of the long-spined sea urchins in 1983. The Banks are year-round habitats for manta rays, whale sharks, tropical spotted and bottlenose dolphins, and the Banks serve as a winter habitat for hammerhead and silky sharks, and spotted eagle rays. Fishing pressure in the Sanctuary is not intense, but there has been longline fishing near banks since the late 1800s, and it appears that grouper, snapper, jewfish, and other target fish populations have declined.

Juvenile loggerhead sea turtles that live on the East and West Flower Garden Banks have a range of approximately 130km², centered on the Banks. Hawksbill and leatherback turtles have also been reported. There are not as many other animals identified as in the Florida Keys e.g. 27 sponge species; 20 polychaete worm species; 667 mollusks; 62 crustaceans; and 36 echinoderms, but figures are likely to increase as more taxonomists visit the Banks.

Puerto Rico
There are 242 reef fish species, but none are endemic to Puerto Rico. The number of fish species is directly related to the amount of live coral cover on shallow reefs, but reef fisheries have plummeted during the last 20 years as a result of over-fishing and reef decline (landings dropped 69% between 1979 and 1990). Total catch and catch per unit
effort have declined, fish are now smaller, and there have been failures in recruitment. The loss of herbivores (i.e., parrotfishes) and large predatory fish has stimulated a proliferation of small fish like damselfish (*Stegastes planifrons*). This adds to the problems for the reefs, because these fish bite and kill coral polyps to promote algal growth for their young.

A NOAA fish monitoring program from 2000 has collected fish abundance, distribution, size-class structure, and micro-scale habitat data at more than 1000 sites throughout the US Caribbean (500 sites for St. Croix, 350 for PR, and 200 for St. John). Of particular concern is that among 50,000 fish counted and measured, only 0.6% of these were more than 30cm fork length. Even worse, of the 8,000 snappers, groupers, and grunts counted, less than 0.4% were larger than 30cm fork length. This means that most are below effective breeding size.

Spiny lobster populations are declining due to persistent and increasing fishing pressure, with an unwanted side effect. Coral-eating molluscs, which are a favourite food of the lobsters are increasing and causing more damage to the corals. Populations of the major grazing sea urchin (*Diadema antillarum*) remain at about 10% of their pre-1983 abundance.

**U.S. Virgin Islands**

There are no new fisheries data since the 2000 Status Report. Habitat losses on the coasts, clearing of mangroves, destruction of seagrass beds and losses of coral cover have all impacted on fish populations. However, the major problem continues to be over-fishing. Regulations exist to protect fish stocks, but these are not enforced and the populations of groupers and snappers continue to decline. Similar to elsewhere in the Caribbean, the excessive use of fish traps continues and many traps are lost and continue ‘fishing’. Queen conchs and lobsters were once abundant, but over-fishing and loss of seagrass beds are causing major population declines. This will continue until management reduces fishing effort and prevents losses of critical habitats.

The prominent sea urchins (*Diadema antillarum*) are recovering very slowly around the USVI, but remain at less than 10% of their original levels. Conch populations are decreasing and there is no difference in conch density inside MPAs compared to areas outside. There has also been an apparent decrease in the size and abundance of lobsters e.g. 19.4 per hectare at 89 sites around St. John in 1970, compared to 5 per ha for 4 sites in 1996.

**Navassa**

Surveys counted 36 to 41 fish species per site around Navassa, with 97-140 fishes per 60m². Density of snapper + grouper was 2.5 fish per 60 m², whereas surgeonfishes + parrotfishes was 15.9 fish/60m². The sign of a reasonably healthy fish population was that 92% of snapper and 23% of parrotfishes were longer than 40cm. These fish, however are attracting more artisinal trap and hook and line fishers from Haiti, which is adding new stresses to Navassa reefs.
ANTHROPOGENIC THREATS TO CORAL REEFS

Florida East Coast
There are varied and chronic stresses from this extremely urbanised coast. Dredging for beach renourishment, channel deepening and maintenance have significantly reduced water quality, smothered corals and other invertebrates and lowered productivity e.g. Boca Raton and Sunny Isles. Recreational usage can be extreme especially in warmer months, with clear evidence of fishing gear impact and anchor damage. Shipping from the large ports (Miami, Port Everglades, and Palm Beach) means that ships frequently run aground or anchor on reefs. Ocean outfalls pour large volumes of secondary treated sewage into the coastal waters.

Florida Keys
The major threats to the coral reefs stem from over 4 million annual visitors and 80,000 residents in the Florida Keys. Growth of the population in Monroe County is limited by a rate-of-growth ordinance, and was only 2% between the 1990 and 2000 censuses. Similarly, the number of registered private boats has increased 6 fold since 1965. Most visible damage in the last 20 years has been from direct human impacts such as grounding of boats in coral, seagrasses, or hard bottom areas, breaking and anchor damage, destructive fishing, and divers and snorkellers standing on corals. Boat propellers have permanently damaged over 12,000ha of seagrasses, and over 500 small boat groundings are reported annually in the Florida Keys National Marine Sanctuary. Large ships have been responsible for damaging or destroying over 10ha of coral reef habitat.

