

ABOUT THIS DOCUMENT

This report is the third in an ongoing series of assessments of the condition of coral reef ecosystems in the United States and Pacific Freely Associated states, and the second report to focus specifically on summarizing the results of coral reef ecosystem monitoring activities carried out by federal, state, territorial, commonwealth, private, academic, and non-governmental partners (Figure A). The chapter authors, who are scientists and managers directly involved in local efforts to conserve and monitor coral reef ecosystems, present data describing the status of water quality, benthic habitats, and the coral reef-associated biological communities and evaluate the impacts of thirteen major threats to coral reefs identified in the *National Coral Reef Action Strategy* (NOAA, 2002). The authors then briefly summarize the current conservation management activities being implemented in the 15 jurisdictions and provide conclusions and recommendations for future action. This edition of the report also contains a chapter describing some of the many National Level Activities that contribute to coral reef conservation and a National Summary chapter that is based on a questionnaire completed by the local report coordinators and/or writing team members.

Much of the work presented in this document has been funded by NOAA's Coral Reef Conservation Program (CRCP). More information about CRCP activities is available at <http://www.coralreef.noaa.gov/>. CRCP support complements funding from many of the other federal, state, territorial, commonwealth, and non-governmental partners who participated in this effort. Thus this report has been made possible through the collective efforts of many organizations.

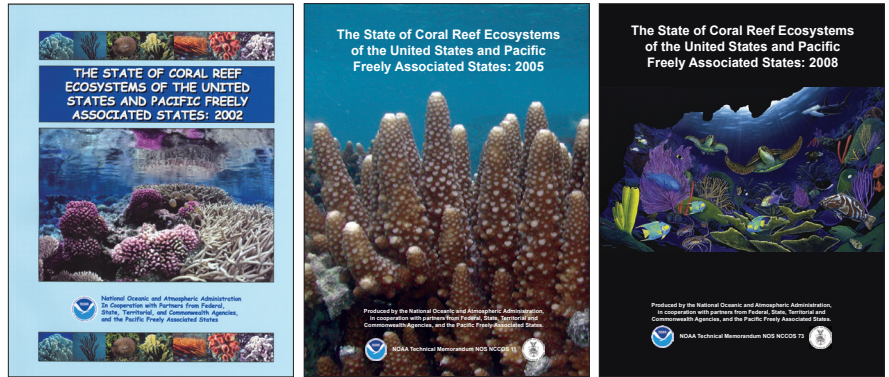


Figure A. Previous reports in this series were published in 2002 (left; Turgeon et al., 2002) and 2005 (center; Waddell, J.E., ed. 2005). The 2005 report and the 2008 report (right; Waddell and Clarke, eds. 2008) rely heavily on quantitative data from coral reef ecosystem monitoring programs.

INTRODUCTION

In the past decade, increased awareness regarding the declining condition of U.S. coral reefs has prompted various actions by governmental and non-governmental organizations. Presidential Executive Order 13089 created the U.S. Coral Reef Task Force (USCRTF) in 1998 to coordinate federal and state/territorial activities (Clinton, 1998), and the Coral Reef Conservation Act of 2000 provided Congressional funding for activities to conserve these important ecosystems, including mapping, monitoring and assessment projects carried out through the support of NOAA's CRCP. Numerous collaborations forged among federal agencies and state, local, non-governmental, academic and private partners now support a variety of monitoring activities. This report shares the results of many of these monitoring activities, relying heavily on quantitative, spatially-explicit data that has been collected in the recent past and comparisons with historical data where possible. The success of this effort can be attributed to the dedication of over 270 report contributors who comprised the expert writing teams in the jurisdictions and contributed to the National Level Activities and National Summary chapters. The scope and content of this report are the result of their dedication to this considerable collaborative effort.

Ultimately, the goal of this report is to answer the difficult but vital question: what is the condition of U.S. coral reef ecosystems? The report attempts to base a response on the best available science emerging from coral reef ecosystem monitoring programs in 15 jurisdictions across the country. However, few monitoring programs have been in place for longer than a decade, and many have been initiated only within the past two to five years. A few jurisdictions are just beginning to implement monitoring programs and face challenges stemming from a lack of basic habitat maps and other ecosystem data in addition to adequate training, capacity building, and technical support. There is also a general paucity of historical data describing the condition of ecosystem resources before major human impacts occurred, which limits any attempt to present the current conditions within an historical context and contributes to the phenomenon of shifting baselines (Jackson, 1997; Jackson et al., 2001; Pandolfi et al., 2005).

This report was intended to catalog existing coral reef ecosystem monitoring programs and link scientists and managers involved in coral reef conservation to additional data products, some of which have not been published before. Summarized data are presented in map, tabular and graph formats, and many of the graph figures utilize dual axes. Metadata resources for projects funded by NOAA can be accessed via the Coral Reef Information System (CoRIS; <http://www.coris.noaa.gov/>). Map products, imagery and other information can be obtained via Internet URLs that appear in the text and references for each chapter. The validity of all of the Internet links in the document were verified in April 2008.

JURISDICTIONAL CHAPTERS

The scope of this report encompasses 15 jurisdictions across the U.S. and Pacific Freely Associated States. From east to west, the six Atlantic/ Caribbean/ Gulf of Mexico jurisdictions are the U.S. Virgin Islands (USVI); Puerto Rico; Navassa Island; Southeast Florida; the Florida Keys; and the Flower Garden Banks National Marine Sanctuary and other banks of the northwestern Gulf of Mexico (FGB; Figure B). In the Pacific, the nine jurisdictions are the Main Hawaiian Islands (MHI); Northwestern Hawaiian Islands (NWHI); American Samoa; Pacific Remote Island Areas (PRIA); Republic of the Marshall Islands (RMI); Federated States of Micronesia (FSM), Commonwealth of the Northern Mariana Islands (CNMI); Guam; and the Republic of Palau. Palau, FSM and RMI are former U.S. territories that gained independence but maintain compacts of free association with the U.S.; together they comprise the Freely Associated States (FAS).

