National Level Activities to Support U.S. and FAS Coral Conservation

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In addition to the local and partnership efforts underway in each of the U.S. and FAS jurisdictions, there are several important activities conducted at the national and regional levels that contribute to coral reef ecosystem conservation across jurisdictional boundaries. These include efforts to map the distribution of and monitor the status of coral reefs that occur as part of the National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Ecosystem Integrated Observing System and NOAA's Coral Reef Watch program; the 2005 Caribbean Coral Bleaching event; the recent Endangered Species Act listing of the Caribbean corals *Acropora cervicornis* and *Acropora palmata* as threatened species; a shift towards greater incorporation of social science to better understand the human dimensions of coral reef conservation; increases in the designation and implementation of Marine Protected Areas (MPAs) and the compilation of a report describing the status of U.S. MPAs in coral reef jurisdictions; the ambitious attempts by Micronesian states to protect terrestrial and marine ecosystems under the Micronesian Challenge; changes in regional fisheries regulations to better protect manage populations of harvested reef organisms; the reauthorization of the Coral Reef Conservation Act of 2000; the 10th anniversary of the U.S. Coral Reef Task Force, which serves as a coordinating body for conservation activities carried out by federal and jurisdictional partners and others; and efforts to raise public awareness and understanding about the plight of coral reef ecosystems through the designation of the International Year of the Reef in 2008. These efforts are introduced in this chapter to characterize some of the major initiatives underway at higher levels of government. The sections provide links to additional information for those who wish to learn more about national level activities that contribute to coral reef conservation.

CORAL REEF ECOSYSTEM INTEGRATED OBSERVING SYSTEM

NOAA's Coral Reef Ecosystem Integrated Observing System (CREIOS) includes mapping and monitoring activities that provide data and information as a foundation for management activities and conservation efforts. Mapping provides a detailed picture of the physical and biological structure of coral reef communities. Monitoring also includes both biological and physical aspects: direct, periodic field observations of the condition of critical reef ecosystems, and automated, continuous monitoring of key environmental factors that are known to affect their status. CREIOS integrates its mapping and monitoring activities to accurately document the status and trends in the conditions of habitats and living marine resources, and determine the depth ranges, geomorphologic zones, and reef types present in coral reef environments. The data produced through mapping and monitoring projects are disseminated to coral reef managers and other users through a variety of NOAA websites and databases that make this information publicly available. The Coral Reef Information System (CoRIS) serves as a single portal for managing coral reef-related metadata generated through NOAA and partnership efforts.

Coral Reef Ecosystem Mapping and Monitoring

Mapping the spatial extent and characteristics of coral reef ecosystems is an integral component of CREIOS. Mapping activities include projects that use image analysis and acoustic sensing to map coral reef ecosystems from the shoreline to a maximum depth of about 1,000 m, which includes the depth limits at which hermatypic (reef-building) corals can survive due to light availability. In shallow water areas (<30 m), NOAA has generated benthic habitat maps through visual interpretation of features that are visible in georeferenced aerial photographs, high-resolution satellite imagery and bathymetric Light Detecting and Ranging (LIDAR) data. These maps classify reef ecosystems using a hierarchical classification scheme based on geomorphological zones, underlying substrate/structure, and biological cover. Areas too deep to be clearly visible in imagery (30 to 1,000 m) are surveyed using acoustic technologies, including sidescan sonar, and single- and multibeam sensors. These sensors provide data used primarily to develop high resolution bathymetric maps of the seafloor, derived products and simplified habitat maps.

An update on the status of NOAA's coral reef ecosystem mapping activities in each jurisdiction is provided in Table 1.1. The table differentiates progress according to the NOAA Coral Reef Conservation Program's two main approaches to mapping: visual interpretation of high-resolution satellite imagery used to create shallow-water (<30 m) benthic habitat maps and the collection of multibeam bathymetric data for seafloor areas deeper than 30 m used to create topographic maps of the seafloor and other derived products. Progress is measured against goals established by the U.S. Coral Reef Task Force in the *National Action Plan to Conserve Coral Reefs* (USCRTF, 2000). By December 2007, the production of high-resolution digital benthic habitat maps for U.S. shallow-water coral reef ecosystems was complete for priority areas identified in the Plan except for portions of the Northwestern Hawaiian Islands (NWHI), Florida, the Pacific Remote Is-

1. NOAA National Ocean Service, Center for Costal Monitoring and Assessment, Biogeography Branch
2. NOAA Coral Reef Conservation Program
3. NOAA Coral Reef Watch
4. NOAA Office of Ocean and Coastal Resource Management
5. NOAA National Marine Fisheries Service, Office of Habitat Conservation
6. The Nature Conservancy
7. NOAA National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Coral Reef Ecosystem Division
8. NOAA National Marine Fisheries Service Protected Resources Division

Table 1.1 Status of shallow-water and moderate depth mapping of seafloor characteristics and habitats for each jurisdiction, status of progress based on product availability and the jurisdictional survey, and ability of jurisdictions to use the map products provided and apply the maps in support of research and conservation efforts. The final category was included to identify where training in how to use mapping products is needed. Sources: CCMA-BB; PIFSC-CRED.

JURISDICTION	BENTHIC HABITAT MAP PRODUCTS		BATHYMETRIC PRODUCTS		Status of Mapping Progress (quantitative)	Status of Mapping Progress (survey of jurisdictions)	APPLICATION OF MAPS
	Shallow-Water (<30 m)	Moderate depth (30-1000 m)	Shallow-Water (<30 m)	Moderate depth (30-1000 m)			Ability to apply map products in support of research & conservation
USVI	75-100%	0-25%	25-50%	25-50%	FAIR	GOOD	GOOD
Puerto Rico	75-100%	0-25%	75-100%	0-25%	FAIR	GOOD	GOOD
Navassa Island	25-50%	0-25%	75-100%	75-100%	GOOD	GOOD	FAIR
Southeast Florida	75-100%	0-25%	0-25%	0-25%	POOR	FAIR	GOOD
Florida Keys	50-75%	0-25%	0-25%	0-25%	POOR	FAIR	FAIR
Flower Garden Banks	N/A	0-25%	N/A	75-100%	GOOD	GOOD	EXCELLENT
Main Hawaiian Islands	75-100%	0-25%	75-100%	75-100%	GOOD	GOOD	GOOD
Northwestern Hawaiian Islands	50-75%	0-25%	25-50%	25-50%	FAIR	FAIR	GOOD
American Samoa	75-100%	0-25%	25-50%	75-100%	GOOD	EXCELLENT	GOOD
PRIA	0-25%	0-25%	0-25%	75-100%	POOR	EXCELLENT	GOOD
Marshall Islands	0-25%	0-25%	0-25%	0-25%	POOR	POOR	POOR
Federated States of Micronesia	0-25%	0-25%	0-25%	0-25%	POOR	POOR	POOR
CNMI	75-100%	0-25%	50-75%	75-100%	GOOD	GOOD	GOOD
Guam	75-100%	0-25%	75-100%	75-100%	GOOD	GOOD	GOOD
Palau	75-100%	0-25%	0-25%	0-25%	POOR	FAIR	FAIR

lands, the Marshall Islands, and the Federated States of Micronesia (Navassa Island and the banks in the Gulf of Mexico were not part of the original scope of work). Moderate-depth bathymetric surveys are largely complete in the Pacific jurisdictions but are partially complete or incomplete in the Caribbean region, the NWHI, and the Freely Associated States. These products were designed to be used together to provide a seamless picture of marine habitats from the shoreline to 1,000 m in support of coral reef management actions.

The final three columns of the table score each jurisdiction according to the status of mapping progress based on the preceding four columns and based on a questionnaire circulated to this report's local report coordinators and writing teams. In the questionnaire, respondents were asked to characterize the availability of map products and evaluate how well the jurisdiction is "able to use the map products and tools available and apply them for research and conservation purposes." More details on the questionnaire and individual responses can be found in the National Summary chapter.

Successful conservation of coral reef ecosystems must respond to changes in environmental, economic, and social conditions over time. CREIOS examines both the biological components of coral reef ecosystems and the physical environmental conditions that influence the development and maintenance of those systems. Monitoring allows managers and others to assess coral reef conditions, diagnose problems, prioritize and implement solutions, evaluate the results of management decisions, and forecast future conditions. In and around the reef ecosystems of the U.S., NOAA uses instrumented buoys, subsurface moored instruments, satellite remote sensing, satellite-tracked drifting buoys, *in situ* oceanographic and biological observations, site-specific ecological assessments, and broad-scale towed-diver surveys conducted by an interdisciplinary team of scientists (Figure 1.1). The *in situ* biological observations of NOAA scientists are augmented by the biological observations of local scientists and managers who receive funding under the National Coral Reef Ecosystem Monitoring Program to conduct complementary monitoring programs with higher temporal frequency.

In addition to *in situ* monitoring in the Pacific and Atlantic regions, CREIOS provides global satellite monitoring of sea surface temperature (SST), thermal stress, and other parameters of the coral reef environment as described below.

CREIOS provides the long-term monitoring that enables coral reef managers to detect and act on significant natural or anthropogenic changes to these ecosystems. Integration of the long-term spatial and temporal data from surface and subsurface moorings, *in situ* observations, and satellite remote sensing provides researchers and resource managers an improved understanding of the influences of global climate changes on coral reef ecosystems.