Indirect human impacts are significantly affecting the coral reefs with eutrophication in nearshore waters a major problem. Wastewater and stormwater treatment, and solid waste disposal facilities are inadequate in the Keys, but improvements are being made. In

IMO AND FLOWER GARDENS BANK
The International Maritime Organisation (IMO) took a historic step in 2000 by creating a new measure under international law for the establishment of ‘No Anchoring Areas’. This measure allows any country to request the IMO to designate a ‘no anchoring area’ where anchoring is hazardous to a ship or could result in unacceptable damage to the marine environment. At the same time, the IMO approved the adoption of 3 mandatory no anchoring areas to protect the fragile coral reefs of Flower Garden Banks National Marine Sanctuary (FGBNMS) and later in the Tortugas. Coral reef communities such as those in the FGBNMS and the Tortugas may take thousands of years to develop, but an anchor can destabilise the reef structure and create loose rubble that causes further damage to sensitive species. Even if conditions for regeneration are optimal, it could take hundreds of years for the reef to return to its former condition. The shipping industry will also benefit from the IMO adoption of ‘no anchoring areas’, as this measure ensures that all countries produce charts for international navigation with such areas marked clearly. This informs the mariner of potentially hazardous areas, whilst also increasing compliance with the prohibition. ‘No anchoring areas’ focus on prevention, rather than enforcement and liability for damage to the resources.
Florida Bay, reduced freshwater flow has resulted in plankton bloom increases, sponge and seagrass die-offs, fish kills, and the loss of critical nursery and juvenile habitat for reef species, which affects populations on the offshore coral reefs. Other indirect pressures on reef resources include serial over-fishing that has dramatically altered fish and other animal populations. Fiber optic cables deployed across reefs have smashed corals and sponges. Introduced, competitive species add additional stress e.g. at least 8 marine mollusk, 6 crab, 5 shrimp, 3 barnacle, 4 isopod, and 1 tanaid species have been introduced in the last decade through ship hull fouling or ballast water dumping. Fish introductions come from released aquarium fish; the Indo-Pacific lionfish (*Pterois volitans*) and the Pacific batfish (*Platax orbicularus*) have been observed off the Upper Keys.

Reducing these impacts is critical to sustaining the Florida Keys economy, which is largely based on the coral reefs. South Florida residents and visitors spent 18.2 million person-days fishing, diving, and viewing natural coral reefs from glass-bottom boats, yielding an annual non-market economic use value estimate of nearly US$228 million. This annual value yields an estimate of the asset value of the natural reefs at US$7.6 billion.
Texas Flower Garden Banks
Physical damage from vessel anchoring, potential water quality degradation, impacts of fishing and fishing related activities, and impacts from oil and gas exploration and development are the primary anthropogenic threats to the coral reefs. Anchors from large ships, including foreign-flagged cargo vessels unaware of anchoring restrictions, have caused devastating local impacts. In 2001, the International Maritime Organization designated the Flower Garden Banks as the world’s first international no-anchor zone. Recreational scuba diving on the Banks is increasing and poses minor problems e.g. three live-aboard charter dive vessels brought 2,350 divers there in 1997. These divers spent over US$1.7 million in Texas, generating over US$708,000 in income and 35 jobs. There is also slight potential for pollution from the land to the north.

Puerto Rico
The present status of Puerto Rican coral reefs is amongst the most critical in the Caribbean, due to accelerated urban and industrial coastal development during the last 40 years, combined with a lack of effective management of these resources. Massive clearing of mangroves, dredging of rivers for sand and harbours, runoff from large-scale agricultural developments, deforestation in large watersheds, raw sewage disposal and power plants all cause major stress to coral reefs. Other major anthropogenic activities include oil spills, anchoring of large oil cargo vessels, over-fishing, uncontrolled recreational activities, eutrophication, and military bombing activities (at Vieques and Culebra Islands). The landed value of Puerto Rico’s fisheries declined from US$7.7 million in 1996 to US$6.4 million in 2000. The coastal waters are monitored and evaluated for direct human and indirect human health problems.

US Virgin Islands
Chronic stresses like over-fishing (commercial, hand-line, pot fishing, spear fishing, net, long-line, trolling, driftnet), point and non-point source water pollution, and sedimentation act together with natural disturbances to accelerate damage to reefs or slow their rate of recovery. Over-fishing throughout the USVI has had profound effects such that the fisheries are close to collapse. Even those ecosystems within the boundaries of ‘marine protected areas’ are deteriorating. Existing zoning, erosion control, and fishing regulations are not providing sufficient protection. The present combination of natural and human stresses and the magnitude of their effects may be unprecedented.

