
Editor: Ruth Kelty


Flower Garden Banks Authors: George Schmahl, Emma Hickerson

Puerto Rico Authors: Jorge R. Garcia, Craig Lilyestrom, Richard Appeldoorn, Andy Bruckner and Ernest Williams

USVI Authors: Christopher F.G. Jeffrey, Ursula Alauf, Alan Friedlander, Caroline Rogers, Jeff Miller, James Beets, Richard Nemeth, Steve Herzlieb, Violeta Mayor, Wesley Toller, Zandy Hillis-Starr, Sheri Caseau

Navassa Author: Margaret Miller

Abstract

Mapping, monitoring, and management of coral reefs of Florida, the Flower Garden Banks National Marine Sanctuary (FGBNMS) northwestern Gulf of Mexico, Puerto Rico, U.S. Virgin Islands and Navassa have all improved with increased awareness and funding from the Government of the USA. Quantitative baseline surveys of coral reef communities have been completed in Puerto Rico at three current or proposed Natural Reserves. Monitoring is demonstrating trends in reef community health and structure in other sensitive coastal areas. The Tres Palmas Marine Reserve has been designated recently, and existing MPAs and revisions to fishing laws were evaluated based on these results. In the U.S. Virgin Islands (USVI), the Buck Island Reef National Monument has been expanded and a new park, the St. Croix East End Marine Park established in 2003. The monitoring programs in the USVI are now detecting changes in fish and coral community structure in and around the managed
areas with a specific focus on elkhorn coral stands. Monitoring of water quality, reef diversity, growth, and populations of dominant fish and benthic organisms in Flower Garden Banks, Stetson Bank, and Navassa has assisted in evaluating impacts of climate change, tropical storms, fishing, and tourism pressures. An expanded Florida monitoring program is now completing the first integrated assessment of the reefs northwards from the Florida Keys. It is hoped that this increased attention to coral reef issues will continue, and that advances in the understanding of how coral reef ecosystems respond to anthropogenic stresses will result in better management plans that protect coastal resources by reducing those stresses. However, an improved understanding of the relative importance of how stresses contribute to or cause coral decline is needed. There is a need also to understand the linkages between water flows and the functioning of coral reef ecosystems. It is essential to strengthen cross-boundary and cross-jurisdictional agreements to facilitate ecosystem-based management and information and technology transfer.

100 Years ago: Virtually all coral reefs were healthy with normal fish populations. Clear, low-nutrient waters were the norm and reefs were dominated by healthy branching corals, urchins, large schools of game fish, sharks, and algal grazers.

In 1994: Coral reefs of the Caribbean had been heavily damaged by disease, coastal development, coral bleaching, and over-fishing. The scientific community was documenting the decline and public awareness was increasing. Management plans were being written for areas protected in National Marine Sanctuaries and Parks and universities, governments, and NGOs conducted research and monitoring. The more isolated reefs in the Western Atlantic were in better condition because they were not affected by land-based stresses.

In 2004: Reefs in the Caribbean and Western Atlantic range in condition from excellent to poor with reefs near population centres showing damage from land-based pollution, fishing, disease, bleaching, and ship groundings. In areas stressed by over-fishing and coastal development, recovery from the sea urchin die-off and coral bleaching events of the late 1980s and early
Status of Coral Reefs of the US Caribbean and Gulf of Mexico

1990s is slow. However, the capacity to understand, monitor and manage coral reefs, and their use is expanding. More coral reefs are managed in protected areas and enforcement of existing regulations is improving in some of these areas.

Predictions for 2014: Reefs away from population centres will remain healthy, unless the adverse predictions for global climate change of more tropical storms and bleaching occur. Human stresses around populated islands will continue, but if governments maintain or build their capacity and commitment to improving reef ecosystem management, these stressors and resulting damage should be minimized.

INTRODUCTION


Florida

The Florida Keys extend from Miami to the Dry Tortugas and are included in the Florida Keys National Marine Sanctuary (FKNMS), and the Biscayne and Dry Tortugas National Parks. The Sanctuary covers 9850 km$^2$ with 1400 km$^2$ of coral reef and hard bottom habitat. The reefs consist of almost continuous parallel banks, and include distinct habitats such as offshore patch reefs, seagrass beds, back reefs, reef flats, bank or transitional reefs, intermediate reefs, deep reefs, outlier reefs, and sand and soft bottom areas. The other major reefs are 3 parallel lines of reefs off southeast Florida. The first reef is shallow with a low cover of algae and small octocorals; channels and numerous octocorals dissect the second reef; and the third reef is deeper with the most diverse hard coral populations. It is evident that the banks of staghorn coral (*Acropora cervicornis*) are recovering from bleaching and disease damage, and many moderate sized colonies of *Montastraea annularis* now occur on the deeper reef; there are no *Acropora palmata* in this area.

Flower Garden Banks NMS – Northwestern Gulf of Mexico

The East and West Flower Garden Banks are the most northerly coral reefs of continental North America and some of the most isolated reefs in the Caribbean. These are 2 Jurassic salt domes that rise from 100 m depth to 17 m and contain 1.4 km$^2$ of luxurious bank reefs in the northwest Gulf of Mexico. There is relatively low coral diversity (21 species), but coral cover is more than 50% and consists of closely spaced, large (up to 3m in diameter) heads, many of which have been hollowed by eroding organisms.

Stetson Bank – the protected third site within the boundaries of the FGBNMS, harbours a small coral pinnacle, dominated by *Madracis decactis* and *Millepora alcicornis*. The coral cover on the pinnacle is close to 30%, and the remainder of the bank is dominated by sponges and algae.
Puerto Rico
Fringing coral reefs with a total area of 3,370 km² occur off the east, south and west coasts, around the 2 inhabited (Culebra and Vieques) and 3 uninhabited (Mona, Monito, Desecheo) small islands off Puerto Rico. Other areas of the shelf consist of hard ground and reef rock with scattered coral colonies and coral patches. The reefs have high hard coral diversity (125 species) along with 112 species of soft corals and gorgonians. The reefs have suffered major losses in coral cover through bleaching and disease, but stands of high coral cover (e.g. 70%) remain on some reefs which are remote from the land.