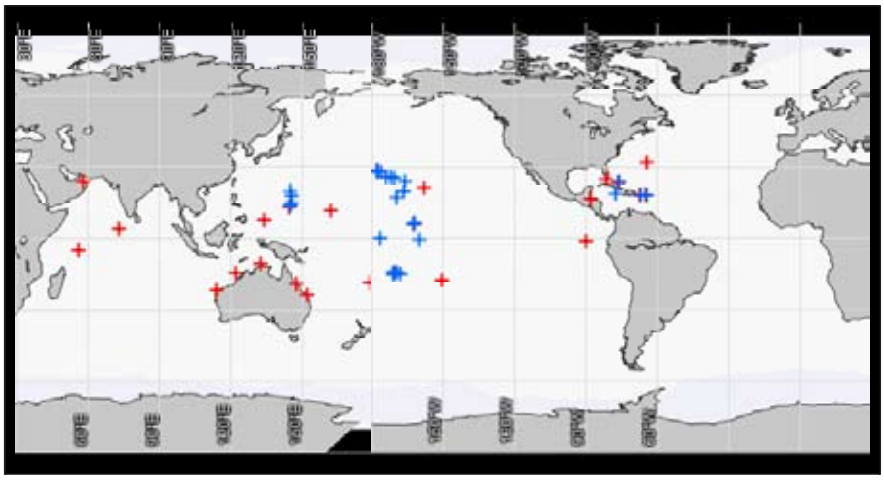

Figure 1.1. CREIOS in situ (blue) and satellite (red) fixed monitoring stations. Source: NOAA Coral Reef Watch.

Ocean Acidification

The 2007 Intergovernmental Panel on Climate Change assessment reported that global temperature increased substantially over the last 100 years, due in large part to the burning of fossil fuels. Increases in ocean temperatures as a consequence of rising atmospheric carbon dioxide (CO_2) levels threaten coral reef ecosystems through increased frequency and severity of mass coral bleaching and disease events, sea level rise, and possibly storm activity (IPCC, 2007). In addition, increasing atmospheric CO_2 is already altering the chemistry of seawater in ways that are likely to reduce calcification rates in reef-building organisms (Figure 1.2). Reduction in calcification rates directly affects both the growth of individual corals and the ability of reefs to build structure at rates greater than erosional forces.

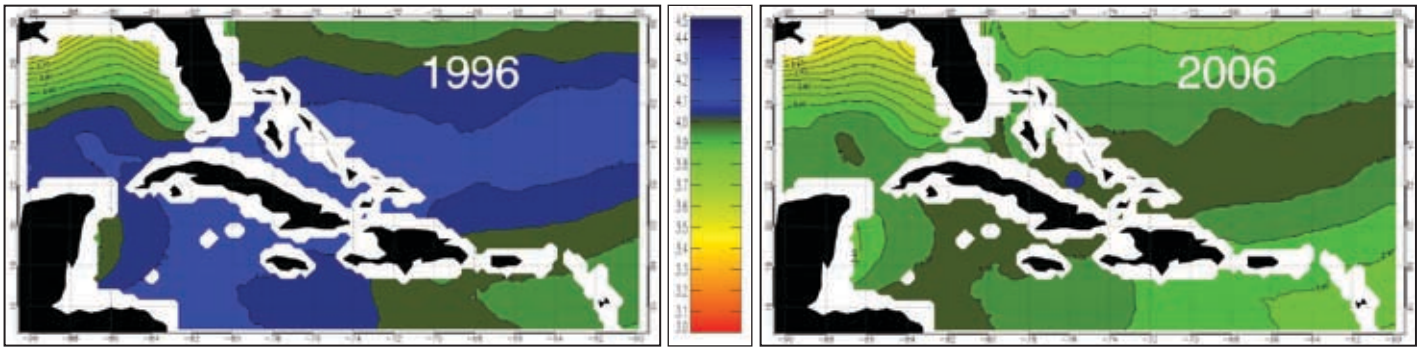

Figure 1.2. Satellite and ship observations are coupled to model changes in surface ocean chemistry as a consequence of ocean acidification, which occurs as a direct consequence of rising atmospheric carbon dioxide and its uptake by ocean surface waters. Shown here are the annual mean aragonite saturation state values for the northern Caribbean region for 1996 (left) and 2006 (right). Aragonite saturation state imparts an important control on the rate at which coral communities build reefs, and its continued decrease may prove detrimental to reefs globally. Source: NOAA Coral Reef Watch.

NOAA, in partnership with the National Science Foundation and the U.S. Geological Survey, released the interagency report *Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research* in 2006, which documents the threats posed by ocean acidification and highlights actions that need to be taken to better understand the consequences for marine ecosystems (http://www.ucar.edu/communications/Final_acidification.pdf). NOAA has been indirectly monitoring ocean acidification through cruises and hydrographic stations and recently began deployment of a limited number of autonomous sensors on buoys and fixed stations capable of measuring the relevant chemistry. NOAA has supported research activities that combine data from *in situ* instruments, satellites, and models to track changes in ocean chemistry and monitor the responses of reef communities. Work has begun on development of concepts for a Coral Reef Metabolic Monitoring Network, which will characterize *in situ* carbonate chemistry near selected reefs in relation to offshore sea surface chemistry as derived from satellite remote sensing. To date, this effort has three components, including: 1) a new model based on satellite data to estimate surface pCO_2 and other carbon chemistry parameters for the greater Caribbean region; 2) deployment of oceanic sensors at Lee Stocking Island (Bahamas), Molasses Reef (Florida Keys), and La Parguera, Puerto Rico to provide near-real-time pCO_2 data, and 3) a Caribbean pilot study of the new Reef Metabolic Index, which incorporates pCO_2 estimates from satellite data with *in situ* pCO_2 sensor data to monitor coral reef status in response to climate- and ocean acidification-related stress.

Satellite Bleaching Alerts

Since 2000, NOAA has been developing and a refining a system to track thermal stress on corals and predict coral bleaching using satellite-based SST data. In 2005, NOAA Coral Reef Watch launched the Satellite Bleaching Alerts (SBA) system, which sends out automated e-mail watches and warnings when conditions are detected that may lead to coral

bleaching. These mass bleaching alerts are an important component of Bleaching Response Plans and reef management planning since they alert managers to the need to deploy monitoring teams. Five alert level categories are monitored in near-real-time at 24 Virtual Station sites worldwide (Figure 1.1), based on satellite-derived SST observations and calculations of coral bleaching "HotSpots", which measure current thermal stress, and Degree Heating Weeks, which measure accumulated thermal stress over time.

Table 1.1. Maximum annual coral bleaching Degree Heating Weeks (DHWs) at each jurisdiction from 2001-2007. Each DHW represents one week of temperatures 1°C above the maximum monthly average. DHW values are color-coded to reflect the intensity of accumulated thermal stress: Blue, DHW=0; Green, 0<DHW<4; Orange, 4≤DHW<8; Red, DHW≥8]. Coral bleaching is expected to occur at DHWs above 4 with mass bleaching and related mortality at DHWs above 8. If a thermal stress event spans two years (e.g., November-January), then the maximum DHW for each year may occur during a single event; this situation is indicated by a gray box.

Jurisdiction	Island	DHW 2001	DHW 2002	DHW 2003	DHW 2004	DHW 2005	DHW 2006	DHW 2007
USVI		0.3	0.7	3.0	2.6	14.7	3.6	1.7
Puerto Rico		0.6	0.8	4.1	3.2	11.2	2.9	1.1
Florida		3.5	1.4	4.2	4.8	9.2	2.3	12.2
Navassa		1.1	0.0	4.7	2.2	10.5	5.1	2.7
Flower Garden Banks		0.0	0.7	0.0	1.9	7.6	2.7	1.3
Hawaii	Hawaii	0.0	0.0	0.0	0.5	0.0	0.0	0.0
	Oahu	0.0	0.0	0.5	2.8	0.0	0.0	0.0
	Kauai	0.0	0.0	0.0	1.1	0.0	0.0	0.0
NWHI	Nihoa	0.0	0.0	0.0	0.6	0.0	0.0	0.0
	French Frigate Shoals	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Maro Reef	0.0	0.0	0.0	1.8	1.1	0.0	0.0
	LIsianski	0.0	1.7	0.0	2.2	0.6	0.0	0.0
	Midway	0.0	7.6	0.0	4.7	0.0	0.0	1.1
	Kure	0.5	8.7	0.0	1.8	0.5	0.0	3.1
American Samoa		0.5	1.5	5.0	1.5	0.0	0.0	0.0
PRIAs	Johnston	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Palmyra	2.5	12.0	4.5	4.1	1.6	1.0	1.0
	Kingman	3.0	8.8	4.3	5.3	2.2	1.0	1.0
	Baker	1.6	18.3	19.7	12.2	8.5	16.2	16.8
	Wake	0.0	0.0	0.0	0.6	0.0	0.0	0.0
	Jarvis	0.5	24.4	23.0	5.5	1.1	4.3	4.3
	Howland	1.6	17.7	18.7	14.0	6.1	16.2	16.8
	Rose	0.0	2.3	6.4	0.5	3.2	0.0	0.0
Marshall Islands	Majuro	0.0	0.0	1.1	1.5	1.5	0.0	0.0
	Kwajalein	1.1	0.5	1.1	0.6	0.5	0.0	0.0
	Bikini	0.6	2.2	0.5	0.0	0.0	0.0	0.0
Federated States of Micronesia	Kosrae	0.6	0.6	4.3	3.3	1.5	1.5	0.0
	Pohnpei	4.0	3.4	1.3	1.3	0.5	0.0	0.0
	Chuuk	3.7	1.2	2.7	2.7	1.0	1.0	1.0
	Yap	2.9	1.7	1.5	0.5	0.0	0.0	0.0
Guam		1.3	0.0	2.2	1.0	0.0	2.6	2.8
CNMI	Asuncion	8.3	0.6	4.8	0.0	0.5	0.0	3.4
	Agrihan	8.3	0.6	4.3	0.0	0.5	0.0	3.5
	Pagan	8.9	0.0	3.6	0.0	0.5	0.0	3.5
	Saipan	3.1	0.5	2.0	0.0	0.0	0.6	1.0
Palau		2.2	0.6	0.6	0.0	0.0	0.0	0.0

When no thermal stress is present, the Virtual Station is under "No Stress" and no coral bleaching is expected. When HotSpots are present (0<HotSpot<1), corals are experiencing low-level thermal stress and a "Bleaching Watch" alert is in effect. As thermal stress begins to accumulate (HotSpot≥1 and 0<DHW<4), a "Bleaching Warning" alert is sent out and managers should be aware that a bleaching event may occur. At "Alert Level 1" (HotSpot≥1 and 4≤DHW<8) coral bleaching is expected. Finally, "Alert Level 2" (HotSpot≥1 and DHW≥8) indicates that significant mass coral bleaching and bleaching-related mortality are likely. The maximum annual DHWs for all U.S. and FAS jurisdictions are given in Table 1.1. Stakeholders can subscribe to the SBA system on the web at: http://coralreefwatch-satops.noaa.gov/email_alert_request.html. To date, over 250 subscribers from at least 29 nations have signed up to receive alerts via this system.