Destruction from boats running aground on reefs has been severe. Large vessels (greater than 20m) run aground with surprising regularity on USVI reefs (more than twice a year) and vessels abandoned after recent hurricanes still litter several harbor and reef areas. The worst was the cruise ship Windspirit, which destroyed 283m² of reef in 1988, with no recovery 10 years later. Small boats frequently run aground on shallow reefs, destroying corals, particularly elkhorn coral making them more susceptible to storm damage and white band disease. National park staff have installed 211 moorings and over 111 resource protection buoys around St. John to help prevent anchor damage to benthic habitats and the entire southern section of of the MPA is a no-anchor zone. The staff have been monitoring coral recovery around the moorings in several bays for the last 3 years.

While hurricanes break the most corals, chronic coral damage also occurs at areas of high recreational use by snorkellers and divers. Many popular snorkel and dive sites experience
heavy visitor use (100-200 visitors/site) on St. Croix when cruise ships are in port e.g. Cane Bay, Davis Bay, Buck Island Reef, Carambola, Protestant Cay and Frederiksted beaches. The intensive use of the underwater trail at Buck Island Reef National Monument shows damage from snorkellers. A mooring system has been installed to limit boats and snorkellers.

Navassa
Fishing is the only anthropogenic threat to Navassa reefs and this is unlikely to change, and 1-4 Haitian boats per day with 3-5 men each were present at Navassa during a March 2000 cruise. They appeared to be non-selective regarding species or size. Increases in technology by these subsistence fishers (e.g. boat motors, ice chests), increasing population pressures, and poor fish resources in Haiti may lead to increased fishing pressure.

CURRENT AND POTENTIAL CLIMATE CHANGE IMPACTS

Florida
The principal natural environmental controls in this area are hurricanes, severe storms, winter cold fronts, cold-water upwelling, and ground water effects. The predicted climate change scenario is for warmer waters, rising sea levels, and more frequent and stronger hurricanes. This will probably cause significant changes to the reefs, including more bleaching. Rising sea levels will flood coastal areas and introduce water quality problems. Therefore, management strategies are focusing on alleviating the controllable, human impacts while working toward legislation and policy that will address global emissions in the long-term.

Texas Flower Garden Banks
There are no anticipated problems, as the location and depth of these reefs buffer them from the short-term effects of global warming and climate change. However, if summer water temperatures approach or exceed 30°C on a more consistent basis, the current minor incidences of bleaching will probably increase in severity.

Puerto Rico
Current levels of natural factors (hurricanes, coral bleaching, coral diseases) are resulting in considerable coral reef degradation which may mask any signals from climate change.

U.S. Virgin Islands
Hurricanes David (1979) and Hugo (1989) caused severe destruction on the reefs in the USVI, and recovery has been very slow due to subsequent hurricanes in 1995, 1998 and in late 1999. Any increases in these hurricane events (as predicted by many climate models) will inhibit the recovery of elkhorn coral at some places around St. John, St. Thomas and, St. Croix.

Navassa
There is very little ecological information on Navassa reefs, and hence no basis for assessing trends in current and potential climate change impacts.
CURRENT MPAS AND MANAGEMENT CAPACITY

Florida
The entire Florida Keys reef tract was given some level of protection when the FKNMS was designated in 1990, with oil exploration, mining, and large shipping traffic being excluded. Anchoring on or touching corals in shallow water is prohibited, as is collecting living or dead coral and harvesting ‘live rock’ for the aquarium trade. Potential pollution sources from outside the Sanctuary that can cause impacts within it can be controlled under existing legislation. After 6 years, a management plan was implemented with strategies for conserving, protecting and managing the significant natural and cultural resources of the Florida Keys environment based on a total ecosystem approach. There are several marine zones to protect specific reef areas more intensely e.g. 23 no-take zones were implemented in 1997, which cover less than 1% of the Sanctuary but protect 65% of shallow coral reef habitats. Most of the smaller zones (Sanctuary Preservation Areas) are on the offshore reef tract in heavily used spur and groove coral formations. The 31km² Western Sambo Ecological Reserve protects offshore reefs and mangrove fringes, seagrasses, productive hard bottom communities and patch reefs. The 518km² Tortugas Ecological Reserve (far west Florida Keys) was implemented in 2001 and increases the total protection of coral reefs within the Sanctuary to 10%.

Biscayne National Park encompasses an additional 291km² of the northern reef tract. Concerns about coastal development, intense use by recreational boaters, and growing fishing pressure prompted the Park managers to revise the General Management Plan. This new plan will include management zones that give greater protection to Park resources, including Natural Resource Reserve areas where fish nurseries and spawning habits will be protected from fishing. The Key West and Great White Heron National Wildlife Refuges, which overlap with portions of the FKNMS, contain over 1,610km² of coral reefs and associated habitats. Wildlife management zones in the Refuges direct human activities away from sensitive habitats.

Some protection is given to the reefs off the southeastern coast and the banks of the Middle Grounds through various MPAs, but neither region is comprehensively protected like the Florida Keys. An Oculina (a hard, but not ‘coral reef’ coral) MPA in the far north is managed by the National Marine Fisheries Service (NMFS) to protect these corals from dredging, trawling and long-line fishing gear damage. The Madison-Swanson and Steamboat Lumps Spawning Sites (offshore of the West Florida shelf) were declared in June 2000 to protect spawning aggregations of gag (Mycteroperca microlepis), and other reef and pelagic fish species, from fishing activities. Deepwater habitats are also protected from fishing impacts, and closed to all fishing for 4 years to evaluate the effects of fishing on spawning aggregations.