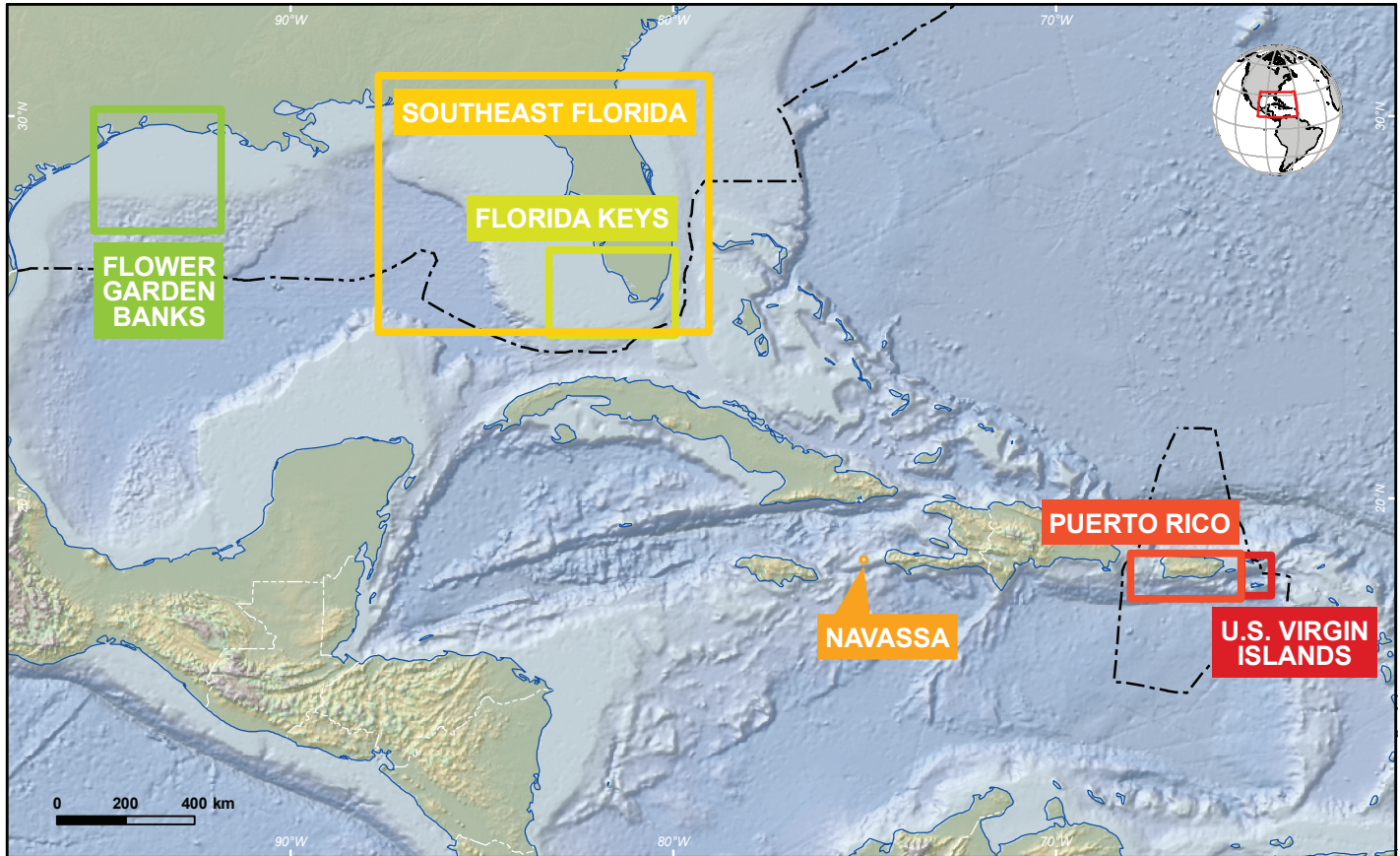


Figure B. Six U.S. jurisdictions containing coral reefs are located in the Atlantic/ Caribbean/ Gulf of Mexico region. Map: K. Buja.

The jurisdictions are based on political boundaries and vary in size from Navassa, with an area of 3 km², to southern Florida, which includes part of the west Florida shelf and encompasses 30,801 km² of shallow water habitats (both figures represent the estimated marine area encompassed by the 10-fathom (18 m) depth contour; Rohmann et al., 2005). Each of the 15 jurisdictions contains a unique mosaic of habitats and marine species, and these differences fundamentally affect the way monitoring is conducted as well as the analytical results obtained.

Ten of the 15 jurisdictions included in this report receive annual support from CRCP under the National Coral Reef Ecosystem Monitoring Program (NCREMP), which provides funding to local jurisdictional agencies to enable them to conduct long-term coral reef ecosystem monitoring activities. Navassa Island, the Florida Keys, FGB, NWHI, and the PRIA have not received funding through NCREMP to date. RMI and FSM have only recently joined the program and are conducting initial characterization work that will support the design and implementation of comprehensive monitoring programs.

To develop the chapters in this report, each jurisdiction was asked to designate a report coordinator who led the writing team in their efforts, edited contributions and served as a primary point of contact for the report's primary editors. Each writing team was provided with a basic chapter outline and a length limit, but the contents of each chapter were largely left to the writing team's discretion. As in the 2005 report, jurisdictional chapters were structured to: 1) describe how each of the primary threats identified in the National Coral Reef Action Strategy (NCRAS) has manifested in the jurisdiction; 2) introduce ongoing monitoring and assessment activities relative to three major categories of inquiry—water quality, benthic habitats, and associated biological communities—and provide summary results in a data-rich format; 3) highlight recent management activities that promote conservation of coral reef ecosystems; and 4) provide conclusions and recommendations for future action.

The resulting chapters contain information about coral reef ecosystem resources relative to a variety of subjects and monitoring activities that have been undertaken to document their condition. A few highlights from each region are pro-

vided below along with results from the National Summary chapter. In general, results from the chapters and the National Summary indicate that coral reef condition is declining in many locations while threats to them are increasing. Coral reef ecosystems in the U.S. and FAS continue to be beset by a number of serious threats stemming from natural and anthropogenic factors, which stress and degrade the living marine resources inhabiting coral reef ecosystems in addition to the corals themselves.