A Reef Manager's Guide to Coral Bleaching

In 2003, USCRTF members committed to develop an interagency partnership to plan a comprehensive, integrative program for understanding local and system-wide coral reef responses to climate change, including application of this knowledge to local reef management. To support this effort, NOAA, EPA and DOI sponsored a workshop on *Coral Reefs, Climate and Coral Bleaching* with participation by over 100 scientists and managers from local and federal governments, universities, the private sector, and non-governmental organizations. As a direct result of this workshop, NOAA and the Great Barrier Reef Marine Park Authority, working with International Union for the Conservation of Nature and Natural Resources, EPA, and a variety of other domestic and international partners, developed *A Reef Manager's Guide to Coral Bleaching* (http://www.coris.noaa.gov/activities/reef_managers_guide/). The Guide articulates the state of knowledge on the causes and consequences of coral bleaching and presents management strategies to help local and regional reef managers prepare for and respond to mass coral bleaching. The Guide includes contributions from over 50 experts in coral bleaching and coral reef management from 30 organizations.

A Reef Manager's Guide to Coral Bleaching was released in the fall of 2006, and is available to managers as a resource for developing strategies to reduce the impacts of coral bleaching in coral reef ecosystems (Figure 1.3). The Guide provides information on responding to mass bleaching events; developing bleaching response plans; assessing ecological, social, and economic impacts; and using tools to identify and build long-term reef resilience.

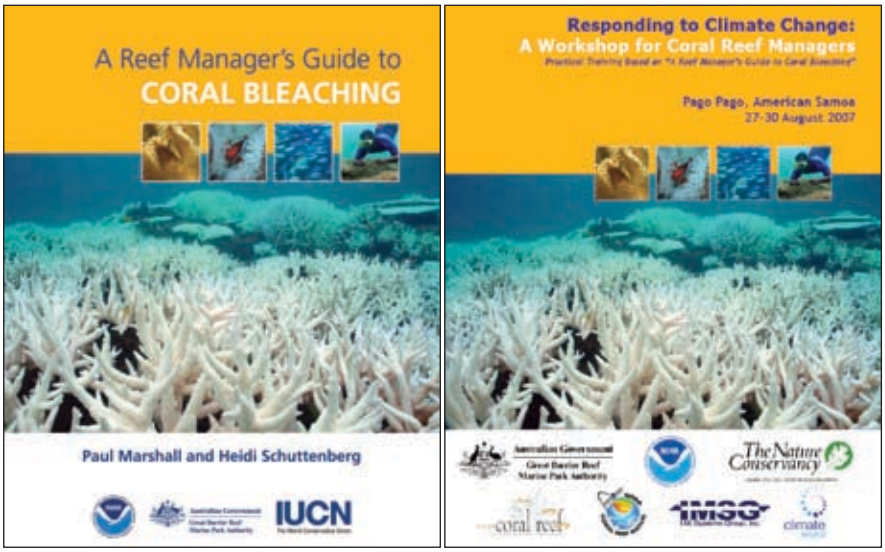

Figure 1.3. Concerns about the effects of coral bleaching on reefs prompted publication of A Reef Manager's Guide to Coral Bleaching *(left) and preparation of materials such as* Responding to Climate Change: A Workshop for Coral Reef Managers *(right). Source: NOAA Coral Reef Watch.*

Following the publication of *A Reef Manager's Guide to Coral Bleaching*, the NOAA Coral Reef Conservation Program (CRCP) and the Great Barrier Reef Marine Park Authority (GBRMPA) collaborated to produce a 4-day workshop to build capacity for responding to climate change by training coral reef managers, researchers, and stakeholders on the information presented in the Guide. The *Responding to Climate Change: A Workshop for Coral Reef Managers* training sessions teach international experts in coral reef management about climate change impacts on coral reefs, ecological resilience, and strategies for mitigating and managing future impacts (Figure 1.3).

More than 60 coral reef managers and scientists from Southeast Asia, Australia, and the Pacific islands, representing 8 nations, participated in two workshops in 2007 held on Australia's Great Barrier Reef at Lady Elliot Island and at Pago Pago, American Samoa. Through presentations, interactive discussions and exercises, and in-water field activities, the workshops provided participants with the skills and tools they need to adapt their management programs to address the growing threat climate change poses to coral reefs, such as predicting where coral bleaching will occur, measuring coral reef resilience and assessing the socioeconomic impacts of coral bleaching. Participants shared strategies and local management actions and participated in exercises that planned draft coral bleaching response plans and hypothetical Marine Protected Areas that emphasize resilience to climate change.

In addition to the Responding to Climate Change workshops, from 2005 to 2007 NOAA conducted nine Satellite Tools Training workshops in the Philippines, Palau, Mexico, Belize, Tanzania, and the U.S. Virgin Islands, in partnership with the World Bank/Global Environment Facility (WB/GEF) Coral Reef Targeted Research Program (CRTR). These workshops trained a total of 160 coral reef managers and scientists from more than 13 nations on state-of-the-art satellite-based monitoring products for predicting mass coral bleaching. These capacity-building trainings enable domestic and international reef managers to improve their understanding of how NOAA satellite data can help them monitor conditions that cause coral bleaching. This knowledge helps trainees improve research and management of their coral resources in the face of future coral bleaching events and climate change.

2005 CARIBBEAN CORAL BLEACHING EVENT

In 2005, coral reefs in the wider Caribbean suffered a widespread and severe bleaching event resulting in extensive coral mortality in much of the region. Persistent elevated SSTs caused an unprecedented bleaching event that stressed coral communities, many of which were later killed by disease or bleaching-related stress. The lingering effects of the event continue to degrade and kill corals in many locations. The USCRTF collaborated to mobilize efforts across the Caribbean to monitor, assess, and research short- and long-term impacts of the bleaching event. The USCRTF Bleaching Committee coordinated the efforts of NOAA, the National Aeronautics and Space Administration (NASA), the Department of the Interior (U.S. Geological Survey and National Park Service), other government agencies, non-governmental partners, university researchers, and local managers. Results of more than 3,600 bleaching observations from 100 researchers in 28 jurisdictions indicate 2005's elevated ocean temperatures produced the most widespread, intense bleaching and perhaps the highest mortality ever documented in the Caribbean.

Most hermatypic, or reef building, tropical corals host symbiotic algae called zooxanthellae, which live inside their tissues. Coral bleaching is the temporary or permanent loss of zooxanthellae from the coral, which can be caused by many types of physiological stress (e.g., ultraviolet rays, excessive warm or cold water temperatures, bacterial infection, etc.). However, widespread mass bleaching events, including the 2005 Caribbean bleaching event, are caused by persistent elevated sea water temperatures and can result in widespread mortality of coral reefs throughout the world. The 2005 bleaching was the result of the most intense high temperature stress ever observed in the Caribbean (from both the 20-year satellite record and the 100-year instrumental record; Figure 1.4).

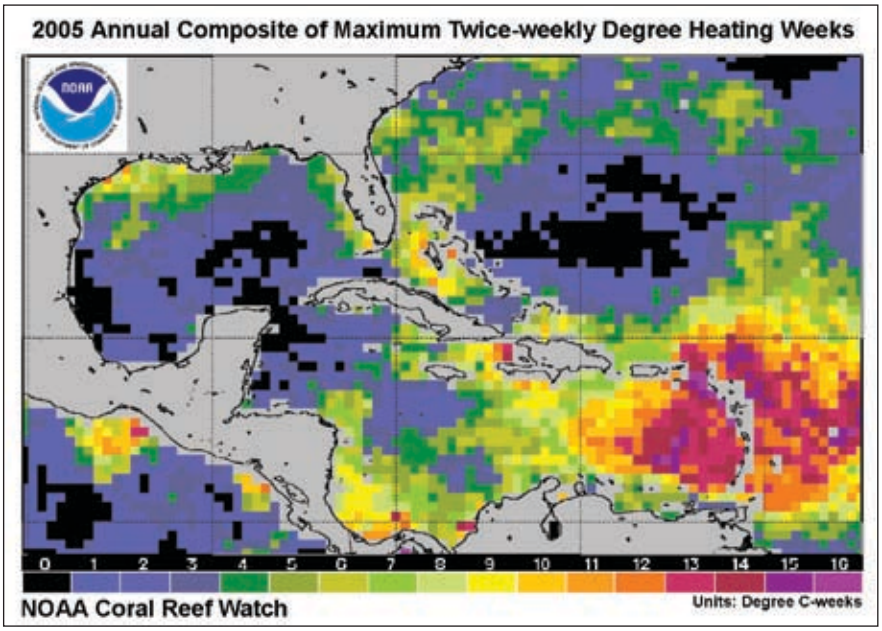

Figure 1.4. Maximum annual coral bleaching Degree Heating Weeks (DHWs, ºC-weeks) for the Caribbean region during 2005. Each DHW represents one week of temperatures 1ºC above the maximum highest monthly average. Coral bleaching is expected to occur at DHW values above 4; significant mass bleaching and related mortality is expected at DHW values above 8. Source: NOAA Coral Reef Watch.