Texas Flower Garden Banks
The Sanctuary protects the fragile ecosystem from anchoring, oil and gas development and destructive fishing. Sanctuary staff direct resource protection, education, research, and enforcement efforts, and there is also a long-term monitoring program. Additional protection is provided by the Minerals Management Service through requirements imposed on industry operators such as the ‘Topographic Features Stipulation’ for the Flower Garden Banks.
Puerto Rico

The Department of Natural and Environmental Resources (DNER) has designated 8 Special Planning Areas (including all mangroves) and 24 coastal and marine natural reserves. No-take zones include the Luis Peña Channel (4.8km², est. 1999) and the Desecheo Marine Reserve (6.2km², est. 2000). In 2000, the Governor approved the Jobos National Estuarine Research Reserve Management Plan, a Non-Point Source Implementation Plan, and revised regulations for the protection of coral reefs, fisheries, and related habitats. Benthic habitat maps resulting from monitoring and research activities were generated in 2001 to assist resource managers in planning, and planning of new MPAs. A major 5-year research program is examining the complex links between natural and human stresses and processes, socio-economic factors, and the use of MPAs in

**CORAL DISEASE AND HEALTH CONSORTIUM: RECOMMENDATIONS FOR ACTION**

Coral diseases have dramatically increased in frequency and distribution over the last decade, leading to unprecedented decreases in live coral and changes to Caribbean coral reefs. The U.S. Coral Reef Task Force has a National Action Plan to Conserve Coral Reefs and formed a Coral Disease and Health Consortium (CDHC) to organise and coordinate scientists in the U.S. and its territories to meet the challenge of declining coral reefs. This Consortium: brings together coral health and disease researchers; identifies research priorities; and encourages a new generation of researchers through education and outreach. The goal is to develop new tools to identify and alleviate hidden stresses to corals before they become serious. The Consortium has 35 partners to tackle the coral reef disease issues within the Coral Conservation Program, which aims to ‘to preserve and protect the health of coral reef ecosystems through an understanding of the effects of natural and anthropogenic stressors on reef-building communities’. The Consortium met in January 2002 with experts in coral diseases, biomedical and veterinary sciences, pathology, chemistry, biology, biotechnology, and marine management who determined the priority needs in information, research, and technology to assess diseases. They also aimed to assist managers with suggestions for risk management and strategies for prevention, mitigation, or remediation. The recommendations focussed on the following issues:

- a need for standardisation in terminology and protocols, mechanisms for technology transfer and training, and public education programs. There is no consensus on the names and status of coral diseases. Similarly, results often cannot be compared because there are no standard field and laboratory protocols in different countries. The Consortium recommended that standardised monitoring, assessment, and collection protocols be developed along with reporting standards, and agreed names of diseases. There is a need for standard sample collection procedures and means of transportation of specimens, while acknowledging the risks in shipping disease samples around the world;
- a need for research on the biological and environmental factors that may trigger diseases, and what are the causative agents e.g. viruses, bacteria or fungi. There is a need to examine the mechanisms of coral bleaching, as well as coral disease susceptibility, and defence and resistance mechanisms. Research scientists
should work with resource managers to determine research priorities and how mechanisms for information and technology transfer;

- a need for training of more scientists to recognise and research diseases and also train managers in recognising diseases and in the correct methods of recording symptoms and collecting samples;
- a need to organise and integrate scientific information to guide management strategies when coral diseases break out e.g. it would assist if people used the same names, reporting methods, and field assessments. A centralised database would assist communication between scientists, managers, and divers. Rapid response teams of researchers, managers, dive masters, and recreational divers may be necessary to investigate bleaching and disease events;
- a need to bring all disciplines together e.g. pathology, microbiology, ecology, and toxicology to put the whole picture together, and then link with the public, policy makers, and resource managers to ensure that information is shared. This will require cross-disciplinary training programs and partnerships, and exchanges between experts.

Information on the Consortium is on the website:
www.coral.noaa.gov/coral_disease/cdhc.html

management strategies. Biological and physical data will be integrated into a unified GIS and visualization tool, allowing managers to see and even predict the impacts of their decisions.

**U.S. Virgin Islands**

Aspects of St. Croix’s coral reefs are protected by 6 federal MPAs. Buck Island Reef National Monument (BINM) was established in 1961, expanded in 1975 and 2001, and now covers 71ha of land and 77.7km² of submerged lands. In 2001, the entire Monument was declared a no-fishing and no-anchoring zone. Until 2001, most of the BINM was open to extractive uses, including the use of fish traps, cast nets, hook and line, and hand collection of conch and lobster. The National Parks Service has had limited success in controlling illegal fishing due to a lack of law enforcement staff. The Salt River Bay National Historical Park and Ecological Preserve, which is also managed by the NPS, still allows fishing. The Park and Preserve has 160ha of land and 245ha of water to a depth of 91m, and includes the marine resources of the Salt River Bay, Triton and Sugar Bays. In the Mutton Snapper and Red Hind Spawning Aggregation Areas seasonal fishing closures are enforced by NOAA. Finally, 2 St. Croix Restricted Areas (0.01km², and 0.4km²) prohibit anchoring of non-authorized vessels.