Results from Atlantic/ Caribbean/ Gulf of Mexico Jurisdiction Chapters

The summer and fall of 2005 was one of the most active hurricane seasons recorded in the region. At the Flower Garden Banks, 192 km (120 mi) from the coast of Texas, passage of Hurricanes Katrina and Rita toppled coral colonies, leveled thickets of branching corals, and scoured channels in habitats deeper than 17 m (55 ft). In southern Florida, Hurricanes Dennis, Katrina, Rita, Ernesto, and especially Wilma caused extensive physical damage to reefs and associated ecosystems and caused the loss of approximately 300,000 lobster traps (Clark, 2006). Ironically, these storms are also credited with churning up the water column and bringing cooler waters to the surface, which reduced sea surface temperatures and buffered the effect of the massive regional coral bleaching event that affected virtually the entire Caribbean basin in the late summer and fall of 2005. Including mortality associated with the coral disease epidemic that followed the bleaching event, coral scientists in USVI and Puerto Rico recorded on average a 50% decline in live coral cover and in places up to 90% mortality of coral colonies at monitoring sites (Miller et al., 2006; García-Sais et al., 2006; Woody et al., 2008).

Few reefs in the U.S. Caribbean and Atlantic currently have a percentage of mean live hard coral cover greater than 10%, but they were once structurally complex reefs dominated by vast stands of branching corals in the genus *Acropora*. In 2005, NOAA's National Marine Fisheries Service released the Atlantic *Acropora* Status Review, which showed data collected since the 1970s indicating that acroporid corals had experienced population declines of $\geq 90\%$ at sites across the region (Atlantic *Acropora* Review Team, 2005). Further work determined that the fates of these important reef-building species were severe enough to warrant a 'threatened' listing under the U.S. Endangered Species Act, which occurred in 2006. Protections for two species, *Acropora palmata* and *A. cervicornis*, under the act are being formulated and may affect future federal, state, territorial, commonwealth and local activities in the region.

Monitoring of Navassa Island's coral reef ecosystems indicated that a significant coral disease event occurred in 2004 following the passage of Hurricanes Charlie and Ivan. Overall hard coral cover declined in Navassa between 2002 and 2006, and in 2006, none of the sites sampled as part of two monitoring studies had a percent live coral cover $> 10\%$. In the Florida Keys, data collected at 43 sites throughout the Florida Keys National Marine Sanctuary (FKNMS) by the Fish and Wildlife Research Institute indicate that both percent live coral cover and coral species richness declined between 1996 and 2006 in all habitat types surveyed, with the greatest declines recorded in deep, offshore reefs (CREMP, unpub. data). Until recently, many believed that coral reefs in deeper waters were less subject to anthropogenic threats than shallow-water reefs near shore, and that deeper reefs would serve as refugia for stressed coral species (Menza et al., 2007). In Broward County, Florida, four years of monitoring data revealed little change in coral species richness; percent live stony coral cover in southeast Florida generally ranges from 0.5% to 2.5% (SECREMP, unpub. data; Gilliam, 2007). Sedimentation of nearshore reefs in the USVI is nearly 50 times greater than at reefs offshore (Blondeau, unpub. data).

Populations of harvested reef fishes in Florida and the U.S. Caribbean are largely depleted. Only 3% of snappers and groupers observed on 2,401 transects in the USVI (St. John and St. Croix) surveyed by NOAA between 2001 and 2007 were equal to or longer than 35 cm (Pittman et al., in press; http://www8.nos.noaa.gov/biogeopublic/query_main.aspx). Only 2 of the 242 groupers seen during four years of surveys ($n=667$) in Broward County, Florida were larger than the minimum legal size (Ferro et al., 2005). In the Florida Keys, 25 of 34 species in the commercially-important snapper-grouper complex for which sufficient data were available were considered 'overfished' according to federal standards (Ault et al., 2005). The number of recreational fishers in southeast Florida increased between 1996 and 2006, as evidenced by the 41,000 additional recreational vessels registered in this period and the 25% increase in the purchases of saltwater fishing licenses (FWC, unpub. data; McDevitt, pers. comm.). By 2000, recreational fishing accounted for over 75% of total finfish landings. At Navassa Island, reef fish biomass declined between 2002 and 2006, particularly among piscivores, herbivores, and planktivores (Miller et al., 2007; McClellan et al., unpub. data). Mean sizes of fish decreased for several important fish families as well, which is thought to be largely a result of unregulated fishing by migrant Haitian artisanal fishers who travel over 30 miles in small open boats to fish at Navassa (Miller et al., 2004). A sociocultural characterization of the Haitian fishing communities was recently completed to illuminate fishing patterns and motivations behind such usage (Wiener, 2005; Miller et al., 2007).

In July 2006, the USVI government banned gill net fishing, a technique that indiscriminately catches fish of all types and size, invertebrates, turtles and birds and was virtually never used in the USVI before the 1990s. Protection of several important fish spawning aggregation (SPAG) sites through the establishment of Marine Conservation Districts (MCD) covering 45 km² of USVI federal waters has helped increase the abundance and size of some commercially important snappers and groupers in nearby St. Thomas, but large snappers and groupers are rarely observed in St. Croix (Toller, 2002). The Caribbean Fishery Management Council, which implemented an emergency closure of one SPAG in 2004 after the yellowfin grouper aggregation there was heavily exploited, continues to support mapping and monitoring efforts at MCD sites in the U.S. Caribbean. Meanwhile, in the Dry Tortugas region of the Florida Keys, state and federal agencies established a no-take Research Natural Area in early 2007 within Dry Tortugas National Park. This action increases the extent of no-take areas in the FKNMS and complements the nearby Tortugas Ecological Reserve, which was established in 2001.