NOAA e-mailed the first Satellite Bleaching Alerts for the 2005 Caribbean bleaching event in response to high temperatures detected in the Florida Keys in August 2005, and for Puerto Rico and the USVI in September 2005. During the 2005 event, the thermal stress detected by satellites in most of the Caribbean exceeded values known to trigger mass bleaching and reached nearly twice this threshold value around the northern Lesser Antilles.

The Global Coral Reef Monitoring Network's report, *Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005*, which represents the work of scientists throughout the Caribbean basin, was released in January 2008 at the kick-off meeting for the International Year of the Reef 2008. The report is available at http://www.gcrmn.org.

ENDANGERED SPECIES ACT LISTING OF CARIBBEAN CORALS IN THE GENUS *ACROPORA*

In May 2006, staghorn coral (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*), once the major reef building coral species in the Caribbean Sea, were formally listed as threatened under the Endangered Species Act (ESA; Figure 1.5). This marks the first time a coral has been listed as endangered or threatened under the ESA since its inception in 1973. According to the act, a species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species in the foreseeable future.

There are more than 110 species of Acropora worldwide. Only three species, *A. cervicornis*, *A. palmata* and *A. prolifera* (a hybrid of *A. cervicornis* and *A. palmata*), occur in the Caribbean and off the coast of Florida (Bruckner and Hourigan, 2002). Staghorn and elkhorn corals were once two of the most abundant and ecologically significant species of scleractinian, or hard coral, in the Caribbean. As recently as three decades ago these corals dominated reef environments at shallow and intermediate depths (0-15 m) where their unique branching characteristics and rapid growth rates produced dense thickets that not only played a vital role in reef accretion, but provided important habitat for numerous reef-associated animals (Acropora Biological Review Team, 2005). The structural and ecological roles of acroporid corals in the Caribbean are unique and cannot be fulfilled by other coral species (Bruckner, 2002). At the current reduced abundance, it is highly likely that both these ecosystem functions have been greatly compromised (Bruckner, 2002).

The 1980s began a period of steep decline for staghorn and elkhorn corals, with both experiencing extreme population losses and serious reductions in spatial distribution within their historical range (Bruckner, 2002). In areas like Florida, Jamaica, Belize and the USVI, acroporid populations suffered losses of 90% or more (Acropora Biological Review Team, 2005). Today in areas where dense populations once stood, there are few, if any, individuals remaining. A number of stressors are implicated in this die-off, the most significant include disease outbreaks, temperature-related stress such as bleaching, and hurricane damage (Precht et al., 2004). Other factors influencing the decline are predation and injuries resulting from other anthropogenic stressors like anchoring and ship groundings.

Figure 1.5. Two species of Caribbean coral, staghorn coral (left) and elkhorn coral (right) were listed as threatened under the U.S. Endangered Species Act in 2006. Photos: NOAA/CCMA Biogeography Branch.

The 2006 ESA listing is the latest step in the long process to formally protect remaining acroporid colonies. Efforts to list staghorn and elkhorn corals began as early as 1991, when both species were identified as candidates for listing under the ESA. According to NOAA's National Marine Fisheries Service (NMFS) a Candidate Species is, "any species being considered by the Secretary [of Commerce or Interior] for listing as an endangered or a threatened species, but not yet the subject of a proposed rule" (50 CFR 424.02). Such a designation does not grant any procedural or substantive protections under the ESA.

Six years later, both species were removed from the candidate list when NMFS failed to present sufficient documentation concerning the biological status and threats facing both species that were required for inclusion in the 1997 Candidate Species List (Hall, 2006). However, using information obtained from a 1998 analysis, both species were again added to the ESA Candidate Species List only to be transferred to the Species of Concern List in early 2004. A species of concern is an informal term referring to a species that might be in need of conservation actions, but for which there is not enough information available to determine if a formal listing is necessary. Neither Candidate Species nor Species of Concern receive legal protection under the ESA (NOAA Fisheries Office of Protected Resources, http://www.nmfs.noaa.gov/pr/species/concern/).

Later in 2004, the Center for Biological Diversity petitioned NMFS to list staghorn corals, elkhorn corals and *A. prolifera* as threatened or endangered. After a lengthy public comment period, a thorough scientific review aimed at establishing the species' status and an evaluation of current protection efforts under way at the time to protect both species, NMFS determined that staghorn and elkhorn corals were indeed likely to become endangered within the foreseeable future throughout their range (Hall, 2006). As a result, NMFS found that listing both species as threatened was warranted. Additionally, NFMS determined that the hybrid, *A. prolifera,* did not meet the definition of a species under the ESA, and therefore it did not warrant listing.

Ultimately, the ESA listing is intended to lessen the threats affecting both coral species until protection is no longer needed and both species are recovered or restored to a level at which they can sustain themselves without additional legal protection (Bruckner and Hourigan, 2002). To achieve these objectives, the ESA requires certain strategies be implemented soon after listing. For example, the act mandates that NMFS identify and designate critical habitat for the listed acroporids. Critical habitats are specific areas within the geographic range of the species that contain the physical or biological features essential to the conservation of the species and which may require special management considerations (Endangered Species Glossary, http://www.fws.gov/northeast/nyfo/es/esaglossary.pdf). Critical habitat regulations apply to any activities that are funded, authorized or carried out by the federal government. In addition to their responsibility not to jeopardize the existence of the listed species, these activities must not destroy or modify a species critical habitat.

In order to determine critical habitat, a request for data on the presence or absence of the two species was made to investigators currently working in the Atlantic and U.S. Caribbean (U.S. Virgin Islands, Puerto Rico, Navassa, Florida, and the Gulf of Mexico). Submitted data are being compiled into a centralized Geographic Information System (GIS) database to be used for mapping and delineating known current habitats. Final products will include Federal Geographic Data Committee compliant metadata and digital GIS maps of the current spatial distribution of live staghorn and elkhorn corals throughout the Atlantic and U.S. Caribbean (Figure 1.6).

NMFS is also required to develop a recovery plan. Recovery is a process by which listed species and their ecosystems are restored and their future is safeguarded such that ESA provisions are no longer necessary. At a minimum the plan must include site-specific management actions that foster recovery and outline objective, measurable criteria that would result in a determination that the species be removed. Finally, the plan must include estimates of the financial costs associated with recovery (NOAA Fisheries Office of Protected Resources, http://www.nmfs.noaa.gov/pr/recovery/).

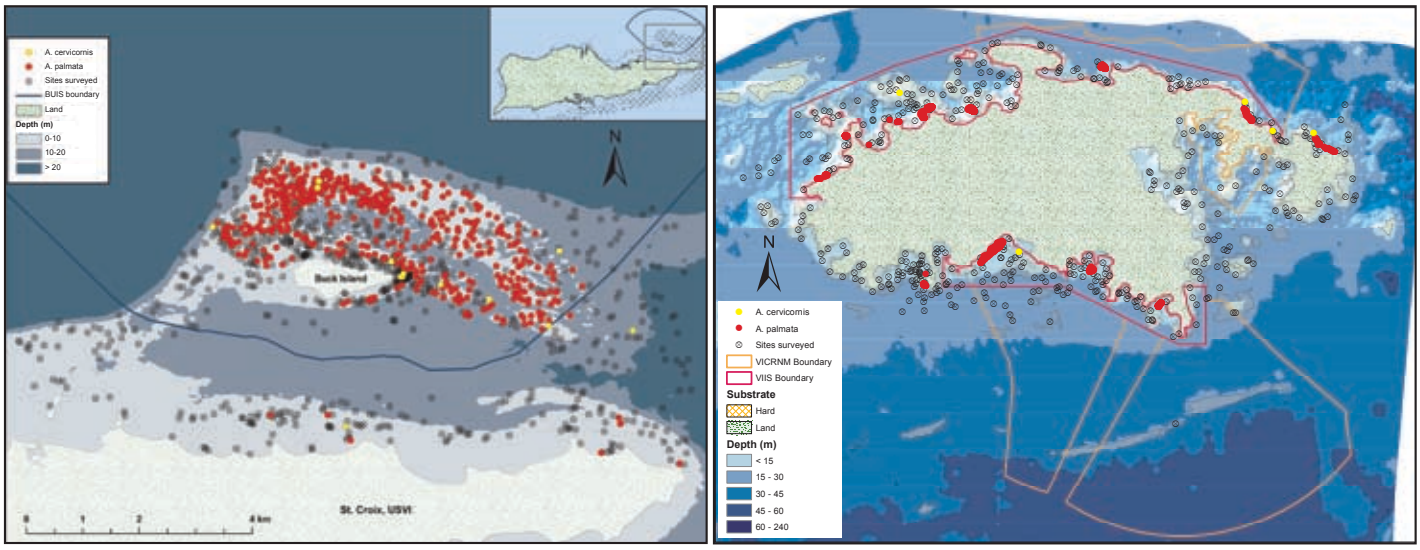

Figure 1.6. Maps of the current distribution of corals in the genus Acropora *have been compiled for several areas in the Atlantic and Caribbean, including at Buck Island near St. Croix (left) and the island of St. John, both of which are part of the USVI. Maps: C. Jeffrey.*

Although listing staghorn and ellkhorn corals as threatened does provide much needed protection, an endangered listing allows for more comprehensive conservation measures. When a species is listed as endangered it automatically receives certain protections (under section 9), including prohibitions against the take of the species, which includes direct removal, damage, injury and harassment. Because NMFS listed staghorn and elkhorn corals as a threatened species, the prohibitions of the ESA do not automatically apply. Therefore, NMFS must determine which of the section 9 ESA prohibitions are necessary to provide for the conservation of the species.