U.S. Virgin Islands
There are fringing, patch and deep reefs (wall and shelf-edge) around all the major islands (St. Croix, St. John, and St. Thomas) and some have prominent spur and groove formations. There are also offshore cays and a barrier reef on St. Croix, with the highest coral diversity on the deeper offshore reefs. Mapping of the area by NOAA showed 61% of the 485 km² area is covered by coral reefs and corals on hard-bottoms, 33% is predominantly seagrass beds, and 4% is sediment or rocky bottom. The jurisdiction over these coral resources is shared by several U.S. Departments (Interior and Commerce) and the Virgin Islands Government.

Navassa
This is a small, uninhabited raised island, 5 km² in area, which lies between Jamaica and Haiti and is managed by the U.S. Fish and Wildlife Service. This report adds considerably to the limited knowledge of these reefs and their resources.

Status of the Coral Reefs
Florida
The Florida Keys are probably the best documented reefs in the Wider Caribbean with 64 hard coral species, 2 fire corals, and 55 species of octocoral recorded. The dominant bottom cover in 2003 was hard bottom (~62%), followed by octocoral (13%), macro-algae (12%), stony coral (7% in the FKNMS, 13% in the Dry Tortugas), 2% sponges, 2% zooanthids, and 0.5% seagrass. This represents a 5% absolute decline in stony coral cover from 1996. Species richness also declined across all habitats between 1996 and 2003; 76 of the monitoring stations had lower species richness, 15 had increases, and 14 stations were unchanged. The offshore deep and patch reef habitats had the most stony coral species with 17 and 16 species, and 9 species on hard-bottom habitats. The number of diseased stony corals has increased alarmingly from 20 stations in 1996 to 95 stations in 2003, with more diseases being observed. A disease outbreak in 2003 affected staghorn corals and prompted Sanctuary management to close an area to divers. They support the quarantine to prevent the disease from spreading. Coral bleaching remains a problem, and has caused some of the dramatic declines in coral cover in the Sanctuary since 1997, but fortunately there has been no recent severe bleaching. Coral cover has not declined since the 1997 bleaching outbreak, but the corals have not shown any significant recovery.

There are also 90 species of marine macro-algae, 7 seagrasses, and 3 species of mangroves in Florida. Seagrasses cover approximately 12,800 km². The algal and invertebrate cover fluctuates widely between years, e.g. algal cover increased between 1996 and 2000, while sponge and soft coral cover decreased.

Poor water quality and pollution from fertilizers, sediments, and nutrients from Southeast Florida and the Keys pose considerable threats to the corals. In response, the Sanctuary has
increased water quality sampling to over 200 tri-monthly sampling stations in the Sanctuary and the Shelf, and 100 monthly stations in Florida Bay, Biscayne Bay, and the mangrove estuaries of southwest Florida. Such monitoring has identified the major nutrient sources, the differences in geographical water quality, and elucidated large-scale water transport pathways. Data from these water samples will provide a baseline to study how the ‘re-plumbing’ of the Everglades has altered water flows and pollution levels in Florida Bay.

**Flower Garden Banks National Marine Sanctuary**

The overall health of the East and West Flower Garden Bank reefs is stable, with about 50% coral cover of mostly robust, massive species. Coral cover on the deep stations of the East Flower Garden Bank is about 69%, dominated by *Montastraea franksi*, *M. cavernosa*, *M. faveolata* and *Diploria strigosa*. Very little coral disease and bleaching mortality has been seen, and when there is minimal bleaching, recovery is usually 100%. Algae continue to play a balanced role in the reef habitat, and do not threaten the corals, while water quality continues to be good.

The corals on top of the East and West Banks of the Marine Sanctuary have been monitored annually since 1989 and continue to thrive with 54% coral cover reported during the 2002-2003 monitoring season. The dominant species on the crest of the reefs are *M. faveolata*, *M. franksi*, *Porites astreoides* and *Diploria strigosa*. The Sanctuary research team has observed the deeper regions with Remotely Operated Vehicles (ROVs) during the last 5 years. They report over 35 species of antipatharians (e.g. black corals) and gorgonians, and several species of non-photosynthetic corals, with indications that these deep coral reefs are important spawning areas for several species of grouper.

**Puerto Rico**

These reefs are the richest reefs in the US Caribbean with 237 coral-like species; 117 hard corals, 99 soft corals and gorgonians, 13 corallimorphs, and 8 hydrocorals. Assessments of 79 reefs around Puerto Rico between 1985 and 2003 show that reefs close to coastal developments have degraded, whereas the reefs near the offshore Descheo Island are probably the best-developed and healthiest in Puerto Rico. Most shallow reefs (1 - 5 m) were covered with 65% algae, with live coral cover ranging from 4 - 49% (mean 16%). The highest cover was on the southeast with 4 species contributing more than 50% of that cover (*Porites astreoides*, *P. porites*, *Siderastrea radians*, *S. siderea*). The encrusting octocoral, *Erythropodium caribbaeorum*, occurred at most sites with a maximum cover of 44%, and zoanthids, particularly the encrusting *Palythoa* sp., and sponges were the other main animals in shallow waters. Most inshore reefs at 6-12 m show advanced stages of degradation, with 0.6 - 49% live coral cover. Only one mainland reef on the northeast coast had live coral cover above 10%. Live coral cover increased with distance from shore in Mayaguez Bay. *Montastrea annularis* was the dominant stony coral on 19 of 22 reefs, but was virtually absent on reefs with low coral cover. Macro and turf algae were dominant on most intermediate depth reefs. Live coral cover on the deeper reefs (15 - 25 m) was highest at the shelf-edge reef off La Parguera (44%). Other reefs on the southwest coast had cover of 16 - 27%, dominated by *Montastrea annularis*, *M. cavernosa*, *Porites astreoides* and *Agaricia* spp. In most areas, stony coral cover was within 3% of previous baseline levels, indicating little recent change. The notable exceptions were at Cayo Coral in Guánica and at Cayo Caribes in Guayama where there was a decline in coral cover. These declines probably relate to local disturbances, as adjacent reefs showed no change. Similarly, an increase in coral cover at Tourmaline Reef was not matched on other reefs in Mayaguez Bay.
**US Virgin Islands**
The USVI has about 57 species of hard corals, 377 reef fish, 500 molluscs, 454 echinoderms, 737 crustaceans, 99 polychaetes, 3 seagrasses, 120 algae, and 75 species of tunicates. Although there were no good estimates or comprehensive data sets of coral abundance before the mid 1970s, dense stands of *A. palmata* were reported and photographed on reefs in St. Croix. In the 1980s and 1990s, hurricanes and diseases severely damaged these coral reefs. The average coral cover declined by 8-33%, with the cover of *A. palmata* falling by as much as 85%, and reefs becoming dominated by macro-algae.