Results from Pacific Jurisdiction Chapters

In the Pacific region, nine chapters of this report document the impact of threats and condition of coral reef ecosystems (Figure C). Pacific coral reef ecosystems appear to be less affected by threats and are generally in better condition than reef ecosystems in the Atlantic/ Caribbean/ Gulf of Mexico region. Many of the Pacific jurisdictions extend over large areas of ocean, encompassing islands and reefs that are either too remote or too inhospitable to support human settlements. As a result, coral reef ecosystems are in relatively good condition in several Pacific jurisdictions, in particular the NWHI, PRIA, RMI, FSM and Palau, where live coral cover can exceed 70%.

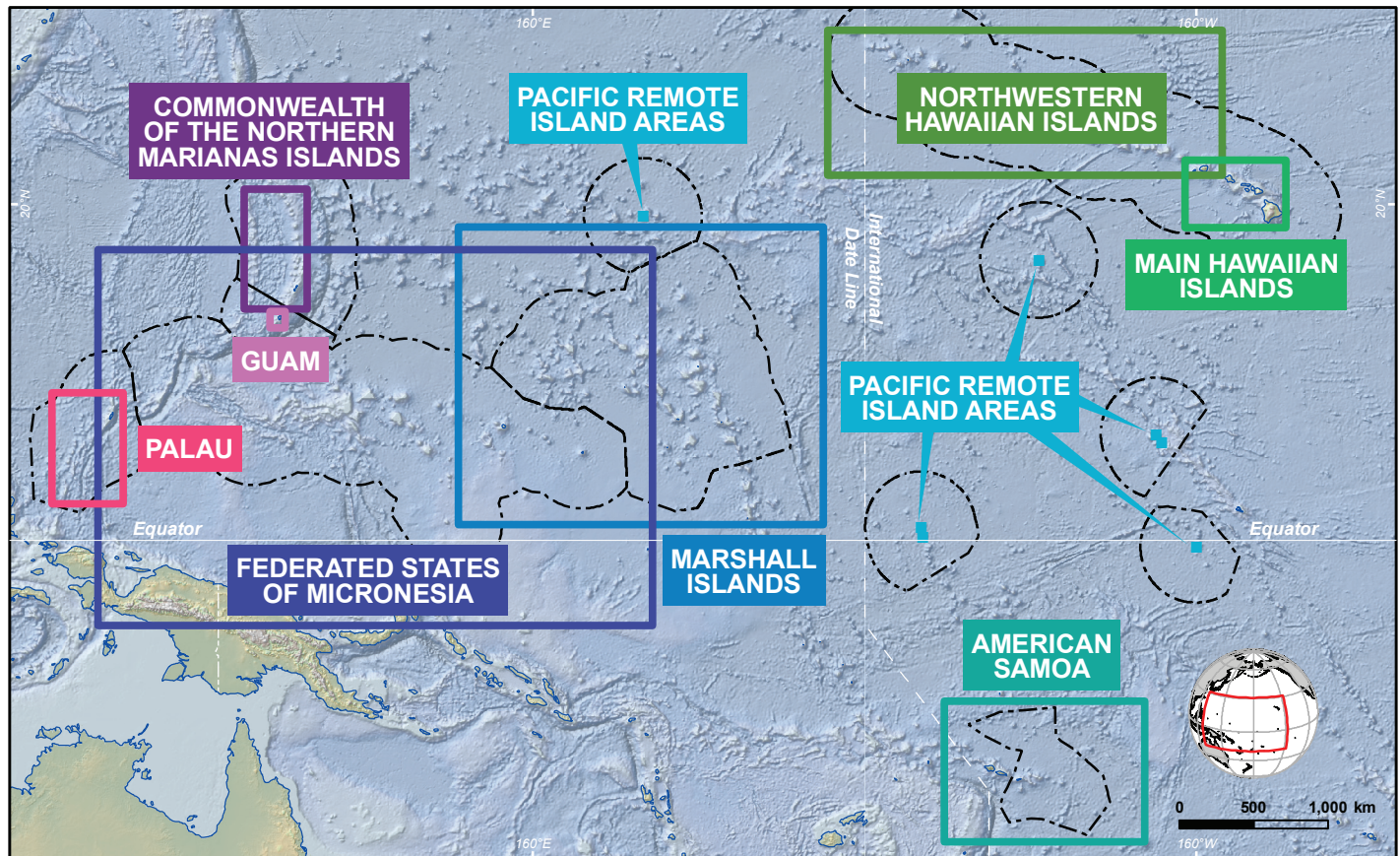


Figure C. Six U.S. jurisdictions containing coral reefs and the three Pacific Freely Associated States (the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau) are located in the Pacific region. Map: K. Buja.

Water quality across the region was generally good to excellent, except in localized areas with reduced flushing such as harbors and semi-enclosed bays. Sewage and stormwater runoff events affected nearshore water quality in Oahu in 2006 and resulted in beach closures and posting of raw sewage advisories along 15.19 mi of beaches (HIDOH, 2007); brown water advisories that warn the public of the danger of stormwater discharges to Hawaii's coastal waters affected nearly 300 total beach miles in 2006 (HIDOH, 2007). Of the 83 water quality monitoring sites surveyed in Saipan, Tinian and Rota (CNMI) in 2006, over 37% were classified as impaired due to excess nutrient and bacteria levels (Houk, 2006). Unfortunately, funding for the CNMI nonpoint source pollution control program was eliminated in 2007. Data from populated areas of the RMI indicate that coral reefs near sewage outfalls and dump sites are prone to overgrowth by a black encrusting algae that can cover 30% of the substrate (D. Jacobson, pers. obs). More data about the oceanographic conditions and environmental variables that influence species distributions is available for U.S. Pacific Islands.

As in the Caribbean, coral reefs adjacent to heavily populated islands are often subject to more intense effects of stressors such as pollution, sedimentation, fishing, tourism, recreational use, and marine debris. Despite this, data from 1,682 independent transects conducted at hardbottom sites by four local monitoring programs across the MHI reported average live coral cover of 19.9%. A 2007 taxonomic expedition to French Frigate Shoals (NWHI) by the Census of Marine Life documented a number of previously unreported coral species and the possible discovery of several reef species that may be new to science. Additional range extensions and new species were observed as part of monitoring activities in the PRIA, RMI, FSM, and American Samoa. Surveys of remote atolls in the RMI documented some areas with live coral cover of 78.5%. Coral recruitment, however, has fallen to very low levels in parts of the Pacific, suggesting a decrease in the ability of corals to recover from disturbance and replenish existing populations through sexual reproduction.