On December 14, 2007, NMFS published a proposed rule under section 4(d) of the ESA to extend all of the section 9 prohibitions with two exceptions. The exceptions provide for specific scientific research and restoration activities. The proposed rule was open for public comment until March 13, 2008. Once the proposed rule is finalized, the prohibitions will apply to all persons subject to the jurisdiction of the U.S.

ESA regulations only apply to the portions of the population that lie within U.S. waters. Both listed acroporid species cross international boundaries; only about 5-10 % of the region's current acroporid population resides within U.S. waters (Bruckner, 2002). Therefore ESA regulations have little or no impact on the vast majority of the population. On the other hand, the mandated recovery plan must address rehabilitation of the species throughout its range. As a result, the plan will identify actions that are necessary to recover the species in all countries in which both species are found, which can encourage international conservation measures. For further information about the ESA and the listing of these species please visit http://www.fws.gov/endangered/ and http://sero.nmfs.noaa.gov/pr/esa/acropora.htm.

SOCIAL SCIENCE AND THE HUMAN DIMENSIONS OF CORAL REEF ECOSYSTEMS

During 2006 and 2007, the U.S. coral reef jurisdictions employed an increased focus on social science projects. Table 1.2 shows what projects have been conducted to date or are ongoing in the jurisdictions.

The external review for NOAA's Coral Reef Conservation Program recommended greater incorporation of social science research in November 2007, so an expanded focus on social science is expected in 2008 and 2009. Next steps include encouraging research in topics that are missing in the matrix, completing economic valuation studies for Puerto Rico and the U.S. Virgin Islands, and making increased connections between biophysical and social science data.

Understanding the value and human use of coral reefs is critical to reducing threats and sustaining healthy coral reef ecosystems. In particular, coral reef ecosystems in nearshore waters are vulnerable to the impacts of human activities, both directly by exploitation of reef resources and indirectly by deleterious land-based activities. The livelihoods and prosperity of people living in tropical coastal areas depend on, and influence, the conditions of marine resources. Coastal activities and their eventual impacts on reefs are inextricably linked, woven into the social, cultural, and economic fabric of regional coastal communities.

U.S. coral reef jurisdictions have implemented various research and monitoring projects to determine the economic valuation of reef resources and the impacts on local communities of coastal management activities such as MPA implementation. Improving our understanding of the underlying human motivations, beliefs, and perceptions regarding coral reef ecosystems is vital to the conservation and adaptive management of these valuable resources.

Between 2004 and early 2007, three major economic valuation projects were completed for the coral reefs of Guam, CNMI, and American Samoa. These studies, described below, used a combination of household interviews, economic

Table 1.2. Social science projects conducted in U.S. coral reef jurisdictions. Source: C. Loper.

	USVI	Puerto Rico	Southeast Florida	Florida Keys	Navassa	Flower Garden Banks	Main Hawaiian Islands	Northwestern Hawaiian Islands	American Samoa	Pacific Remote Island Areas	Marshall Islands	Federated States of Micronesia	CNMI	Guam	Palau
Commercial Fishing															
creel surveys	●	●	●	●	X	O	●	●	●	X	●	O	●	●	●
knowledge, attitudes, and perceptions	●	●	O	●	●	O	Θ	●	O	X	●	Θ	O	Θ[3]	Θ
economic impacts of coral reefs	●	●	●	●	●	O	●	●	●[2]	X	●	O	●[2]	●[2]	O
dependency on reefs	●	●	●	●	●	O	●[2]	●	●[2]	X	●	O	●[2]	●[2]	O
Recreational Fishing															
knowledge, attitudes, and perceptions	O	O	●	●	X	O	Θ	X	O	X	O	Θ	O	Θ[3]	Θ
economic impacts of coral reefs	O	O	●	●	X	O	●[2]	X	●[2]	X	O	O	●[2]	●[2]	O
dependency on reefs	O	O	●	●	X	O	●[2]	X	●[2]	X	O	O	●[2]	●[2]	O
Subsistence Fishing															
knowledge, attitudes, and perceptions	O	O	X	X	●	X	Θ	X	Θ[4]	X	●	Θ	O	Θ[3]	Θ
economic impacts of coral reefs	O	O	X	X	●	X	●[2]	X	●[2]	X	●	O	●[2]	●[2]	O
dependency on reefs	O	O	X	X	●	X	●[2]	X	●[2]	X	●	O	●[2]	●[2]	O
non-market use valuation	O	O	X	X	●	X	●[2]	X	●[2]	X	●	O	●[2]	●[2]	O
Non-consumptive users (residents)															
knowledge, attitudes, and perceptions	Θ[1]	Θ[1]	O	●	X	●	Θ	X	O	X	Θ	Θ	O	Θ[3]	O
economic impacts of marine reserves	Θ[1]	Θ[1]	O	●	X	●	O	X	O	X	O	O	O	O	O
non-market use valuation	Θ[1]	Θ[1]	●	●	X	●	●	X	●[2]	X	O	O	●[2]	●[2]	O
Non-consumptive users (visitors)															
knowledge, attitudes, and perceptions	O	O	O	●	X	Θ	Θ	X	O	O	O	O	O	O	Θ
economic impacts of marine reserves	O	O	O	●	X	Θ	Θ[1]	X	O	O	O	O	O	O	Θ
non-market use valuation	O	O	O	●	X	Θ	Θ[1]	X	●[2]	O	O	O	●[2]	●[2]	Θ
Non Users															
knowledge, attitudes, and perceptions	O	O	O	O	O	O	Θ[1]	Θ[1]	O	O	O	Θ	O	O	O
non-market non-use valuation	O	O	O	O	O	O	Θ[1]	Θ[1]	O	O	O	O	O	O	O

O not completed
Θ partially completed
● completed
X not applicable

1. In progress
2. Commercial Fishing Panels
3. Economic Valuation Studies
4. Knowledge, Attitudes and Perceptions (KAP) study of the Florida Keys
5. Education Study

impact analysis, and stated preference surveys to estimate a total value for coral reef resources in the jurisdictions. Two more projects are planned for Puerto Rico and the USVI. Conducted by independent researchers, these studies will be used to highlight the economic importance of coral reefs to the economies and cultures of U.S. coral reef jurisdictions.

The Economic Value of Guam's Coral Reefs
This study, which included interviews of 400 local residents, revealed that over 90 percent of Guam residents make regular use of the beach and ocean for activities such as swimming, barbequing, fishing, and snorkeling. Approximately 40 percent of local residents fish on a regular basis, and fishing was identified to be more important as a social activity than for generating income. In economic terms, the value of Guam's coral reefs is derived from tourism, diving and snorkeling, fishing, property values, coastal protection, and biodiversity. The total economic value of Guam's reefs was estimated at $127.28 million per year, with tourism accounting for approximately 75 percent of this value. This report is available online at: http://www.coralreef.gov/taskforce/pdf/guam_susfin_palau.pdf.

The Economic Value of the Coral Reefs of Saipan, Commonwealth of the Northern Mariana Islands
This report estimated the total economic value of Saipan's reefs is $61.16 million per year, with tourism comprising about 70 percent of this value. The report concluded with three main recommendations, combining the findings of the valuation study and associated surveys with priorities identified in CNMI's Local Action Strategy. These recommendations include establishing measures to: address the issue of nonpoint and point source pollution; make use of the cultural importance residents place on marine ecosystems to improve coral reef management; and develop a comprehensive system of user fees for visitors of MPAs on Saipan. The report is available online at: http://cnmicoralreef.net/Saipan%20final%20report%20zip%20Feb2006.pdf.

Economic Valuation of American Samoa's Coral Reefs and Adjacent Habitats
This study estimated that the territory's coral reefs provide $5 million in benefits each year to American Samoan residents and visitors. While still significant, this value was lower than expected because tourism and recreational access to corals are limited, extensive man-made shoreline defenses have already been constructed due to beach sand and rubble mining, and the population is relatively small and poor. The American Samoa reef valuation study was conducted by a different set of researchers than the Guam and CNMI studies, which may have resulted in different methodologies for determining total economic values and may account for some of the differences in the totals for American Samoa versus Guam and CNMI. A copy of the report is available online at: http://doc.asg.as/crag/ASCoralValuation04.pdf.

The American Samoa Department of Marine and Wildlife Resources (DMWR), in partnership with the Coral Reef Advisory Group and NOAA, hosted a training workshop in Socioeconomic Assessment and Monitoring. The training was designed to improve manager and staff capacity to integrate socioeconomic analysis into the design, management, and monitoring of MPAs in American Samoa.

Socioeconomic Monitoring through the Global Socioeconomic Monitoring Initiative
In 2006, NOAA began coordination of the Global Socioeconomic Monitoring Initiative (SocMon). SocMon supports regional and national training workshops around the world to help reef managers incorporate socioeconomic assessments and monitoring into their reef management programs. This program has expanded to include domestic areas, including Puerto Rico, USVI, the Pacific territories and the FAS in 2007.

Tortugas Integrated Assessment in the Florida Keys National Marine Sanctuary
In 2006, NOAA initiated an integrated assessment of the Tortugas Ecological Reserve (TER) in the Florida Keys National Marine Sanctuary (FKNMS). The TER is a 151 nmi^2 (119 km^2) no-take zone created in July 2001 and located approximately 70 miles west of Key West. The Tortugas Integrated Assessment, which will be completed in 2008, involves a team of biophysical and social scientists assembled to assess the pre- and post-designation conditions of the TER and surrounding areas, as well as the impacts on both human and biophysical systems from establishment of the TER. This project, when complete, will provide important data regarding the effectiveness of MPAs. This study will also assess any short-term negative impacts to displaced users and identify shifts from consumptive to non-consumptive uses that may have occurred to offset losses that resulted from the displacement.