In 2001, the NPS established the Virgin Islands Coral Reef National Monument on St. John with most of the 51.4km² MPA being a no-take and no-anchor zone, however, the lack of published federal regulations make this MPA unenforceable. The Virgin Islands National Park occupies 56% of the 48km² island of St. John and 2,286ha of the surrounding waters. Traditional fishing with traps is allowed in the park, although illegal commercial fishing is occurring. Spear fishing is illegal in all Park waters and Trunk Bay, the site of an underwater trail, is a no-take zone. St. Thomas’ Hind Bank Marine Conservation District was started in 1990 as a seasonal federal closure that protected the
FLORIDA KEYS CORAL REEFS: IN DECLINE, BUT NOT BEYOND HOPE

The coral reefs of the Florida Keys have declined in health and vitality at an incredible rate over the past 20 years. Even the declaration of the Florida Keys National Marine Sanctuary in 1990 as an American underwater treasure has apparently not reversed the decline, but now many government, academic and private partners are collaborating to tackle the complex range of problems. The evidence is clear: long-time residents report that the reefs are disappearing before their eyes; and scientists are documenting the decline and pointing fingers at the causes. The coral reefs of the Florida Keys grow at the northern limits for reef growth, often with severe fluctuations in water temperatures, but they also face an amazing range of human impacts. The evidence for decline comes from unparalleled research and monitoring efforts over these 20 years. The Coral Reef Monitoring Project has shown that 35% of living corals have died on most shallow reefs since 1996. These are not isolated examples, but come from over 120 stations at 43 fixed monitoring sites along the whole reef tract. The decline of the prominent elkhorn coral (Acropora palmata), is a stunning example. Elkhorn cover was once dominant on shallow reefs, but has declined by 86%, suggesting that it may be a candidate for endangered species status. The staghorn coral (Acropora cervicornis) has declined by more than 300% and the bladed fire coral (Millepora complanata) declined by more than 200%. The number of coral species has also declined, with two-thirds of sites reporting missing species, and much of the remaining coral is threatened by disease. The Sanctuary’s long-term Water Quality Protection Program has shown that water quality at all sites continues to decline, with increases in nutrient pollution from sewage, agriculture and industry.

Local residents are concerned that their thriving tourism and commercial fishing industries are threatened; the Keys receive more than 3 million visitors each year, with most going snorkelling and scuba diving expecting to see clear water with flourishing, colourful corals and abundant fish populations. These visitors spend US$1.2 billion in Florida. Commercial fishermen land US$70 million worth of seafood every year, and 6 million people call South Florida ‘home’. However, these same industries result in damage to the coral reefs. More than 7,000 cesspits, 900 shallow-injection wells and 25,000 septic tanks release nutrients that percolate through the porous rock out to the near-shore waters. Heavy rains also wash animal waste and petroleum pollutants from roads directly into the ocean. Careless tourists run boats aground, cut through seagrass beds or destroy fragile corals. Inexperienced snorkellers break corals by standing on or kicking them, and anchors still damage corals, despite an extensive system of mooring buoys. Key target fish, lobsters and conchs have been reduced below sustainable levels, which disrupt coral reef food chains and clean up mechanisms.

Reduced and channelised freshwater flows into Florida Bay has affected the quantity, quality, timing and distribution of water entering the Bay. Either the quantity of freshwater is limited during droughts, or catastrophic releases occur during storms. This has resulted in increased plankton blooms, and sponge, seagrass and fish kills. But the Bay is a critical nursery and juvenile habitat for many reef species. The Comprehensive Everglades Restoration Plan aims to return freshwater flows back to
natural levels by managing activities upstream in the Everglades. A disturbing sign has been the increase in coral diseases, with more than 10 reported so far. Another worrying sign for managers is that increasing warm waters from global climate change is causing coral bleaching and may exacerbate diseases. Coral bleaching in the Florida Keys has increased in frequency and duration over these 20 years, with 1997 and 1998 being the worst on record.