Corals living in shallow back reef pools in American Samoa have begun to bleach annually, but with little resulting mortality. The corals' apparent resistance to bleaching is being investigated. Sedimentation studies in Palau, American Samoa, CNMI, and Guam document inputs and track impacts of sediment pulses on nearby reefs. In American Samoa, sites near river mouths averaged about 60 times more sediment than sites near points. In Guam and CNMI, corals suffered disturbances from crown-of-thorns sea stars, which eat live corals, and bleaching events, particularly in early fall of 2006

and 2007. Data from local long-term monitoring sites in CNMI indicate significant reductions in the cover of live coral and coralline algae and concomitant increases in the cover of turf algae (CNMI MMT, unpub. data). Coral disease increased between 2002 and 2005 in CNMI and was found to be more abundant at sites with high levels of scuba diving activity (Gochfeld, pers. obs). Studies of disease prevalence on Guam recorded values > 10% at three of 10 reefs surveyed for disease. Sedimentation is a major factor influencing the condition of nearshore habitats in Guam and is exacerbated by erosion caused by wildfires that are intentionally set by hunters.

Reef fish populations in the NWHI continue to be dominated by medium (> 25 cm) and large (> 50 cm) fish, and are similar to fish communities in many of the PRIA and remote parts of CNMI. However, comparable regional monitoring data indicate that reef fish populations adjacent to populated areas such as the main Hawaiian Islands, Guam, and parts of CNMI and American Samoa tend to have lower total fish biomass and smaller fish than sparsely-inhabited or uninhabited areas (PIFSC-CRED, unpub. data). Information on recreational landings is scarce since catch reports are not required in many Pacific jurisdictions, but recreational fishing is believed to be quite high based on creel surveys, market surveys, and other interviews of residents and fishers. In 2007, the Governor of American Samoa announced protection from fishing for 10 species of sharks and large fish, all of which had become sufficiently rare to prompt such an action. Large numbers of shark fins, allegedly harvested as tuna bycatch, continue to be exported from the Marshall Islands, which likely contributes to the decrease in shark observations in areas where they had previously been abundant. Populations of bumphead parrotfish and Napoleon wrasse, which are both targets of the live food fish trade, have declined in many places but are still present in a few remote parts of the PRIA, RMI, and FSM.

Aquatic invasive species have become major management challenges, particularly for islands that are shipping industry hubs. In the main Hawaiian Islands, where at least 287 non-native or cryptogenic species have been intentionally or unintentionally introduced, concerted efforts made by state agencies and local NGOs to remove invasive algae have met with limited long-term success but have raised public awareness of the problem. The NWHI contains far fewer introduced species, and efforts there are focused on preventing the spread of existing species and the establishment of additional non-native species. Crown-of-thorns sea stars (*Acanthaster planci*) are present in all nine Pacific jurisdictions in varying densities, and significant damage to coral communities has been documented in locations that experience periodic population increases.

NOAA's Abandoned Vessel Inventory lists over 130 abandoned vessels in Guam and 42 in the CNMI and has prioritized them for removal based on ecological and navigational considerations. Efforts to remove several of these rusting vessels and their associated debris have been undertaken in American Samoa (9 vessels) and CNMI (3 vessels) in the past few years; other removals are planned. A ship carrying 300,000 tons of cement grounded on a reef near Oahu in 2005.

Major conservation actions that have been taken in the past few years are likely to help protect some coral reef ecosystem resources in the Pacific region. For example, June 2006 marked the establishment of the Papahānaumokuākea Marine National Monument, which protects more than 140,000 mi² (362,600 km²) in the central north Pacific surrounding the NWHI. Studies of marine protected areas in the MHI, Guam, and CNMI continue to demonstrate the value of MPAs in protecting fish biomass; in studies of pairs of protected and unprotected sites in the MHI, protected areas were found to contain up to eight times the biomass of unprotected areas (Friedlander et al., 2007).

In the Pacific Freely Associated States, the events of the past three years indicate an increase in momentum for building local management capacity and developing comprehensive coral reef monitoring programs. Additional monitoring activities and the data they yield will help support the development and implementation of the Micronesia Challenge. Approved by chief executives from Guam, CNMI, FSM, RMI, and Palau, the challenge sets ambitious conservation goals by calling for effective conservation of 30% of nearshore marine resources and 20% of terrestrial resources across Micronesia by 2020. Reef monitoring experts in Palau are helping train local agency personnel and provide technical assistance to the RMI and FSM. The expansion of grant funding available for monitoring in Micronesia provided through NOAA's National Coral Reef Ecosystem Monitoring Program will augment the initial characterization and monitoring efforts conducted to date, largely through the support of NGO partners and private foundations.

In Kosrae (FSM), a recent study of fish markets revealed that 70% of the fish for sale are immature and thus have never reproduced. Monitoring activities related to fish spawning aggregations, MPAs, and benthic community composition in Pohnpei are beginning to produce results, and a sedimentation study is documenting terrestrial inputs to nearshore systems which have increased due to changes in agricultural land use patterns in upland watersheds. Surveys in Kosrae in 2006 suggested that some economically and ecologically important species of fish that were recorded in 1986 surveys were no longer present. In Yap (FSM), where all reefs are privately owned within a complex system of marine tenure, recent ecological assessments are providing data that can be used in conjunction with traditional ecological knowledge to support management practices implemented by Yap's council of chiefs, government agencies, and local landowners.