Monitoring studies from 2000-2004 indicate that coral cover remains low, while macro-algal abundance remains high and the epidemic of coral diseases continues. AGRRA (1998-2000) and video (2001-2003) assessments indicate a range of live coral cover from 4-39%, with *Montastraea* spp. and *Siderastrea siderea* as the most common corals. Macro-algal cover was significantly lower on St. Croix than on the northern Virgin Island reefs. *Diadema* urchins were twice as abundant on the shallow reefs of St. John than on deeper reefs.

The US Geological Survey, National Park Service, and the University of the Virgin Islands are mapping elkhorn coral stands in the Virgin Islands National Park (St. John), Buck Island Reef National Monument (St. Croix) and Biscayne National Park (Florida). They are also examining threats that could prevent recovery of this coral, which was once the most important reef-building species in shallow water throughout the Caribbean. Elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) coral are now being considered for listing under the Endangered Species Act because of extensive declines (more than 90% at some sites) from white band disease and storms in the last 15-25 years (Box 15). It is not yet known whether elkhorn coral populations will recover to the levels seen 30 years ago. Early evidence suggests that there has been an increase in the abundance and size within the 3 national parks, but disease, predation, and breakage from boats and snorkelers may delay or prevent recovery.

**Navassa**
An extensive survey of various reef habitats in 2002 showed that the highest live coral cover was 46% at 25 – 30 m. Cover ranged from 10 - 20% in shallower habitats (10 – 20 m). Macroalgae (predominantly *Lobophora variegata* and *Dictyota* spp.) were the dominant organisms in some reef habitats. Macro-algal cover doubled from 2000-2002 at one site (25 to 50%), but was similar at two other sites and there were no overall changes in benthic community structure. *Neofibrilaria nolitange* was the dominant sponge and 21 species of gorgonians were observed at low densities. The dominant corals are *Montastrea* spp., *Agaricia* spp. and *Porites porites*, and shallow species such as *Acropora palmata*. Some coralline algae and foraminifera are found at depths much greater than expected indicating very clear water around Navassa. *Acropora palmata* appears to be increasing in abundance with substantial populations at 3 shallow reef sites, with the increase probably due to continuing sexual reproduction and recruitment. In contrast, the staghorn coral *A. cervicornis* remains rare and in poor condition. Diseases were not observed on any shallow water coral colonies. The impacts of predators (4% of colonies), and competition by algae and sponges (14% of the colonies) were the major direct causes of damage to corals. However, an unknown disease, similar to white plague was observed on brain corals at deeper reef sites.
Status of Coral Reefs of the US Caribbean and Gulf of Mexico

Status of Coral Reef Fishes and Invertebrates

Florida Keys
The Florida Keys has 389 reef fish among the total of 517 fish species. Fishing impacts are highest near Miami and lowest in the Dry Tortugas; in 2001, 6.7 million recreational fishers made 28.9 million marine fishing trips in Florida, and caught 171.6 million fish with half being released or discarded. The number of registered recreational boats in the 5 southern Florida counties increased by more than 500% between 1964 and 2002, while the commercial vessel numbers grew by 150%. Fish stock biomass was well below accepted standards for most of the key target species within the reef fish fishery, e.g. the average size of black grouper caught in Biscayne National Park was 40% of the size of those caught in 1940, fishing mortality is several times the level needed to achieve optimum yield, and the spawning stock is now less than 5% of the historical un-fished maximum. Fishing pressure was particularly high, resulting in 77% of the 35 stocks examined being over-fished according to federal standards. This included 13 of 16 grouper species, 11 of 13 snapper, the barracuda, and 2 of 5 grunt species.

In 2003, 6 Florida reef fishes (speckled hind, warsaw grouper, black grouper, red porgy, goliath grouper and Nassau grouper) were listed as either over-fished (i.e. depleted below minimum standards) or being fished at a rate that would lead to over-fishing; 4 species were not over-fished; and the status of 46 species was unknown. Recently, the hogfish (Lachnolaimus maximus) was listed as over-fished and undergoing over-fishing in the Florida Keys, although trends have improved following the establishment of minimum size regulations in 1993 and a fish trap prohibition in 1990. In the Gulf of Mexico in 2003, the goliath and Nassau grouper were over-fished or undergoing over-fishing, and 26 species were in unknown condition. 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 underway to improve reproductive output. Populations of the long-spined sea urchin (Diadema antillarum) are recovering slowly since the massive die-off in 1983.

Flower Garden Banks National Marine Sanctuary
Fish diversity is lower (266 species) than on other Caribbean reefs, with planktivore and invertebrate feeders being the most abundant species, and commercial species, like grunts and snappers being much less common. These reefs may be important spawning areas for grouper. There have been significant increases in queen and stoplight parrotfish (Scarus vetula and Sparisoma viride), possibly due to an increase in algal food following the disappearance of the long-spined sea urchins in 1983. Manta rays, whale sharks, tropical spotted dolphins, bottlenose dolphins, hammerhead and silky sharks, and spotted eagle rays can all be seen on the Banks. Only traditional hook and line fishing is allowed in the Sanctuary, however, illegal fishing by commercial long-liners and recreational spearfishers has been reported, but little is known about any resulting damage. Current legal fishing for snapper and grouper may be having a detrimental effect on populations. Lost and discarded fishing gear in the Sanctuary and on Stetson Banks is causing some damage to the coral reefs and loggerhead turtles have become entangled and injured. Stetson Bank is closer to shore, and is often targeted by recreational fishermen, and there appears to be more mechanical injury from fishing because of the relatively soft nature of the claystone and siltstone bottom.
Puerto Rico
There are 242 reef fish species, with the target fish under intense pressure from commercial and recreational fishers, and aquarium collectors. Reef fish catches have plummeted for two decades indicating classic symptoms of over-fishing: reduced total landings; declining catch per unit effort; shifts to smaller fish; and recruitment failures e.g. commercial fish landings fell by 69% between 1979 and 1990. Reef fish density (individuals per 30 m²) ranged from 93.2 near Desecheo Island to 12.6 near Caja de Muertos, with both reef fish density and species richness correlated directly with coral cover and the bottom rugosity. The mean number of fish species per transect ranged from 16.8 near Desecheo Island to 7.0 at Cabo Rojo.