These are the problems facing resource managers for the Florida Keys: to reduce the local, regional and global threats to the valuable resources; while at the same time permitting tourism and fishing industries to continue on or near the reefs, and without undue disruption of agriculture, industry or domestic activities. Wastewater and stormwater treatment must be accelerated and no-take ecological reserves implemented to conserve biodiversity and prevent the collapse of fish stocks. The Western Sambo and Tortugas Ecological Reserves are examples of how no-take areas can conserve and protect Sanctuary marine life. Above all, managers must involve all stakeholders and bring the public along through aggressive education programs and vigilant enforcement of protected areas. If the public support the Sanctuary management plans, including using mooring buoys and marked channels, some stresses can be minimised. In the wider region, it is essential that all people in the catchment understand that the health of the Florida Keys depends on what happens upstream in the Everglades, and in cities and towns. Restoration of natural freshwater flows and effective treatment of wastewaters is essential to reduce nutrient excesses on the reefs. The goals of the managers, and the whole community, are to give the Florida Keys reefs a fighting chance to survive and remains as a heritage for our children. From: Billy Causey and Cheva Heck, Florida Keys National Marine Sanctuary, Billy.Causey@noaa.gov

Red Hind spawning site. In November 1999 the closed area (41km²) was designated a marine reserve with all fishing and anchoring prohibited. Average length of spawning red hind have increased from 29.5cm in 1988 to 38.8cm in 2000, and the number of spawning fish increased from 5 to 25 fish/100m². The USVI Government has also designated Marine Reserves and Wildlife Sanctuaries (Salt River, Cas Cay/Mangrove Lagoon and St. James) where fishing is allowed only with handlines or for baitfish with a permit (St. James).

Navassa
This island is part of the US Fish and Wildlife Service’s Caribbean Islands National Wildlife Refuge. A Comprehensive Conservation Plan for the entire Caribbean Islands Refuge is being developed in 2002.

GOVERNMENT POLICIES AND LEGISLATION
Florida
Management strategies for the FKNMS are largely non-regulatory. Instead, they aim to educate citizens and visitors, use volunteers to build stewardship for marine resources, mark channels and waterways, install and maintain mooring buoys, survey submerged cultural resources, and protect water quality. Five types of marine zones reduce pressures
in heavily used areas, protect critical habitats and species, and separate use conflicts. In addition, the International Maritime Organization is designating the FKNMS a Particularly Sensitive Sea Area in 2002. Florida’s East coast is not as well served; policies on environmental impacts of dredging, fresh-water management, and nutrient input should receive attention. Vessel anchorages off Miami, Port Everglades and Palm Beach should be reviewed and changed to provide maximum protection for the reef system.

**Texas Flower Garden Banks**
Regulations governing the FGBNMS under the National Marine Sanctuaries Act, as amended, 16 U.S.C. 1431 are contained within the Code of Federal Regulations and can be viewed on the web at:

http://www.sanctuaries.nos.noaa.gov/oms/pdfs/FlowerGardensRegs.pdf. In 2001 the International Maritime Organization designated the Flower Garden Banks as the world’s first international no-anchor zone.

**Puerto Rico**
Land use policy and development control are proposed by the Planning Board and approved by the Governor. A general policy encourages avoidance of urban sprawl, concentration of industrial development, and agricultural practices that protect soils and avoid adverse impacts, including erosion, on water resources. The coastal zone is managed by the DNER, the Environmental Quality Board monitors water quality, and the Regulations and Permits Administration administers land-use regulations. A Coastal Non-Point Sources of Pollution Control Plan was approved by NOAA and the US EPA in 2000. A 5-year Coral Reef Action Plan written in 1999 guides management, research, and education efforts.

**U.S. Virgin Islands**
The U.S. Department of Interior, the U.S. Department of Commerce (including NOAA and the Caribbean Fishery Management Council), and the USVI Government all have policies, laws and legislation relating to coral reefs in that area. The Code of Federal Regulations Title 36 and the enabling legislation for Virgin Islands National Park and Buck Island Reef National Monument relate to reefs in the national parks. The Caribbean Fishery Management Council has Reef Fish and Coral Reef Management Plans with regulations pertaining to federal waters. Title 12 of the Virgin Islands Code presents environmental laws and regulations of the Virgin Islands. Several specific Acts relate to regulations on corals, fishing, etc. The Code of Federal Regulations states that commercial fishing is prohibited ‘except where specifically authorized by Federal Statutory law’. However, commercial fishing is occurring in the waters of Virgin Islands National Park and Buck Island Reef National Monument.

**Navassa**
A 12-mile fringe of marine habitat around Navassa (estimated at 134,000ha) is under U.S. Fish and Wildlife management. Refuge policies allow subsistence fishing. A Comprehensive Conservation Plan is being developed.
GAPS IN CURRENT MONITORING AND CONSERVATION CAPACITY

In 2001, NOAA and U.S. State agencies developed a nationally coordinated, long-term program to assess species and conditions, monitor trends, and predict changes in U.S. coral reef and related habitats. This program was expanded to include Florida in 2002 and currently supports monitoring in all U.S. States and Territories with coral reefs.

Florida

There is no comprehensive and systematic monitoring program for the reefs of Florida’s East Coast, but one is needed to provide a baseline. Site selection should ensure that representative habitats and unique sites are mapped and monitored. This will require that a selection committee of academic, county, state, conservation and fishing groups, and decisions rapidly disseminated for public discussion. The reef fish communities from seagrass and mangrove habitats of Port Everglades and the Intra-coastal Waterway also remain a mystery. Reefs along the southeast coast and Middle Grounds banks should also be mapped.