Ethnographic Profiles
Ethnographic community profiles related to fisheries and fish resources have been completed for the USVI and Puerto Rico, and the results can be found in the Puerto Rico and USVI chapters of this report.

Commercial Fishing Panels in the Florida Keys National Marine Sanctuary (FKNMS): Years 7 and 8
In the Florida Keys, four panels of commercial fishermen have been studied each year since 1998 to track impacts of fishing regulations. The panels were designed to monitor the impacts of the no-take regulations that went into effect on July 1, 1997 and establish a baseline panel for the TER, which went into effect on July 1, 2001. The four panels are: (1) general commercial fishermen not displaced from the no-take areas (used as a control group); (2) marine life collectors for the aquaria trade; (3) fishermen displaced from the Sambos Ecological Reserve; and 4) fishermen displaced from the TER. Information collected from these fishermen each year includes total catch, spatial distribution of catch, revenues, costs, and net earnings. An assessment based on eight years of data will assess whether the no-take areas in the FKNMS had any financial impact on the commercial fisheries. Information from the Tortugas panel is also being used in the Tortugas Integrated Assessment. The research team has recommended that the panels be converted to regionally-oriented panels and integrated with biological/ecological monitoring in the region.

Knowledge, Attitudes, and Perceptions of Regulations and Management Strategies in the FKNMS
In 2005, NOAA funded a ten-year replication of a baseline study completed in 1995-1996 by researchers at the University of Florida and the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences, through a Florida Sea Grant Project. Baseline information was obtained on the knowledge, attitudes, and perceptions about regulations and management strategies being proposed for the FKNMS, in particular the no-take areas, which went into effect in 1997. The baseline and ten-year replication will assess changes in the knowledge, attitudes, and perceptions of FKNMS regulations and management strategies for three user groups: commercial fishermen, dive shop owners and operators, and members of local environmental groups. In 2006, the surveys of commercial fishermen and dive shop owners/operators were completed. A 100 percent response rate was achieved on a random sample of 300 commercial fishing operations, and a 95 percent response rate was achieved for the 65 dive shop owners/operators in the Florida Keys in 2006. The survey of members of local environmental groups began in December 2006, were completed in May 2007, and the analyses and reports are expected in 2008.

IMPROVING THE USE OF MARINE PROTECTED AREAS IN CORAL REEF ECOSYSTEMS

The *Report on the Status of Marine Protected Areas in Coral Reef Ecosystems of the United States Volume 1: Marine Protected Areas Managed by U.S. States, Territories, and Commonwealths* (http://coralreef.noaa.gov/Library/Publications/cr_mpa_report_vol_1.pdf), was developed by NOAA in conjunction with federal, state, territory, and commonwealth partners from the U.S. Coral Reef Task Force (USCRTF). It was produced to help fulfill the goals and objectives of the U.S. *National Action Plan to Conserve Coral Reefs* (USCRTF, 2000) and the *National Coral Reef Action Strategy* (NOAA,

2002), and also helps to advance the goals of Executive Order 13158 on MPAs. Goal number five of the *National Coral Reef Action Strategy* calls for "improving the use of marine protected areas in coral reef ecosystems." Objective one under this goal area is to "conduct and support nationwide, state and territory assessments of the effectiveness and gaps in the existing system of U.S. coral reef MPAs." The report directly addresses that objective by providing an inventory and assessment of existing MPAs that have been established and are managed by the governments of the seven coral reef states and territories. It illustrates the goals and objectives of these areas; describes current efforts to manage them; recognizes common challenges to successful management; and identifies actions that can increase the effectiveness of MPA initiatives.

Efforts to manage a total of 207 MPAs across the seven coral reef jurisdictions are summarized in the report. The large majority of these MPAs (76%) are multiple-use areas that allow some level of extractive activity throughout the entire site. The remaining 49 MPAs include no-take areas in which the harvesting of marine resources is prohibited in parts or all of the MPA. One hundred and forty-seven (71%) of the MPAs were established to sustain, conserve, restore, and understand the coral reef ecosystems or ecosystem components they contain, while almost one quarter of them were established to support the continued extraction of renewable living resources. Of the 207 sites, 86% are permanent sites as opposed to conditional sites whose potential to persist must be considered after a set period of time. Nearly all of the sites (97%) provide constant protection throughout the year; only three percent are seasonal sites in which resources are protected during fixed periods of time. Most of the MPAs (78%) were established to provide an ecosystem scale of protection through which management measures are intended to protect all of the components and processes of the coral reef ecosystem within MPA boundaries. The remaining 22% target a particular habitat, species complex, or single resource.

Many of the MPAs in the assessment contain priority natural resources for coral reef conservation such as fish spawning areas (81 sites) and threatened or endangered species (164 sites). Only 20% of the MPAs (42 sites) have approved management plans (another nine are in development), suggesting that the development of plans to guide long-term MPA management is a challenge for many sites. However, this finding does not mean that management action is not occurring. Of the 194 sites that reported on management actions being implemented, approximately 42% have targeted research and outreach and education programs or activities, 45% have ongoing monitoring activities, and over 74% reported the existence of enforcement activities or programs.

Finally, MPA managers and practitioners from 126 of the sites identified several key challenges that impede the effective management of their MPAs. The most commonly noted challenges were enforcement (83%) and funding and resources (80%). Management capacity (76%), monitoring (65%), and public support (59%) are also challenges for a majority of sites. Other frequently identified challenges to management were lack of interagency coordination and insufficient communication between researchers and managers. These problems must be addressed to improve MPA management effectiveness.

The Pacific Islands Marine Protected Area Community

It has been recognized that Marine Protected Area (MPA) managers in the Pacific Islands face a unique set of challenges including limitations in human and financial resources and isolation from other MPAs. While each MPA has its own strengths and issues, most share the challenge of capacity limitations. They also have in common the great distances between islands that restrict the ability of managers to learn from and apply approaches that have been successful elsewhere. These shared challenges inhibit Pacific Islands MPA systems from being as effective as possible. Nevertheless, many people feel the answers to today's challenges can be found in the islands. Traditional approaches to marine resource management across the Pacific Islands are thousands of years old. For MPA managers, the difficulty lies in building on these traditional approaches while adapting to modern technology and practices. Therefore, to play a successful role in MPA management, traditional and local approaches must be actively fostered, developed, and integrated into current MPA systems.

To address these unique challenges, more than 45 MPA leaders from around the Pacific Islands met in Tumon, Guam from August 26 to 31, 2005 to discuss their common strengths, challenges, and commitments to work together to support effective MPA management in the region (Figure 1.7). The meeting participants shared a common vision for a regional coordination network that would strengthen their individual and collective MPA efforts. The group committed to work together in an evolving regional Pacific Islands MPA Community (PIMPAC). The implementation of PIMPAC aims to build partnerships among Pacific Island MPA practitioners and to bring support to the region in order to strengthen MPA planning, develop-

Figure 1.7. Pacific Island MPA leaders come together in Guam to initiate PIMPAC in 2005. Photo: PIMPAC.

ment, management, and evaluation efforts and better conserve the marine resources of the Pacific Islands. Utilizing these partnerships, PIMPAC has developed a three-year strategic plan that focuses on four main activities:

1) providing training and technical assistance through regional workshops that offer skill development in specific topic areas and on-site technical support for site specific consultations (Figure 1.8);

2) building capacity at academic institutions to foster long-term development of MPA management curriculum and internships to build the next generation of MPA leaders;

3) sharing information and updates on recent MPA accomplishments, science, and funding or learning opportunities relevant to the region;

4) conducting exchange visits to foster peer-to-peer learning among MPA managers and provide opportunities for gaining hands-on experience.

Figure 1.8. Participants learn to assist communities in the development of management plans in Chuuk, 2006. Photo: PIMPAC.

Through collaboration among PIMPAC partners, all of these activities are in progress. Presently, the main focus of PIMPAC training and technical assistance is stakeholder involvement in the development and management of sites, as well as management planning. However, future years will build on this foundation of management planning to provide in-depth technical support in other key MPA topics such as networking, monitoring, enforcement, outreach, and sustainable funding. PIMPAC activities carried out in 2006 and 2007 include; hiring a co-coordinator to support NOAA activities in Micronesia, development of a management planning guidebook, a regional training on management planning, on-site management planning technical assistance for 7 PIMPAC jurisdictions, development of a website/newsletter/list serve, three learning exchanges, and support for seven communications interns.

Finally, the efforts of PIMPAC strongly support several national and regional efforts to develop networks of effective marine protected areas. These efforts include; the U.S. Coral Reef Task Force, the U.S. National System of Marine Protected Areas, and the Micronesia Challenge. PIMPAC will continue to work to coordinate the implementation and establishment of effectively managed MPA sites to help achieve the goals of these large-scale efforts.

THE MICRONESIA CHALLENGE

In January 2006, Governor Felix P. Camacho signed the Micronesia Challenge (MC), a commitment by the Chief Executives of Guam, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau to effectively conserve at least 30% of nearshore marine resources and 20% of terrestrial resources across Micronesia by 2020.

The MC is the result of a process that began at the 7th Conference of the Parties in 2004 in Kuala Lumpur, Malaysia where world leaders committed to an increase in protected areas around the globe. At the 2005 Mauritius International Meeting High Level Event, the Presidents of Palau and the Seychelles called for the establishment of a Global Island Partnership. In November 2005 at the U.S. Coral Reef Task Force Meeting, Palau President Tommy E. Remengesau, Jr. invited the other chief executives from Micronesia to join him in committing to the MC. The MC was then officially announced to the international community by President Remengesau at the 8th Conference of the Parties to the Convention on Biological Diversity (CBD) held in March 2006 in Curitiba, Brazil.