In 2003, there were 219,910 recreational anglers in Puerto Rico, with 34,905 being non-residents. Recreational anglers made 1,411,943 fishing trips in 2001, 1,098,420 in 2002 and 1,111,405 trips in 2003. The total number of fishers declined from 249,869 in 2001 to 219,910 in 2003, and commercial use of traps and nets also declined due to their high costs and relatively low yield. There was, however, an increase in the use of lines and scuba gear. Most recreational fishing (56 - 64%) was from the shoreline, 35 - 40% was from private boats, with the remainder being charter trips (1 - 3%). Most of the total recreational catch of 2.08 metric tons in 2000 and 1.09 tons in 2002 was caught by private boat anglers, with 16 - 29% being reef fish. The total catch decreased by 40% per year between 2000 and 2002. There were consistent declines in the catch of lane, mutton and silk snapper. There is an unwanted side effect of the decline in spiny lobster populations due to increasing fishing pressures. Coral-eating molluscs, which are a favourite food of the lobsters, increased and are causing more damage to the corals.

U.S. Virgin Islands
The composition of reef fish populations and landings has changed markedly in the USVI over the past 40 years. In the 1960s and 1970s, large grouper and snapper species were plentiful on reefs and common in fisheries landings. From the 1980s to the 1990s, there was a shift in fish species composition in catches and on the reefs to more herbivores. Fewer grouper and snapper species were seen or caught, and the average size of fishes decreased. The Nassau grouper fishery crashed, followed by a crash in the replacement redhind fishery. Monitoring studies from 2000-2004 indicate that herbivorous fish species remain abundant on reefs and in fishery landings. Populations of large snappers and groupers remain low, but their numbers may be increasing. The size and numbers of fishes spawning within some enforced protected areas also appear to be increasing.

Navassa
Surveys in 2002 found 35 new fish species records to make the total 272 for Navassa. They counted 20,901 fishes in 110 species from 45 families at 110 stationary samples, with plankton feeders dominating (71%), including blue chromis, creole wrasse, bluehead wrasse, and bicolor damselfish as the most abundant species (59.1% of the total). Most importantly, large fish were virtually absent from the population, with the average total length being 4.6 cm and only 11 of 1227 individual fish were longer than 24 cm. This is in stark contrast to findings in 2000, when in a less extensive survey, 92% of snapper and 23% of parrotfishes were longer than 40cm. This indicates that fishing is having a major impact on Navassa reefs.

Diadema antillarum were present at mid-depths (0.16 ± 0.24 m²) but much rarer on the shallow reefs (0.02 ± 0.02 m²). Coral eating molluscs, Coralliophila abbreviata, were found infesting Agaricia spp., Montastraea spp., Diploria spp. and Acropora palmata in the shallower
sites (<20 m). Although no quantitative data on queen conch (*Strombus gigas*) were collected, intense harvesting of mature conch populations was observed. This will be a high priority monitoring theme for the future.

**Anthropogenic Threats to Coral Reefs**

**Florida**

A combination of geography, multiple stressors acting synergistically, and natural factors explain the condition of the Florida reefs. Because coral reefs in Florida represent the northern extension of a rich Caribbean flora and fauna they are negatively affected by winter cold fronts which have previously killed substantial amounts of coral as far as the Dry Tortugas. Reefs in Florida suffer from many of the same problems that have caused coral decline throughout the Caribbean, especially white band disease (affecting the branching corals *Acropora palmata* and *A. cervicornis*) and an urchin disease. In combination, these events have considerably altered the condition of the offshore reefs in the Keys.

Over-fishing is a well-documented problem in the Keys (65% of the 35 species analyzed were over-fished). Between 1995 and 2000, the commercial fishing fleet grew by 26%, and the recreational fleet by 465%. In addition, 400-600 vessels have run aground each year in the FKNMS, with 15% of these damaging the corals. Large-vessel groundings cause more immediate damage, but the cumulative effects of small-vessel groundings have long-lasting impacts. Damage also occurs from anchors and chains. Fibre optic cables and gas pipelines have recently been installed off Miami-Dade, Broward, and Palm Beach Counties. The drilling and trenching has released sediments and raised turbidity, further adding to reef degradation. The State of Florida has directed cable companies to install cables where there are gaps in the reefs to reduce damage. The growing South Florida population has added to fishing pressures and increased problems associated with coastal development.

Nutrient enrichment is a problem close to shore, but the relative importance and effects of different nutrient sources is unclear. Harmful macro-algal blooms have increased off Palm Beach County during the past decade, and the cyanobacterium, *Lyngbya confervoides*, has covered extensive areas of the middle reef tract off Broward County over the past 2 years. Such algal blooms smother and kill coral, and reduce larval settlement. Water pollution has increased bioerosion rates and may be linked to coral diseases. The primary nitrogen source for these blooms is land-based, i.e. sewage, followed by surface water run-off, stormwater discharge, and groundwater seeps. Nutrient loading of nitrogen and phosphorus from inland agriculture is evident in the coastal waters offshore from Palm Beach County due to surface water discharge was 2,473 and 197 metric tons per year, respectively, and 5,727 and 414 metric tons per year via submarine groundwater discharge. The water quality monitoring program that started in 1995 has shown elevated nitrogen levels in the nearshore areas of the keys, but not in the Tortugas region, indicating that the source is from the land.

**Flower Garden Banks National Marine Sanctuary**

These reefs are in the middle of one of the largest oil and gas fields in the world; 6,500 oil production platforms have been installed, 43,300 wells drilled, and 168,474 km of pipeline laid in the Gulf of Mexico. Within the Minerals Management Service 4 mile regulatory zone of the East and West Flower Garden Banks, there are 14 production platforms and 178 km of pipeline, and Sanctuary staff review many requests to lay pipelines or install platforms in this regulatory
zone each year. In addition, many scuba divers, and recreational and commercial fishers visit the Banks. The main physical damage is from vessel anchors, minor water pollution, fishing activities, and oil and gas exploration and development. The managers of the Sanctuary consider that there is a need for a public awareness program targeting the potential for divers to spread coral diseases, and to encourage visiting divers to adequately wash out their dive gear, particularly wetsuits, prior to traveling to new dive sites.