Current monitoring in the Sanctuary has focused largely on detecting changes in designated no-take zones and establishing the status and trends in corals, seagrasses, and water quality. Such monitoring must continue in the short-term until solid baseline data are obtained. This baseline will assist in detecting possible long-term changes in communities that may result from management practices (e.g. zoning) or from massive restoration efforts soon to be implemented in the south Florida Everglades.

Texas Flower Garden Banks

Recent observations of increased algal abundance highlight the need to improve water quality monitoring and assess currents and water circulation. The monitoring should include studies on algal populations, coral diseases, and extend to deeper coral reef communities. The great distance of the Sanctuary offshore makes surveillance and enforcement more difficult. Currently, the Sanctuary does not own a boat and relies on charter vessels to get to the area. Recent observations are that the Banks may be important spawning areas for several grouper species and this highlights the need to create a marine reserve to protect the biodiversity.

Puerto Rico

New research and monitoring programs in Puerto Rico are filling gaps and providing managers with information on status and trends of the coral reefs. The Coral Reef Ecosystem Study, a major 5-year research program lead by researchers at the University of Puerto Rico and supported by NOAA, started in 2002 to investigate causes of coral reef declines in the Caribbean. The project examines links between natural and human stresses and processes, socio-economic factors, and the use of marine protected areas in development of management strategies, and aims to integrate all data into a unified GIS tool that will help managers predict the outcomes of potential management actions. A cooperative agreement between the DNR and NOAA supports long-term monitoring and additional U.S. Federal grants support graduate student training in monitoring techniques and research on remote sensing of water quality and bottom cover.
**U.S. Virgin Islands**

Some of the longest data sets on coral reefs in the Caribbean come from a diverse array of ongoing monitoring activities. However, intensive, long-term monitoring has only been conducted at a few sites around St. Croix and St. John, with less information for St. Thomas. Coral reef monitoring needs to be extended to include a wider variety of coral habitats and more sites to provide managers with critical information to enable further protection and preservation of key reef areas. Very little is known of the deeper reefs around the USVI especially in the critical grouper and snapper spawning aggregation sites along the shelf edge. Some of these reefs have exceptionally high coral cover. Little is known about the interactions among reefs, mangroves and seagrass beds and how the losses of mangroves and seagrass beds contributes to the degradation of coral reefs. All agencies involved in coral reef monitoring suffer from a shortage of staff, and enforcement of regulations has been limited.

**Navassa**

There is no monitoring program nor planned for Navassa reefs, nor to assess the artisinal fisheries. This presents an important chance to assess the impacts of artisanal reef fisheries in the absence of other anthropogenic effects.

**Conclusions**

**Florida**

Advances in research and monitoring over the last 2 years reinforce the conclusion that immediate action is needed to curtail declines in coral reef condition throughout Florida. Local communities that are culturally and economically supported by coral reefs must employ management strategies that alleviate controllable human impacts. For example, in Southeastern Florida, the environmental impacts of fisheries, dredging, vessel anchorages, freshwater management, and nutrient input should receive attention to maximise protection to these reefs. Solutions to the wastewater and stormwater problems, habitat degradation, and over-fishing must be pursued in the Florida Keys. Elected officials and policy-makers at the regional level, should work to conserve and protect watersheds, reduce emissions, and decrease energy use. Citizens, elected officials, and MPA managers must work together to improve water quality, minimise physical impacts to corals and seagrasses, employ sustainable fishing practices, reduce pollution and save energy. Strict air pollution standards must be adopted, carbon dioxide emissions reduced, and renewable energy technologies employed to curb global warming trends. International policies on global climate change should be adopted and implemented. Comprehensive coral reef protection will ultimately require both proactive local steps and engaging leaders regionally and globally on climate change issues.

**Texas and Flower Garden Banks**

Recent data indicate that the Flower Garden Banks may be an important spawning area for several species of grouper. This highlights the importance of implementing no-take reserves to protect the biodiversity of this area.

**Puerto Rico**

Human pressures on Puerto Rican coral reefs are among the most extreme in the Caribbean. Many of Puerto Rico’s near-shore reefs are degraded as a result of decades of
accelerated urban and industrial coastal development, and poor implementation of policies designed to protect the reefs. Since the late 1990s, scientists and the Government have made a concerted effort to better understand, protect, and manage the reefs. Environmental Impact Statements are required by local law for development along the shoreline, and have generated quantitative and qualitative studies of reef communities. But these mostly relate to underwater outfalls from regional wastewater treatment plants and discharges from conventional electric power plants. In the last two years, significant progress has been made in mapping, monitoring, and researching the coral reefs of Puerto Rico. Continued U.S. Federal support for these programs should provide managers and policy-makers with the information they need to design and implement effective management plans aimed at reversing coral reef decline.