The MC was conceived as a result of the deep commitment of these five leaders to ensure a healthy future for their people, protect their unique island cultures, and sustain the livelihoods of their island communities, by sustaining the island biodiversity of Micronesia (Figure 1.9). The MC also contributes to global and national targets set out in the Millennium Development Goals, the Johannesburg Plan of Implementation for the World Summit on Sustainable Development, the Mauritius Strategy for Small Island Developing States, the U.S. National Action Plan to Conserve Coral Reefs and the relevant Programmes of Work of the Convention on Biological Diversity.

To begin the process of implementing the Micronesia Challenge, 80 representatives from the five jurisdictions participated in a regional action planning meeting in Palau in early December 2006 (Figure 1.10). This meeting resulted in a comprehensive set of recommendations that were endorsed by the Chief Executives of Palau, CNMI and Guam at the

Western Micronesia Chief Executives' Summit in March 2006 and will be presented to the Presidents of the FSM and the RMI at the upcoming Presidents' Summit. Recommendations included the following:

- The establishment of a Steering Committee, comprised of a focal point from each of the jurisdictions;
- The budgeting for and recruitment of a regional coordinator and support staff;
- The development of an annual report;
- The development of a regional fundraising strategy in coordination with national strategies for public and private funds to support the MC;
- The proposal that the Micronesia Conservation Trust house a single endowment in support of the MC;
- The commitment that each jurisdiction takes the appropriate steps to institutionalize the MC, including the engagement of traditional and community leaders; and
- Guam and each of the other four jurisdictions are designing their own strategies to implement the MC involving partnerships between Government agencies, NGOs and local communities. The MC Steering Committee is recruiting a regional coordinator to advance coordination of MC activities across the region.

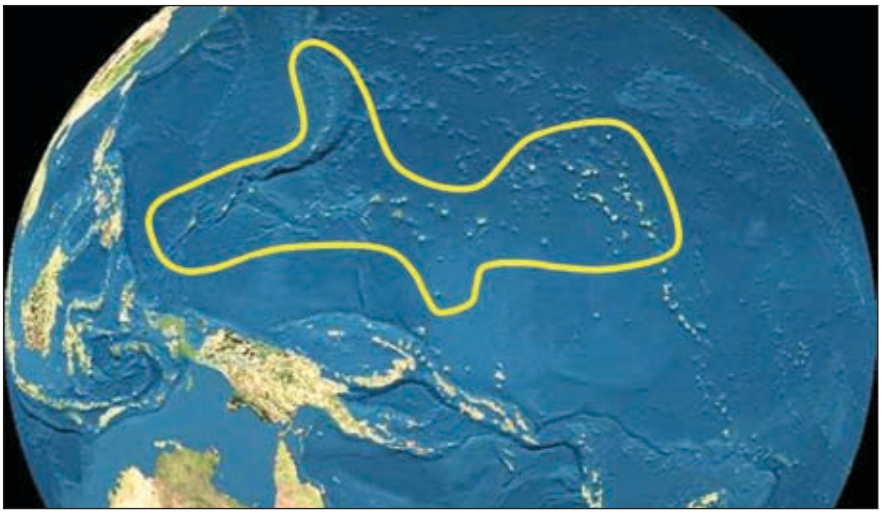

Figure 1.9. The Micronesia Challenge aims to effectively conserve at least 30% of the nearshore marine resources and 20% of the terrestrial resources across Micronesia by 2020. Source: T. Leberer. Map: TNC.

Figure 1.10. President Tommy E. Remengesau, Jr. welcoming delegations from CNMI, FSM, Guam, and the Marshall Islands to Palau for the Micronesia Challenge Action Planning Meeting in December 2006. Photo: S. Menazza Olmsted.

The MC Regional Support Team, with representatives from Conservation International (CI), the Secretariat of the Pacific Regional Environment Program (SPREP), NOAA, Rare (formerly RARE Center for Tropical Conservation), the Micronesia Conservation Trust (MCT), the Locally Managed Marine Area Network, the Community Conservation Network, the Pacific Islands Forum, The Nature Conservancy (TNC), and the U.S. Department of Interior has been formed to provide strategic assistance and external resources required for effective implementation of the MC.

THE CORAL REEF ECOSYSTEM CONSERVATION AMENDMENTS ACT (CRECAA) OF 2007

In May 2007, the Department of Commerce presented Congress with the Coral Reef Ecosystem Conservation Amendments Act (CRECAA) of 2007, an Administration proposal with objectives that aim to strengthen and expand the tools needed to protect coral reef ecosystems for future generations. CRECAA reauthorizes and builds upon the Coral Reef Conservation Act (CRCA) of 2000, extending and increasing authorized funding levels and improving the ability of NOAA and DOI to be more effective at protecting and managing coral reef ecosystems.

Since the 2000 enactment of the CRCA, NOAA and the Coral Reef Conservation Program have worked to build the scientific capacity within a number of U.S. coral jurisdictions, as well as internationally. These efforts are focused on supporting several key objectives. They include: (1) map, monitor, characterize, restore, research, and assess the condition of coral reef ecosystems; (2) provide support for marine protected areas; (3) understand the threats to healthy coral reef ecosystems; and (4) promote public awareness and education on the value of and threats to coral reef ecosystems.

In order to update current coral legislation and tackle new threats, the CRECAA explicitly focuses implementation and management towards better understanding emerging issues (e.g., the association of coral disease and bleaching with climate change). The Administration's proposal would establish consistent guidelines for maintaining environmental data, products and information allowing for more effective information sharing. The most significant proposed changes add authorities to address injuries to coral reefs by providing authorization for funds to be placed into an emergency response fund, allow the government to hold the parties responsible for reef injuries liable for the costs of response and restoration, and provide NOAA and the Department of the Interior with various enforcement authorities. This would establish a damage recovery and enforcement process for all U.S. shallow coral reefs including those in National Wildlife Refuges, and increases the effectiveness of current authorities for recovering damages to reefs in National Parks and National Marine Sanctuaries. The CRECAA provides statutory authorization for DOI coral conservation activities and allows for direct removal of marine debris by the federal government. Finally, recognizing that NOAA's and DOI's existing partnerships are some of the most effective assets in addressing threats to corals, the bill is designed to facilitate existing partnerships with other agencies, governments and organizations.

NOAA anticipates reauthorization of the Coral Reef Conservation Act in 2008 and has been working closely with the House and Senate on development of a final bill. Senate bill S.1580 and House bill H.R.1205 both contain similar concepts to the Administration's proposal, and NOAA is hopeful that these concepts will be included in final legislation. The concepts as they currently appear in the Administration's proposal specifically call for the following nine additions or changes:

1. *Provide additional rationale as to the value of protecting coral reefs and coral reef ecosystems*.
   Additional context on the ecological, social and economic benefits of coral reefs and the threats to coral reef health supports the need for a suite of tools that will enable managers to better understand, manage, and protect coral reefs and coral reef ecosystems provided for by the CRCA.
2. *Provide tools to facilitate response to injury and restoration of coral reefs.*
   A major and all too common threat to coral reefs is mechanical injury, often from events such as ship groundings and improper anchoring. The CRECAA allows for better response to activities resulting in injury to coral reefs, with the costs borne by the parties responsible.
3. *Allow for stronger partnerships.*
   The bill builds on existing NOAA-DOI partner efforts and facilitates partnerships with other agencies, governments and organizations to better meet the directives and mandates of the Act.
4. *Highlight specific threats to coral reef ecosystems and responses to those threats.*
   Provides the authority to conduct a wide variety of activities to understand emerging issues related to coral bleaching and disease, climate change and vessel impacts to reefs.
5. *Data archive, access and availability.*
   The CRECAA of 2007 enhances previous legislation by providing for consistent guidelines for maintaining and sharing environmental data, products, and information that relate to coral reefs.
6. *Update Authorization of Appropriations to reflect the President's budget request and clarify the use of funds.*
   The CRCA specifies the amount of funding that can be used for program administration and overhead; these provisions are updated in the CRECAA.
7. *Amends definitions.*
   The definitions for "coral," "coral reef," and "coral reef ecosystem" are amended for accuracy, to reflect the limited use of the term "coral reef" in the regulatory sections, and to better reflect the scope of the coral reef ecosystem.
8. *Authorize a Coral Program for the Department of the Interior.*
   Enhances DOI's ability to provide technical assistance to states and territories and carry out their research and management objectives.
9. *Minor technical changes.*
   Minor changes including language and further clarification to illustrate that the conservation and management activities undertaken pursuant to the CRCA will have a wider international and global impact on coral reef ecosystems.

For the latest information about CRECAA and to read more about the bill, please visit http://www.coralreef.noaa.gov/welcome.html.

FEDERAL FISHERIES MANAGEMENT

Coral reefs and associated habitats provide important commercial, recreational, and subsistence fishery resources in the U.S. and around the world, and represent a critical food source for many developing countries. Fishing plays a central social and cultural role in many island communities as well. The rich biodiversity of reefs also supports a valuable marine aquarium industry and promises rich genetic resources for pharmaceuticals. However, human population growth, the emergence of export fisheries, and the use of more efficient fishing equipment have led to overfishing[1] and fishing-related impacts on habitats and ecosystems. Increasing evidence shows overfishing significantly alters the ecological balance and contributes to the degradation of coral reef ecosystems.

Overfishing of coral reef resources is the most widespread threat around the world (WRI, 1998). Fishing has been identified as a high threat in every populated U.S. jurisdiction except the Commonwealth of the Mariana Islands (CNMI), where it is categorized as a moderate threat (Waddell (ed), 2005). Fishing was also identified by the states and territories in 2004 as one of five key threats that need to be addressed through specific local action strategies.