**Puerto Rico**
The coral reefs are deteriorating due to accelerated urban and industrial development on the coast, and a lack of effective resource management. There has been 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 building of power plants all resulting in coral reef damage. Other major anthropogenic activities include oil spills, anchoring of large cargo vessels, over-fishing, uncontrolled recreational activities, eutrophication, and military bombing activities (at Vieques and Culebra Islands).

The 2002 commercial fishery census reported 1,163 active commercial fishers using 956 fishing vessels, 10,372 fish traps, 2,774 lobster pots, 147 beach seine nets, 993 gill nets, 391 trammel nets, 1,267 cast nets and 12,310 fishing lines of different types. These fishers caught 1.6 million tons of fish per year from 1995-2002, with 87% of them targeting reef fish, as well as conch and lobster. Recreational fishers and ornamental collectors also target reef fish, consequently reef fisheries have plummeted during the last 20 years and commercial fish landings have fallen by 69% between 1979 and 1990. Over 200 species of ornamental fish and invertebrates have been exported from Puerto Rico as an unregulated industry. New State fisheries regulations approved in 2004 limit the species allowed for export, and establish annual export quotas.

**US Virgin Islands**
Water quality around the USVI is generally good but it is declining with increased point and non-point source pollution. Overloaded municipal sewerage systems are responsible for much of the point source pollution. Increased tourism and the accompanying increase in solid waste have exacerbated the problem. Other impacts from tourism include physical damage to habitats, groundwater depletion and contamination, increased sediment loads, and the displacement of traditional resource users. Sediments running off coastal developments are reducing water quality in St. Thomas and St. John where 80% of the slopes exceed a 30% gradient with increased runoff from unpaved roads.

**Navassa**
Despite its status as a National Wildlife Refuge, fisheries at Navassa are poorly managed as the regulations are not well publicised or enforced, due to remoteness and other challenges. In 2002, most fishing boats were 6-9 m wooden vessels manned by 3 to 6 fishers using either hook-and-line, nets or Antillean Z-traps. The extent of larger commercial fishing vessels operating in Navassa waters is not known. Finfish catch appeared unselective and included predominantly small (<30 cm) fishes such as trunkfish, ocean triggerfish, surgeonfish, and bar jack. The catches also included queen conch (*Strombus gigas*) and Hawksbill sea turtles (*Eretmochelys imbricata*). In addition, the artisanal fishers have installed a system of makeshift moorings and rock anchors at Lulu Bay in the middle of an extensive stand of *Acropora palmata*. 
CURRENT AND POTENTIAL CLIMATE CHANGE IMPACTS

Florida
Coral bleaching has affected the Keys many times in the past 15 years. In 1997 and 1998, significant bleaching was observed for the first time in successive years. Large numbers of corals are presumed to have been killed by the bleaching, but this was not well documented because there were no appropriate monitoring programs. There has been no repeat of severe bleaching since 1998.

Flower Garden Banks National Marine Sanctuary
The location and depth of these coral reefs buffer them from the short-term effects of global warming and climate change, and 2002-2003 data indicate negligible bleaching, except when the water temperature approached 30°C, which caused 4% bleaching but negligible mortality. It is predicted that the incidence and severity of bleaching events will increase with rises in global ocean temperatures.

Puerto Rico
Current levels of ‘natural’ events (hurricanes, coral bleaching, coral diseases) together with anthropogenic pressures are causing considerable coral reef degradation, which may mask any signals from climate change.

U.S. Virgin Islands
Coral bleaching was recorded at all AGRRA sites in 1998 - 2000, with the most frequent around St. Croix and the least frequent around St. Thomas. The 1998 bleaching coincided with the highest seawater temperatures. Bleaching in 1999 was associated with milder temperatures (28.8°C) but did not result in extensive coral colony mortality with most colonies recovering within 6 months. Recent data suggest that climate change remains a threat to the coral reefs in the USVI.

Navassa
Virtually no historic observations or data exist for the physical parameters or condition of Navassa reef resources. There are no records of coral bleaching because no regular observations have been made. However, most of the high coral-cover habitat around Navassa is relatively deep (18-30m), and the exposed oceanic location ensures that strong currents and surges may provide some level of protection from bleaching.

CURRENT MPAS AND MANAGEMENT CAPACITY

Florida
An ecosystem-based plan to conserve, protect and manage the natural and cultural resources of the Florida Keys now prohibits oil exploration, mining, large shipping traffic, anchoring on or touching corals, and collecting coral or ‘live rock’ in the Sanctuary. The sources of pollution from outside the Sanctuary are being identified and abatement measures are being adopted. In 2002, a ‘no discharge zone’ for vessels within state waters of the Sanctuary was implemented. With the designation of 23 no-take zones in 1997 covering less than 1% of the Sanctuary, it was possible to protect 65% of shallow coral reef habitats. Three years later in 2000, densities of economically important yellowtail snapper and grouper species in these no-take areas had increased significantly compared to reefs outside, and one year later, gray snapper had also increased significantly. In comparison, average densities of non-exploited striped and stoplight parrotfish were unchanged compared to baseline data. The 518 km² Tortugas Ecological Reserve (far west Florida Keys) was implemented in 2001 increasing the amount of coral reef in no-take zones within the Sanctuary to 10%.
Biscayne National Park encompasses an additional 291 km² of the northern reef tract. The decision to declare the Park was prompted by concerns about coastal development, intense use by recreational boaters, and growing fishing pressure. Protection of Park resources includes Natural Resource Reserve areas where fish nurseries and spawning habits are protected from fishing. Wildlife management zones in the Key West and Great White Heron National Wildlife Refuges direct human activities away from the 1,610 km² of sensitive coral reef habitat.

Goliath grouper fishing was closed in Florida and Atlantic waters in 1990 and in the Gulf of Mexico in 1992. The Madison-Swanson and Steamboat Lumps Spawning Sites (off the West Florida shelf) were established in June 2000 to protect spawning aggregations of gag (*Mycteroperca microlepis*), as well as other reef and pelagic fish. There was evidence in 2003 that the stock was recovering and had a 50% chance of returning to historical levels in the core habitat of southern Florida. Similarly, signs of recovery of adult queen conch are evident after the fishery was closed in 1986.