U.S. Virgin Islands
There is irrefutable evidence that additional regulations, and enhanced enforcement of existing regulations are necessary to reverse serious declines and degradation in the marine resources of the USVI. Resource managers from the local government and the NPS have requested additional marine reserves to protect functional reef ecosystems, to allow their recovery where damage has occurred, and to allow recovery of fish populations. The 2001 expansion of Buck Island sanctuary will close only 7% of the shelf area around St. Croix. Only 3% of the St. Thomas/St. John shelf area is closed and bait fish and line fishing is still allowed. This is less than the 20% goal for no-take protection of reef resources recommended by the U.S. Coral Reef Task Force. More effective enforcement of existing environmental regulations is also needed. Management plans should be developed for all territorially designated Areas of Particular Concern. Environmental education for residents and visitors should be expanded and improved.

Navassa
The presence of a relatively intact Caribbean reef could provide a unique opportunity for research on the ecology of Caribbean reefs to improve understanding and effective management and restoration of reefs in other areas of the Caribbean. Furthermore, it is predicted that fishing effort and reef impacts will escalate at Navassa, therefore the implementation of a rigorous reef and fishery monitoring program would provide critical information on the subsistence fishery and how this impacts on Caribbean reefs.

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SUPPORTING DOCUMENTATION


EVERGALDES AND DRY TORTUGAS, USA – MAN AND THE BIOSPHERE RESERVE

Everglades National Park is on the southern tip of the Florida Peninsula, bounded by the Gulf of Mexico to the west and the Florida Keys to the south and south-east. The biosphere reserve includes the Dry Tortugas National Park, a group of 7 coral reefs and surrounding shoals, coral reefs and waters in the Florida Keys. The Dry Tortugas is primarily a marine park and Everglades National Park is both terrestrial and marine, containing a vast marine area in Florida Bay. The total area of the biosphere reserve is 585,867ha and the environment is characterized by saltmarshes, mangrove forests, beach and dune complexes, brackish water estuaries, cypress swamps, and marine systems including coral reefs. The 2 parks were accepted together as a biosphere reserve in 1976 and the Everglades National Park was inscribed on the World Heritage List in 1979, and was designated a Ramsar site in 1987.

The Reserve is under the administration of the US National Park Service and both parks have Strategic Management Plans. The government and conservation organizations work to protect and enhance the marine areas of the biosphere reserve by finding innovative new ways to manage activities in the parks to avoid harm to coral reefs, seagrass beds, sunken archaeological treasures, and marine flora and fauna. Strategies include creating no-take zones where only research is allowed and limiting the traffic of motorized boats.

Ecological Monitoring: National Oceanic and Atmospheric Administration (NOAA) is undertaking long-term coral reef monitoring studies in the reserve and other institutions are examining issues such as surface hydrology, water quality, vertebrate ecology and restoration ecology. The monitoring was enhanced when significant areas of the Dry Tortugas were declared no-take zones to conserve dwindling fish stocks. Early results show improving fish stocks in these no-take areas.

Socio-economic Monitoring: NOAA is also conducting socio-assessments of the key stakeholder groups, especially fishers.

Monitoring Effectiveness: The baseline data assessing the resources of the Dry Tortugas was instrumental in the designation of different zones and was used in consultation with fishers and other users to gain agreement on reserve boundaries. Now monitoring data are instrumental as performance evaluation measures of the effectiveness of resource management, especially for fish and lobster populations.

Coral reefs are 30% of the natural resources. Ecological Monitoring is substantial. Socio-economic Monitoring is substantial.
The U.S. Virgin Islands (USVI) is a group of 3 islands, St. Thomas, St. John, and St. Croix, in the Eastern Caribbean. Most of the coral reefs around the islands are shallow fringing reefs that run parallel to the coastlines. The Virgin Islands National Park includes 3 individual areas, whereas the Biosphere Reserve, established in 1972, incorporates the entire area.

The effects of hurricanes and coral disease have seriously damaged the coral reefs in the USVI with coral cover dropping from 85% in 1976 in the Buck Island special reserve to 5% in 1988 following storms and disease. Damage to reefs is also comes from tourism, and especially fishing, with significant harm being caused by anchoring and ship groundings. Direct damage by divers and snorkellers has been recorded at heavily used sites. Within the last 15 to 20 years, the amount of live coral cover has declined, while the abundance of algae has increased. Overfishing is also widespread throughout the islands.

The U.S. National Park Service supports management of the area as well as research work by the Virgin Islands Resource Management Co-operative (VIRMC). In cooperation with other local institutions and agencies, the Management Cooperative has completed studies within the reserve including ecological and social characterization of local fisheries, and description and mapping of near-shore marine communities. In 1999 a marine conservation district was declared southwest of St. Thomas, as a cooperative effort amongst fishers, divers and the local government. The area is closed to all fishing and anchoring, and represents an important step towards cooperative fisheries management.

Ecological Monitoring: U.S. Park Service and U.S. Geological Service initiated a long-term reef monitoring program around St. John and Buck Island in 1989. In 1991, other long-term sites were established around St. John in Newfound and Francis bays. These sites have provided detailed information about the effects of storms and the recovery of reefs from storms and anchor damage.

Socio-economic Monitoring: This is not as detailed as the ecological monitoring, however there are plans to implement more substantial monitoring.

Coral reefs are 60% of the natural resources.
Ecological Monitoring is substantial.
Socio-economic Monitoring is effective.