NOAA's Fisheries Service has been delegated authority under the Magnuson-Stevens Fisheries Conservation and Management Act to manage coral reef fisheries in federal waters sustainably, principally through fishery management plans developed by regional fishery management councils (FMC). The agency also has responsibility for ensuring the identification, conservation and enhancement of essential fish habitat (EFH), including through consultations with other federal agencies on their activities that may adversely affect such habitat in either state or federal waters. NOAA may also have direct management responsibilities for fisheries within National Marine Sanctuaries, often in collaboration with either the state management agency or the regional FMC.

The four regional fishery management councils that address coral reef fishery issues such as overfishing, habitat impacts, and bycatch are the South Atlantic FMC (http://www.safmc.net); the Gulf of Mexico FMC (http://www.gulfcouncil.org); the Caribbean FMC (http://www.caribbeanfmc.com); and the Western Pacific FMC (http://www.wpcouncil.org). Each of these organizations is active in conserving coral reef associated species within the federal waters under their jurisdiction through various measures, such as the establishment of seasonal and permanent fishery closures in federal waters to protect spawning aggregations or sensitive habitats, promulgation of regulations to control gear types, size limits, catch limits, implementation of actions to reduce interactions between fisheries and protected species, compilation and analysis of commercial and recreational catch data, assessments of socioeconomic and other factors that contribute to fishery issues, and other activities. The FMCs also serve as a resource for fishers by providing timely updates to both federal and state/territorial regulations, identification guides, educational materials and presentations, links to important scientific findings, information on aquaculture initiatives, and other tools. Some of these actions and resources are encompassed in the chapters of this report; further detail can be found on the FMC web sites.

[1] The term "overfishing" refers to significant depletion of reef species by commercial, recreational, or artisinal fisheries. It does not necessarily imply that a status of overfishing or overfished as defined by the Magnuson-Stevens Fisheries Conservation and Management Act has been determined.

U.S. CORAL REEF TASK FORCE 10TH ANNIVERSARY

Given the frequency with which coral reef ecosystems span a broad range of geographical and organizational jurisdictions, coordination across federal, state, and local governments and with non-governmental organizations is essential for designing and implementing effective management and conservation solutions. Executive Order 13089 (Clinton, 1998) on Coral Reef Protection recognizes the value of coral reef ecosystems and directs the U.S. Government agencies to work independently "to ensure actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems." Federal agencies are also directed to work together through the U.S. Coral Reef Task Force (USCRTF) to address, in a collective and strategic way, the threats to coral reef ecosystems and to lead, coordinate, and strengthen U.S. Government actions to conserve coral reef ecosystems, both domestic and international. Co-chaired by the Department of Commerce through NOAA and the Department of the Interior, the USCRTF membership includes senior leaders from 12 federal agencies, seven states, and territories and the three Freely Associated States (Figure 1.11). To implement the policies and requirements of the Executive Order, the USCRTF has provided a forum for coordinated planning and action among federal agencies, state and territorial governments, and non-governmental partners. To fulfill its mission, the USCRTF developed national strategies, targeted initiatives, and new partnerships to strengthen stewardship of the coral reef ecosystems in the United States and around the world. The USCRTF uses a variety of mechanisms to promote collaborative planning, priority-setting, coordination, and partnership building.

U.S. Coral Reef Task Force Members

Co-Chairs
U.S. Department of Commerce, NOAA
U.S. Department of the Interior

Federal Agencies
U.S. Agency for International Development
U.S. Department of Agriculture
U.S. Department of Defense
U.S. Department of Homeland Security
U.S. Department of Justice
U.S. Department of State
U.S. Department of Transportation
U.S. Environmental Protection Agency
National Aeronautics and Space Administration
National Science Foundation

States and Territories
Commonwealth of the Northern Mariana Islands
Commonwealth of Puerto Rico
State of Florida
State of Hawai`i
Territory of American Samoa
Territory of Guam
Territory of the US Virgin Islands

Non-Voting Members
Federated States of Micronesia
Republic of the Marshall Islands
Republic of Palau

The USCRTF has played a key role in identifying the actions required to conserve U.S. coral reef ecosystems through the development of the U.S. *National Action Plan to Conserve Coral Reefs* (USCRTF, 2000) and the *National Coral Reef Action Strategy* (NOAA, 2002). The Plan provides 13 broad goals and objectives, while the Strategy focuses on key implementation measures. The Strategy, which has been in place for more than 5 years, needs a comprehensive reexamination and identification of ongoing and emerging priorities and targets to help guide the future work of the USCRTF. The USCRTF will lead this reexamination and launch a "Renewed Call to Action" at the end of 2008, to carry the legacy of ten years of the USCRTF into the future. The USCRTF, as a leader in collaborative action to conserve coral reefs, wishes to help create a community empowered to better manage and conserve our nations' coral reef ecosystems. More information about the USCRTF activities can be found at http://www.coralreef.gov/.

Figure 1.11. USCRTF members attended a semiannual meeting in American Samoa in August 2007 which included a working retreat at Ofu in the Manua Islands. Photo: B. Dieveney.

INTERNATIONAL YEAR OF THE REEF 2008

Ten years ago, 1997 was declared the International Year of the Reef (IYOR). The first IYOR campaign was initiated in response to the increasing threats and loss of coral reefs and associated ecosystems such as mangroves and seagrass beds. IYOR 97 was a global effort to increase awareness and understanding of coral reefs, and support conservation, research and management efforts.

Ten years later, there continues to be an urgent need to increase awareness and understanding of coral reefs and their connectivity to land-based activities and to further conserve valuable coral reefs and associated ecosystems. Because of this need, the International Coral Reef Initiative designated 2008 as the second International Year of the Reef (IYOR 2008).

IYOR 2008 is intended to:

- Strengthen awareness of ecological, economic, social and cultural values of coral reefs and associated ecosystems;
- Improve understanding of the critical threats to coral reef ecosystems and generate practical and innovative solutions to reduce these threats; and
- Generate urgent action at all levels to develop and implement effective management strategies for conservation and sustainable use of these ecosystems.

While the 1997 IYOR served to raise the profile of coral reef issues and increase our collective awareness of the threats facing these valuable ecosystems, the 2008 IYOR aims to create a community with the knowledge and power to take action to address the threats faced by coral reef ecosystems. There are outstanding examples of successful past efforts to reduce threats and sustain coral reefs, but increased action over the next several years is critical.

Figure 1.12. The artist Wyland created this Caribbean reef scene in honor of IYOR and unveiled the painting at the USCRTF's 10th Anniversary meeting in Washington D.C. in February 2008. Artwork and photo: Wyland.

Wyland, the official artist of IYOR 2008, unveiled his original painting "Year of the Reef" at the 19th U.S. Coral Reef Task Force meeting in Washinton D.C. (Figure 1.12). This partnership, which brings together Wyland's inspirational creativity and the collaborative nature of the U.S. Coral Reef Task Force, creates a new avenue through which we can inspire stewardship of our nations' coral reef resources.

To learn more about IYOR, please visit http://www.iyor.org/.

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.

Bruckner, A.W. 2002. Proceedings of the Caribbean Acropora Workshop: Potential Application of the U.S. Endangered Species Act as a Conservation Strategy. NOAA Tech Memo. NMFS-OPR-24.

Bruckner, A.W., Hourigan, T.F. 2002. Proactive management for conservation of Acropora cervicornis and Acropora palmata: application of the U.S. Endangered Species Act. Proceedings of the 9th International Coral Reef Symposium. Bali.

Bryant, D., L. Burke, J. McManus, M. Spalding. 1998. Reefs at Risk: A map-based indicator of threats to the world's coral reefs. World Resources Institute. Washington D.C.

Hall, H.D. 2006. Endangered and threatened species: final listing determinations for Elkhorn Coral and Staghorn Coral. Federal Registry 79: 26852-26872.

IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/ipccreports/ar4-wg1.htm

Kleypas, J.A., R.A. Feely, V.J. Fabry, C. Langdon, C.L. Sabine, and L.L. Robbins, 2006. Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research, report of a workshop held 18-20 April 2005, St. Petersburg, FL, sponsored by NSF, NOAA, and the U.S. Geological Survey, 88 pp.

Marshall, P. and Schuttenberg, H. 2006. A Reef Manager's Guide to Coral Bleaching. Great Barrier Reef Marine Park Authority, Townsville, Australia.

National Oceanic and Atmospheric Administration (NOAA). Recovery of Species under the Endangered Species Act (ESA). Available from the internet URL: http://www.nmfs.noaa.gov/pr/recovery.

National Oceanic and Atmospheric Administration (NOAA). 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. 120 pp. + appendix. http://www.coris.noaa.gov/activities/actionstrategy/action_reef_final.pdf

National Oceanic and Atmospheric Administration (NOAA). 2007. Proactive Conservation Program: Species of Concern and Candidate Species. Available from the internet URL: http://www.nmfs.noaa.gov/pr/species/concern/.

Precht, W.F., Robbart, M.L., and Aronson, R.B. 2004. The potential listing of *Acropora* species under the U.S. Endangers Species Act. Marine Pollution Bulletin 49: 534-536.

USCRTF (United States Coral Reef Task Force). 2000. The National Action Plan to Conserve Coral Reefs. USCRTF. Washington, D.C. 33 pp. + appendices. http://www.coralreef.gov/taskforce/pdf/CRTFAxnPlan9.pdf

U.S. Fish and Wildlife Service. 2005. Endangered Species Glossary. Available at http://www.fws.gov/endangered/glossary.pdf.

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'sBiogeography Team. Silver Spring, MD. 522 pp. http://ccma.nos.noaa.gov/ecosystems/coralreef/coral_report_2005/

Wusinich-Mendez, D. and C. Trappe, eds., "Report on the Status of Marine Protected Areas in Coral Reef Ecosystems of the United States Volume I." Silver Spring, MD: NOAA Coral Reef Conservation Program, February 2007. http://www.coralreef.noaa.gov/Library/Publications/cr_mpa_report_vol_1.pdf