**Flower Garden Banks National Marine Sanctuary**

The Sanctuary was designated in 1992, and Stetson Bank added in 1996. The regulations are designed to protect sensitive coral reef features by prohibiting: anchoring of vessels within the Sanctuary; mooring of any vessel longer than 30 m on a Sanctuary mooring buoy; oil and gas exploration and development within a designated no activity zone (almost the entire sanctuary); injuring or taking coral and other marine organisms; using fishing gear other than traditional hook and line; discharging or depositing any substances or materials; altering the seabed; building or abandoning any structures; and using explosives or electrical charges. The Banks were designated by the International Maritime Organization in 2001 as the world’s first international no-anchor zone, with the location and regulations listed on international charts.

**Puerto Rico**

The island Government (Department of Natural and Environmental Resources) and the Caribbean Fisheries Management Council share responsibility for managing 24 MPAs, with most sites having some year-round protection, while 3 red hind Spawning Aggregation Sites are under a temporary fishing ban from December to February. Recent legislation has strengthened coral reef management, and Puerto Rico designated Tres Palmas Marine Reserve in Rincón as a natural reserve in 2004 with funds allocated for a management plan. New State fishing regulations, compatible with USA Federal regulations were signed in 2004, and recreational use of 6 coral reef keys within 5 Natural Reserves is now regulated via an administrative order. State regulations designate 1/2 mile around Mona, Monito and Desecheo Islands as MPAs, and the red hind closed season has been extended to the entire territorial sea. Large-scale assessment of fish and benthic communities is being used to determine the size and location of other proposed MPAs, with an emphasis on protecting essential fish habitats and populations and also assessing the socioeconomic impacts of MPA designation.

**U.S. Virgin Islands**

The St. Croix East End Marine Park was designated by the USVI Legislature in 2003 as the first territorial marine park. This opened the way for the establishment of a territorial network of Marine Parks. Buck Island Reef National Monument was expanded by 7,700 ha of submerged land in 2003 with a marine park advisory committee of community stakeholders developing a management plan. A Marine Managed Area (MMA) inventory is accessible online at www.mpa.gov. The Department of Planning and Natural Resources has deployed fish aggregating devices (FADs) in territorial waters to reduce fishing on the reefs and promote a shift to
pelagic fishes. Six FADS are deployed around St. Croix, three around St. Thomas, and more are
planned. Mooring buoys have been installed to decrease damage by dive operators, recreational
fishermen and boaters on the coral reefs. More buoys are being added, especially within the
St. Croix East End Marine Park. Outside the managed areas, fishing is regulated by federal
and territorial regulations with size restrictions for whelks, conch, and lobster. The harvest of
goliath grouper and the commercial harvest of billfish are prohibited.

Navassa
In 1999, the island and a 12-mile radius of marine habitat became the 517th National Wildlife
Refuge administered by the U.S. Fish and Wildlife Service. Comprehensive conservation
planning began in 2004 with development of a 15-year management plan, which will soon
be open to the public for comment. Bi-annual marine expeditions have produced substantial
biological information, which will assist in developing the management plan.

Government Policies and Legislation

Florida
The FKNMS is a federal/state partnership between NOAA and the State of Florida Department of
Environmental Protection (FDEP). The Sanctuary implements various management programs
including: scientific research; education and outreach; damage assessment and restoration; and
mooring buoys. In 2004, a Draft Revised Management Plan was released for public comment.

FDEP, as a member of the US Coral Reef Task Force, has begun the Southeast Florida Coral
Reef Initiative, which is focused on improving coral reef conservation for the reef tracts off
southeast Florida from Miami-Dade County to Hobe Sound. The Initiative has 4 focus areas

- Land-Based Sources of Pollution;
- Fishing, Diving and Other Uses;
- Awareness and Appreciation; and
- Maritime Industry and Coastal Construction Impacts.

Water quality standards are being re-evaluated to reduce damage to reef systems e.g. the
National Pollution Discharge Elimination System regulates point sources that discharge
pollutants into State waters. Industrial, municipal and other facilities must obtain permits
to discharge directly into surface waters, and discharged storm water must meet appropriate
treatment criteria and not violate water quality standards. The program has been effective in
requiring many private small wastewater package plants to eliminate raw sewage discharges,
and all municipal treatment plants must achieve minimum levels of effluent quality to
secondary treatment level, even for ocean outfalls. Wastewater in the Florida Keys is handled
by approximately 200 treatment plants and septic tanks, however these leach nutrient-rich
water through the porous limestone into the coastal waters. The Monroe County is studying
the effects of septic tanks and will consolidate wastewater plants into regional facilities to
decrease this nutrient loading.

Fishing in state waters is managed by the Florida Fish and Wildlife Conservation Commission
(www.myFWC.com) and in federal waters by the South Atlantic (www.safmc.net/fishid) and Gulf
of Mexico Fishery Management Councils (www.gulfcouncil.org). Actions include: prohibiting
destructive or wasteful fishing gear (e.g. roller trawls, explosives, wire fish traps); requirements
to reduce bycatch death (e.g. vessel holding requirements and limits on number of short lobster used as live bait in lobster traps, escape gaps and release hatches for lobster traps); establishing minimum size and bag limits on a number of reef species landed; establishing seasonal and spatial closures for certain fishing gears (e.g. spears, power heads, lobster diving) and breeding seasons (e.g. amberjack, black grouper); limiting or restricting fishing for some species; and limiting entry to certain fisheries. Some areas in the Sanctuary restrict fishing and diving. Fisheries for Nassau grouper (*Epinephelus striatus*), goliath grouper (*E. itajara* – formerly jewfish), queen conch (*Strombus gigas*), and stony corals remain closed.

Installation of mooring buoys on highly visited reefs in Monroe, Dade, and Broward Counties is reducing chronic effects from small boat anchors. To reduce groundings, the State and the FKNMS are educating boaters about navigating in coral reef areas, and large vessel avoidance areas are marked with radar sensitive beacons installed on lighthouses between Dry Tortugas and Key Largo. Future efforts will include extending vessel avoidance zones, prohibiting the use of the Port Everglades anchorage when the wind speed exceeds 25 knots, and enhancing management of the Port Everglades anchorage.

**Flower Garden Banks National Marine Sanctuary**

Regulations governing the Sanctuary under the National Marine Sanctuaries Act (16 U.S.C. 1431), including the International Maritime Organization designated no-anchor zone, 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](http://www.sanctuaries.nos.noaa.gov/oms/pdfs/FlowerGardensRegs.pdf).