In Palau, the completion of the compact road encircling the island of Babeldaob has encouraged many Palauans to return to Babeldaob and begin clearing forests, developing private land and constructing access roads, often without necessary permits or protective measures. These actions have resulted in increased sedimentation and smothering of nearshore reefs. Elsewhere in Palau, data from reef monitoring sites suggest that between 2002-2005 coral cover increased at shallow (3 m) reefs and increased even more at deeper (10 m) reefs, with an overall increase of 2.9% at long-term sites. Fish abundance also increased over this period, particularly at exposed sites on the western barrier reef.

NATIONAL SUMMARY

Because no standard monitoring methods are used throughout all fifteen jurisdictions, data values could not be compared across jurisdictions in a National Summary format. Only data collection efforts that employ consistent methods across multiple jurisdictions at similar spatial and temporal scales will allow for the comparison of actual data values.

Instead, the contents of the National Summary chapter of this report are based on the knowledge and opinions of coastal managers and scientists who are responsible for monitoring and managing coral reef ecosystems in each jurisdiction. Opinions were collected using a survey that was completed by each chapter's report coordinator and/or writing team. The survey consisted of a multiple-choice questionnaire that allowed respondents to choose from a set of responses to evaluate the present condition, short-term trend, long-term trend and ability to monitor four key resources and ten threats (Table A). The four key resources were chosen for inclusion based on their relevance to overall ecosystem health. The ten threats were selected based on their importance and relevance across all jurisdictions. Together these 14 metrics offer a robust, standardized data set to compare coral reef ecosystem condition and trends. The questionnaire also included two questions about conservation management capacity and benthic habitat mapping in order to provide an initial self-evaluation of the ability of jurisdictions to implement conservation actions and use the available mapping products for research and conservation purposes.

The results of the survey corroborate the data and information included in jurisdictional chapters and reveal that:

- The majority of key resources in the Caribbean/Atlantic/Gulf of Mexico region were reported to be in poor or fair condition. Only 6 of the 24 responses (25%) reported conditions were good (4) or excellent (2).
- Of the six jurisdictions in the Caribbean/Atlantic/Gulf of Mexico region, the most remote jurisdiction, the Flower Garden Banks, had the fewest high threats (1), and all four key resources were reported to be in good or excellent condition.
- In the Pacific, the majority (69%) of key resources (for which condition was known) were reported to be in good (16) or excellent (8) condition.
- Harvested reef fish and macroinvertebrates was the only key resource to be classified by the majority of Pacific jurisdictions as fair and the only key resource to be reported in poor condition (MHI).
- In terms of ability to monitor all threats and key resources, 17% of the responses indicated a poor ability to monitor, 49% were fair, 30% were good, and only 3% reported an excellent ability to monitor threats and/or key resources.
- Living coral cover was the only key resource for which monitoring ability was reported to be good (9) or excellent (1) by a majority of the jurisdictions. The ability to monitor three of the key threats, commercial fishing, subsistence and recreational fishing, and aquatic invasive species, was considered to be poor by nearly half of the jurisdictions.
- The average condition of most key resources declined over both the short- and long-term. More jurisdictions reported a declining trend in key resources over 10-25 years than over the past 3 years. Overall trends indicate that resource condition is declining and threats are increasing.
- For short-term trends in the condition of threats, overall results indicate that all threats but one increased over the past 3 years; 12 of 15 jurisdictions reported that tropical storms remained about the same. All threats but one also increased over the 10-25 year trend; the overall trend in the threat of commercial fishing was reported to be about the same over time based on the distribution of responses of increasing (5), about the same (5), decreasing (3) and unknown (2).
- Over the 10-25 year time period, threats for which more than 2/3 of jurisdictions reported increasing trends were climate change and coral bleaching, coral disease, tourism and recreation, subsistence and recreational fishing, and marine debris.
- Trends in threat levels over the past 3 years were reported as unknown in 8 of the responses. Fifteen responses indicated the trend of a threat was unknown over the past 10-25 years.

Although there are several important caveats regarding interpretation of these results (please see the National Summary chapter) the questionnaire provided an opportunity to focus attention on places, resources, threats and monitoring capacity that are in need of additional support. Consequently a low score in any category should be interpreted not as a failure of management, but as an indication that more concerted attention and care may be required to protect coral reef ecosystems in that location.

Table A. Four key resources and ten threats evaluated in the National Summary chapter.

Key Resources
<ul style="list-style-type: none"> • Water Quality • Living Coral Cover • Reef Fish Populations • Harvested Reef Fish and Macroinvertebrates
Commonly Addressed Threats
<ul style="list-style-type: none"> • Climate Change and Coral Bleaching • Coral Disease • Tropical Storms • Coastal Development • Tourism and Recreation • Commercial Fishing • Subsistence and Recreational Fishing • Vessel Damage • Marine Debris • Aquatic Invasive Species

NATIONAL LEVEL ACTIVITIES

This edition of the report includes a short chapter summarizing some of the activities underway at regional and national levels to support coral reef conservation. While some of these are mentioned in one or more of the jurisdictional chapters, many topics are not covered elsewhere in the report. Topics in the National Activities chapter include the Coral Reef Ecosystem Integrated Observing System (higher level integration of results of coral reef mapping and monitoring activities by NOAA and jurisdictional partners); the 2005 Caribbean region-wide bleaching event; the Endangered Species Act listing of two coral species in 2006; a review of the status of important social science projects that document motivations, values, and perceptions related to human use patterns in and economic value of coral reef ecosystems; the use of marine protected areas as a management tool for conserving coral reefs; regional implementation of the Micronesia Challenge; federal fishery management in coral reef ecosystems; changes to the Coral Reef Conservation Act of 2000 that have been proposed during the ongoing reauthorization process; the 10th anniversary of the creation of the U.S. Coral Reef Task Force; and the various activities that are planned for the International Year of the Reef in 2008.

CONCLUSIONS

Since publication of the last report in 2005, news reports have documented several major events with negative consequences for coral reefs. As the 2005 report was being prepared for printing, a massive tsunami in Asia aptly illustrated the value of coral reefs in protecting coastal areas. Scientists surveying the tsunami damage noted a striking fact: where reefs were in good condition and structurally intact, adjacent coastal areas were spared from the full force of the waves. Where reefs had deteriorated from dredging, blast fishing and other destructive activities, there was little reef left to break the waves' momentum, which hit nearby coasts with unabated force. Later that year, the media tracked the paths of a record-breaking number of powerful hurricanes that damaged coastal areas across the Caribbean, Florida and Gulf of Mexico.

The past three years have also seen a rise in concern about the affects of climate change on the planet including ocean and coastal areas. In addition to long-standing concerns about sea level rise, increases in sea surface temperatures, and mass coral bleaching and disease epidemics, recent evidence has emerged to focus attention on predicted changes to ocean chemistry that would likely affect future coral growth. Corals and other important reef-building organisms are able to calcify their skeletal structures from sea water because of particular chemical properties. Continued increases in CO₂ may result in acidification of waters to the point that calcification by marine organisms can no longer occur, which would prevent future coral reef growth altogether.

Since the last reporting effort, more information has also become available to characterize the extent and distribution of nearshore sea floor habitats. Between 2005 and 2007, digital benthic habitat maps in formats compatible with Geographic Information Systems (GIS) were released for CNMI, Guam, American Samoa, the Republic of Palau and the main Hawaiian Islands. These habitat maps, along with similar products for USVI and Puerto Rico, provide baseline information on the extent and distribution of habitat types found in the seascape and are invaluable in structuring monitoring and research efforts and supporting management. Because all of the component imagery and data used to create the maps are provided to users, the initial maps produced by NOAA were able to be refined in key locations to depict habitats in greater detail for management applications. In Florida, where shallow water habitats (<18 m) are estimated to cover a vast area and numerous mapping programs are in progress, important initial steps have been taken to develop maps for targeted priority areas not previously surveyed in detail.

In water depths of 20-1,000 m, bathymetric surveys using high-resolution multibeam sonar are nearly complete for CNMI, Guam, American Samoa, the Pacific Remote Island Areas (PRIA), and the main Hawaiian Islands, and partially complete in the NWHI. A suite of additional products that are derived from multibeam sonar data are also now available. Bathymetric data collection in the Atlantic/ Caribbean/ Gulf of Mexico is proceeding more slowly and focuses survey effort on priority areas such as fishery closures, deep reef habitats, unique seafloor features, National Marine Sanctuaries, and other targeted areas. Analogous data have been collected in parts of the USVI and Puerto Rico as well. The availability of habitat maps and high-resolution bathymetric data represents major progress toward mapping goals established by the U.S. Coral Reef Task Force at its inception in 2000 (USCRTF, 2000) and provide a fundamental spatial structure that supports management, monitoring and research objectives.

Efforts are underway in several jurisdictions to nominate and designate coral reef ecosystems as World Heritage natural sites under UNESCO. Locations such as Bikini, Likiep, Mili and other atolls in the northern Marshall Islands, Palau's Rock Islands, Papahānaumokuākea Marine National Monument (NWHI) and And Atoll (FSM) have been proposed or nominated as sites that may join the immense Phoenix Islands Protected Area of Kiribati on the list of natural sites in the tropical Pacific considered important to the global community for their exceptional natural beauty, importance to biological and ecological processes, and conservation of the earth's biological diversity (<http://whc.unesco.org/en/criteria/>).

For all the pressures presently stressing reefs adjacent to populated coastlines, vast areas of reefs in relatively good condition persist in remote parts of the Pacific. A recent research expedition to the Line and Phoenix Islands (including the PRIA) led by the Scripps Institute of Oceanography documented a correlation between level of human influence and reef health metrics, but found that even remote areas are not immune to threats. By the time the Pacific Islands Fishery Science Center's Coral Reef Ecosystem Division returned from their biennial cruise to American Samoa and the PRIA

in April 2008, preliminary data analysis suggested that large (> 50 cm) fish biomass at Rose Atoll National Wildlife Refuge (American Samoa) in 2008 had dropped to 20% of 2002 levels, likely due to poaching at this remote protected atoll (R. Brainard, pers. comm.). Other recent surveys in remote areas of the Marshall Islands and FSM also noted a virtual absence of large, long-lived species coveted in the live food fish trade where once they were abundant. These findings emphasize the need for new technology to enable effective surveillance and enforcement of fisheries regulations regardless of the location's proximity to major human settlements.

As the global population continues to increase and demographic shifts toward coastal areas persist, even greater pressures will be placed on nearshore resources to satisfy human desires for food, culture, tourism, recreation and profit. Key issues related to usage and access to coral reef ecosystem resources are likely to intensify as conflicts over incompatible uses become more frequent. Looking ahead, decision makers must find a means to balance users' demands with efforts to conserve the resources that remain.

Despite the investments made to date in managing and monitoring U.S. coral reef ecosystems and increasing management capacity at all levels, coral reef ecosystem resources have continued to decline over the short- and long-term. Present monitoring efforts are inadequate to support effective management and document the impacts of key threats and resource condition with sufficient confidence to detect change at meaningful temporal and spatial scales. Further support at all levels is needed to augment our ability to understand the impacts of threats and mitigate damage that occurs. Significant actions and bold protective measures are required if reef conditions are expected to improve in the future.