**Puerto Rico**

In an effort to convert a collapsing fishery into a sustainable one, the Government of Puerto Rico has enacted new fishing regulations that: require recreational fishing licences; prohibit recreational spearfishing with scuba; will eliminate beach seine nets within 3 years; establish size limits and daily quotas on several species; require species-specific permits for high-value and sensitive species (i.e. spiny lobsters, queen conch and land crabs); and create MPAs around Mona and Monito Islands, Desecheo Island and the Condado lagoon. Compatibility with USA federal fisheries management measures has largely been achieved. Puerto Rico is developing a Local Action Strategy to address land-based pollution by reducing urban sprawl, concentrating industrial development, and developing agricultural practices to protect soils and avoid erosion into waterways. 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 USEPA in 2000.

**U.S. Virgin Islands**

The U.S. Departments of the Interior and Commerce, and the Virgin Islands Territorial Government have overlapping jurisdiction over the submerged lands within the USVI. These agencies supervise research and monitoring to assist management of the coral reefs. They employ a variety of management tools to reduce the effects of fishing, recreational use, and land-based sources of pollution.

**Navassa**

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

Florida
A comprehensive coastal water quality monitoring program is needed for southeast Florida, especially as extensive macro-algal blooms have recently covered the adjacent reefs. Research on the response of reef communities to changing water quality is also required. Reef monitoring in southeastern Florida is limited by a lack of comprehensive information about marine communities, and effective baseline assessments are needed for all monitoring sites in the region. These should include a functional classification of all reef habitats, and instigation of regular monitoring on the Florida Middle Grounds. All data collected should be consistent with state, national, and international programs, and should be rapidly disseminated to the public. Reef fish monitoring should be expanded to detect cryptic species, and fish below 30 m which are poorly characterised, but are exploited by recreational fishers. Likewise, data are needed on the reef fish communities in seagrass and mangrove habitats of Port Everglades and coastal waterways, as these have high potential to be nursery grounds, but are subjected to high levels of human activity. Only 50% of Florida’s coral reef and associated habitats have been mapped, therefore it is difficult to determine which areas should be considered for protection by no-take provisions. Major mapping gaps include the reefs on the southeast coast, the Middle Grounds banks and deeper regions of the Tortugas.

Flower Garden Banks National Marine Sanctuary
These Banks are approximately 100 miles from shore, which hampers research and enforcement. Thus, the Sanctuary lacks on-site enforcement, observation and management of human activities. A remote camera/radar system may provide the answer to this management need. The Banks may serve as important spawning areas for several grouper species with the larvae probably traveling to other reefs and banks in the northwestern Gulf of Mexico and further afield, although data on larval flow in and out of the system are limited. An example of this unique system has been the discovery of an endemic wrasse on the Banks and nearby reefs. These highlight the importance of protecting the biodiversity and confirming the size and extent of spawning observations. Research is needed on effects of the expansion of oil and gas activities on water quality around the coral reefs. Currently the management authorities are unable to determine the carrying capacity of recreational divers and fishers on the Banks. To date, data from long-term monitoring of nearby Stetson Bank have not been analysed. Oceanographic data buoys are located in the proximity of the Sanctuary, but no analysis has been conducted on the archived data.

Puerto Rico
New research and monitoring programs in Puerto Rico are filling gaps and providing information to managers on status and trends of the coral reefs. The 5-year Coral Reef Ecosystem Study by researchers at the University of Puerto Rico and NOAA commenced in 2002 to investigate natural and human stresses and processes, socioeconomic factors, and the use of MPAs in management planning. The study aims to integrate all data into a unified GIS visualization tool to help managers predict the outcomes of management actions.

U.S. Virgin Islands
A lack of adequate staffing in State and Federal agencies limits the enforcement of existing rules and regulations and should be addressed before considering additional or stricter regulations. Management agencies lack information on the impacts of resource use, e.g. recreational fishers do not obtain fishing permits so there is no record of their activities.
Another complication is that ‘recreational fishing’ is used to describe all non-commercial fishing including occasional and frequent fishers, subsistence-level and ‘commercial’ fishers. Some of these unlicenced fishers sell their catch, although it is illegal; thus they are probably responsible for a substantial impact on coral reef fish resources. Another problem, which often results from similar capacity needs, is a gap between research and management. Data have not been analysed such that the effectiveness of MPAs cannot be evaluated. Research is often donor driven because of inadequate funding, whereas it should address territory issues and support innovative management. Management plans are needed for all designated Areas of Particular Concern, because at the moment these exist only on paper and are used to support coastal development decisions.

**Navassa**
The Island is remote and highly susceptible to episodic disturbance or recruitment events. The current information consists of a series of ‘snapshots’ of reef condition, and cannot be used to draw conclusions about possible trends in reef condition or used to develop management plans. Recent depletion of large fish around the island indicates major information gaps on catch statistics and fishing effort.

**CONCLUSIONS**

**Florida**
Citizens, stakeholders, elected officials, and resource managers must work together to improve water quality, minimise physical damage to corals and seagrasses, reduce non-point pollution, and raise awareness to introduce a stronger sense of stewardship for coral reef conservation. Immediate action is needed to curtail alarming declines in coral reef condition throughout Florida. Local communities, which are culturally and economically supported by the reefs are working to implement management strategies and focus attention on the need for more reef protection. They aim to control adverse human pressures such as the environmental impacts of fisheries, dredging, vessel anchorages, freshwater management, and nutrient flows into southeastern Florida. Communities in the Florida Keys are continuing to seek solutions to reduce wastewater and stormwater problems, and limit habitat degradation and over-fishing.

**Flower Garden Banks National Marine Sanctuary**
While long-term monitoring shows that the Banks are virtually pristine, these coral reefs are potentially susceptible to the same decline as other systems. It is therefore crucial that the resources be maintained as standards of coral reef health for the Caribbean, where there is almost universal decline. The reefs of the Sanctuary may contain the parent stock to assist recovery in other areas through the transfer of juvenile fishes, e.g. recent data indicate that the Banks may be major sources of grouper larvae for other reefs, highlighting the benefits of no-take status in protecting biodiversity.

**Puerto Rico**
Many of the nearshore reefs are degraded from decades of accelerated urban and industrial coastal development, and poor implementation of policies, which are designed to protect them. Scientists and the Government continue to try to understand, protect, and manage the reefs, but the failure of existing regulations and the lack of enforcement continue to undermine these efforts. Unfortunately, full compliance with existing regulations may not be sufficient to reverse the decline in fisheries stocks, but recent legislation may help. The Tres Palmas Marine Reserve in Rincón was designated in 2004. New State fishing regulations and an administrative
order regulating recreational use in 6 coral reef keys within 5 Natural Reserves were all approved, and new coral reef regulations are nearing completion. A strategy to address land-based pollution is being developed.

**U.S. Virgin Islands**
The importance of MPAs has been recognized and the Buck Island Reef National Monument in St. Croix was expanded in 2003 and the St. Croix East End Marine Park was established. However, a lack of enforcement may undermine their effectiveness. Management plans are still required for some designated Areas of Particular Concern, and existing plans need to be implemented. However, a Nassau grouper spawning population is re-establishing itself and the biomass of spawning red hind at the Marine Conservation District south of St Thomas is increasing. Continued coral reef ecosystem monitoring is recommended to track changes in reef health, biodiversity, and coral disease. Management could be improved with stronger coordination and collaboration among Federal, Territorial, and non-governmental agencies, increased public education and outreach, and enforcement of existing marine protected areas and laws governing resource extraction. An increased research and analytical capacity in management agencies is also needed. Efforts to reduce threats to coral reefs should focus on reducing land-based sources of pollution from coastal development and runoff, the effects of fishing and ship groundings, and improving or maintaining water quality in densely populated areas.

**Navassa**
Declining coral reef habitat conditions throughout the Caribbean underscore the conservation importance of this National Wildlife Refuge’s 290,000 acres of marine habitat in the heart of the Caribbean. Multinational fishing pressure within this largely marine refuge remains unquantified, but it is certainly damaging the coral reefs. Systematic monitoring, including quantitative fishery data, is needed to document ongoing changes. Monitoring should also include catch data of the critically endangered Hawksbill turtles. This will require a regular source of funding for the Navassa National Wildlife Refuge.

The ‘island biogeographic theory’ predicts that small isolated islands like Navassa will have reduced species diversity in the future. This is clearly born out in the fish populations, as there is not enough habitat variation to contain all the common Caribbean fish groups. Now strong fishing pressures are clearly damaging the Navassa reefs, such that there is a real chance for population crashes because the island is small and subject to high physical disturbance, and the reefs around Navassa are poorly buffered.

**100 Years ago:** The major pressures on coral reef ecosystems were tropical storms, and cyclone damage was a primary factor in shaping coral reef structure. Anecdotal reports were of flourishing reefs with high coral cover and large populations of fishes. The coral reefs were probably dominated by apex-predators. Subsistence fishing was generally small-scale and was managed by traditional tribal regulations.

**In 1994:** Coral reefs in close proximity to large human populations showed clear signs of damage from sediment runoff, nutrient pollution, over-fishing, and coastal development. Many fisheries in the region: were experiencing declines in the average size of fish; were under pressure from an increase in fishing effort with no significant increase in landings; and showed that pre-spawning juveniles made up most of the catch. In some cases, the combined impacts of over-fishing and nutrient pollution resulted in a phase shift from coral to algal dominated
systems. Concern was growing about coral bleaching and disease, and coral reef management was becoming stronger.

**In 2004:** The cumulative impacts of sedimentation, coastal development, commercial and recreational fisheries, land-based pollution, ship groundings, and recreational activities are apparent on many reefs. Warmer temperatures have increased coral and fish vulnerability to diseases; this is further exacerbated by man-made pollutants that nourish bacteria and fungi running off the land into the sea. Many reef ecosystems adjacent to population centres are declining towards fair and poor categories, with recorded decreases in coral cover, fish abundance, and resilience to natural disturbances. However, reefs in isolated areas, like the Flower Garden Banks and Dry Tortugas remain in good to excellent condition.

**Predictions for 2014:** Improved research and monitoring capacity should translate to informed coastal stewardship decisions that minimize damage to coral reef ecosystems, while maximizing social and economic benefits. Better enforcement of existing fishing, pollution, and MPA regulations should slow the downward trend in reef condition. Management efforts will continue to focus on improving water quality and reducing fishing pressure. Reef conditions should stabilize or slightly improve, but climate change and the associated increases in the incidence and severity of diseases and bleaching may restrict recovery in susceptible areas.

**AUTHORS AND KEY RESOURCE MATERIAL**


Fishbase (http://www.fishbase.org)


ReefBase (http://www.reefbase.org)


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 636,411 ha and the environment is characterised 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:** The National Oceanic and Atmospheric Administration (NOAA) conducts 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. 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.

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

**Contact:** Richard Ring, Everglades National Park, 40001 State Road 9336, 33034 Homestead, Florida, USA (Phone: 1-305-242-7700, Email: dick_ring@nps.gov).

Coral reefs are 30% of the natural resources.
**Ecological Monitoring** is substantial.
**Socio-economic Monitoring** is substantial.
VIRGIN ISLANDS, USA – MAN AND THE BIOSPHERE RESERVE

The U.S. Virgin Islands (USVI) is a group of 3 islands, St. Thomas, St. John, and St. Croix, in the Eastern Caribbean. The Virgin Islands National Park includes 3 individual areas, whereas the Biosphere Reserve, established in 1976, incorporates the entire area, including rocky shores, coral and sand beaches, numerous bays, fringing coral reefs, canyons of coral ledges, coral gardens, mangrove swamps and natural salt ponds. About 900,000 visitors per year visit the area for diving and snorkeling, boating, fishing, and hiking. The Cruz Bay Visitor Centre provides orientation talks, guided snorkel trips and cultural demonstrations. The islands now face serious environmental problems from increasing tourism and residential development, including destruction of wildlife habitats, reef destruction, commercial fishing activities, land erosion and related sedimentation on coral reefs. The aim of the biosphere reserve is to protect natural systems while enhancing the quality of life for the local community.

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. 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. 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.

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 cooperation with other local institutions and agencies, the Virgin Islands Resource Management Co-operative (VIRMC) has completed a variety of studies within the reserve including characterization of local fisheries, analysis of the cultural role of fishing, mapping of nearshore marine communities, as well as descriptions of the bays.

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

Contact: Russell W. Berry Jr., Virgin Islands National Park, 1300 Cruz Bay Creek, 00830 St. John, VI, USA (Phone: 1-340-776-6201, Email: Russ_Berry@nps.gov, Website: www.nps.gov/viis/)

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