REFERENCES

- Acropora Biological Review Team. 2005. Atlantic Acropora Status Review Document. Report to National Marine Fisheries Service, Southeast Regional Office. March 3, 2005. 152 p + App. <http://sero.nmfs.noaa.gov/pr/pdf/050303%20status%20review.pdf>.
- Ault, J.S., J.A. Bohnsack, S.G. Smith, and L. Luo. 2005. Towards sustainable multispecies fisheries in the Florida, USA, coral reef ecosystem. *Bull. Mar. Sci.* 76: 595-622.
- Blondeau, J. University of the Virgin Islands, Center for Marine and Environmental Studies. St. Thomas, USVI. Personal communication.
- Brainard, R.E. NOAA Pacific Islands Fishery Science Center, Coral Reef Ecosystem Division. Honolulu, HI. Personal communication.
- Caldow, C., R.D. Clark, M.E. Monaco. In press. A point for comparison: the Flower Garden Banks National Marine Sanctuary. In: Proceedings of the 60th Gulf and Caribbean Fisheries Institute, Punta Cana, Dominican Republic. November, 2007.
- Clark, C. 2006. Lobster fishermen stake it all on 2006 season. *Miami Herald*. Miami, FL. http://www.redorbit.com/news/business/605221/lobster_fishermen_stake_it_all_on_2006_season/index.html.
- Clinton, W. J. 1998. Executive Order 13089: Coral Reef Protection. The White House.
- Ferro, F.M., L.K.B. Jordan, and R.M. Spieler. 2005. The Marine Fishes of Broward County, Florida: Final Report of 1998-2002 Survey Results. NOAA Technical Memorandum NMFS SEFSC 532. Miami, FL. 73 pp.
- Friedlander, A.M., Brown, E.K., Monaco, M.E. 2007b. Defining Reef Fish Habitat Utilization Patterns in Hawaii: Comparisons Between Marine Protected Areas and Areas Open to Fishing. *Marine Ecology Progress Series*.
- García-Sais, J. R., R. Castro, J. Sabater-Clavell, R. Esteves and M. Carlo. 2006. Monitoring of coral reef communities from natural reserves in Puerto Rico, 2006: Isla Desecheo, Rincon, Mayaguez Bay, Guanica, Ponce and Isla Caja de Muerto. Final Report submitted to the Department of Natural and Environmental Resources of Puerto Rico, San Juan, P. R. 151 p
- Gilliam, D.S. 2007. Southeast Florida Coral Reef Evaluation and Monitoring Project 2006 Year 4 Final Report. Prepared for: Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Florida Department of Environmental Protection. 31 pp. <http://www.floridadep.org/coastal/programs/coral/reports/>.
- Gochfeld, Deborah. National Center for Natural Products Research, University of Mississippi. University, MS. Personal observation.
- Jackson, J.B.C. 1997. Reef Since Columbus. *Coral Reefs* 16 (suppl.): S23-S32.
- Jackson, J.B.C : Kirby, M X : Berger, W H : Bjorndal, K A : Botsford, L W : Bourque, B J : Bradbury, R H : Cooke, R : Erlandson, J : Estes, J A : Hughes, T P : Kidwell, S : Lange, C B : Lenihan, H S : Pandolfi, J M : Peterson, C H : Steneck, R S : Tegner, M J : Warner, R R. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293(5530): 629-37.
- Menza, C., M. Kendall, C. Rogers and J. Miller. 2007. A deep reef in deep trouble. *Continental Shelf Research* 27: 2224-2230.
- Miller, J., R. Waara, E. Muller, and C.S. Rogers. 2006. Coral bleaching and disease combine to cause extensive mortality on reefs in U.S. Virgin Islands. *Coral Reefs* 25(3): 418.
- Miller, M.W., D.B. McClellan, J.W. Wiener, and B. Stoffle. 2007. Apparent rapid fisheries escalation at a remote Caribbean island. *Environ. Conserv.* 34: 92-94.
- NOAA (National Oceanic and Atmospheric Administration). 2002. A National Coral Reef Action Strategy: Report to Congress on implementation of the Coral Reef Conservation Act of 2002 and the National Action Plan to Conserve Coral Reefs in 2002-2003. NOAA. Silver Spring, Maryland.
- Pandolfi, J.M., Jackson, J.B.C., Baron, N., Bradbury, R.H., Guzman, H.M., Hughes, T.P., Kappel, C.V., Micheli, F., Ogden, J.C., Posingham, H.P. and E. Sala. 2005. Are U.S. coral reefs on the slippery slope to slime?. *Science* 307(5716): 1725-1726.
- Pittman, S.J., S.D. Hile, C.F.G. Jeffrey, C. Caldow, M.S. Kendall, M.E. Monaco, Z. Hillis-Starr. 2008. Fish assemblages and benthic habitats of the Buck Island Reef National Monument (St. Croix, U.S. Virgin Islands) and the surrounding seascape: A characterization of spatial and temporal patterns. NOAA Technical Memorandum 71. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Branch. Silver Spring, MD. 67 pp.
- Toller, W. 2002. Quantitative estimates of species composition and abundance of fishes, and fish species/habitat associations in St. Croix, U.S. Virgin Islands. Final Report, F-7-17. Division of Fish and Wildlife, Department of Planning and Natural Resources, U.S. Virgin Islands. 44 pp. <http://www.vifishandwildlife.com/Fisheries/FisheriesReports/2002/>.

The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008

Turgeon, D.D., R.G. Asch, B.D. Causey, R.E. Dodge, W. Jaap, K. Banks, J. Delaney, B.D. Keller, R. Speiler, C.A. Matos, J.R. Garcia, E. Diaz, D. Catanzaro, C.S. Rogers, Z. Hillis-Starr, R. Nemeth, M. Taylor, G.P. Schmahl, M.W. Miller, D.A. Gulko, J.E. Maragos, A.M. Friedlander, C.L. Hunter, R.S. Brainard, P. Craig, R.H. Richond, G. Davis, J. Starmer, M. Trianni, P. Houk, C.E. Birkeland, A. Edward, Y. Golbuu, J. Gutierrez, N. Idechong, G. Paulay, A. Tafleichig, and N. Vander Velde. 2002. *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002*. National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science. Silver Spring, MD. 265 pp.

USCRTF (United States Coral Reef Task Force). 2000. *The National Action Plan to Conserve Coral Reefs*. USCRTF. Washington, D.C. 33 pp. + appendices.

Waddell, J.E. (ed.), 2005. *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. 522 pp.

Woody, K., A. Atkinson, R. Clark, C. Jeffrey, I. Lundgren, J. Miller, M. Monaco, E. Muller, M. Patterson, C. Rogers, T. Smith, T. Spitzak, R. Waara, K. Whelan, B. Witcher, and A. Wright. 2008. Coral Bleaching in the U.S. Virgin Islands in 2005 and 2006. pp. 68-72. In: Wilkinson, C. and D. Souter (eds.). *Status of Caribbean coral reefs after bleaching and hurricanes in 2005*. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia. 152 pp.