

REPORT ON NOAA CORAL REEF CONSERVATION PROGRAM ACTIVITIES FROM 2010 TO 2011



U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Produced by NOAA's Coral Reef Conservation Program

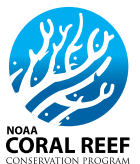
IMPLEMENTATION OF THE NATIONAL CORAL REEF ACTION STRATEGY

REPORT TO CONGRESS



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This document was produced by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, to fulfill requirements of the Coral Reef Conservation Act of 2000 (P.L. 106-562; 16 U.S.C. & 6401 et seq.).

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About

This report covers coral reef-related activities conducted by the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program during Fiscal Years 2010 and 2011. It fulfills the requirement under the Coral Reef Conservation Act of 2000 of periodic reporting on the activities undertaken to advance coral reef conservation as outlined in the National Coral Reef Action Strategy.

During the period covered by this report, the Coral Reef Conservation Program operated pursuant to the goals and objectives organized under the following three themes established by the NOAA Coral Reef Conservation Program Goals & Objectives 2010-2015: climate change impacts, fishing impacts, and impacts from land-based sources of pollution. The Coral Reef Conservation Program was also directed by goals and strategies outlined in the NOAA Coral Reef Conservation Program International Strategy 2010-2015 and the NOAA Coral Reef Conservation Program Communications, Education and Outreach Strategy 2010-2015. The goals described in each of these strategies guided most of the funding and activities undertaken by the program from 2010-2011, and the content is organized accordingly.

Acknowledgments

This document highlights NOAA activities to implement the National Coral Reef Action Strategy as required through the Coral Reef Conservation Act of 2000. However, NOAA works closely with many collaborators and partners to implement this work. We would like to thank our Federal, State, Territory, and local agency partners; non-governmental organizations; academic institutions; and other partners for their contributions and dedication to improving the condition of coral reef ecosystems.

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Executive Summary

Healthy coral reefs provide valuable services to the American public and communities living along our coastlines – food security, resources for economic growth, recreation and tourism, coastline protection, and cultural identity. Among the most biologically diverse and economically valuable ecosystems on earth, coral reefs ensure the well-being of growing coastal communities and local economies. Yet, their ability to provide for the health and well-being of present and future generations is increasingly compromised worldwide. According to *Reefs at Risk Revisited*, approximately 75 percent of the world’s coral reefs are currently threatened by a combination of local and global pressures (Burke et al. 2011), relating to the impacts of fishing, land-based sources of pollution, and global climate change, among others. For coral reef ecosystems in the future to provide for human well-being depends increasingly on developing the capacity of the U.S. and coral reef countries to better manage human uses and impacts and to protect and conserve coral reefs’ self-repairing capabilities (Agardy et al. 2011). Central to addressing the impacts to coral reef ecosystems is fundamentally broadening the way people have been managing coral reefs and coastal systems.

Coral reef ecosystem management must be done through an ecosystem-based management approach that goes beyond a sectoral approach to managing single-issues or single-species in isolation, to recognize the ecological system holistically as a rich mix of natural and social factors that interact with each other in important ways. Thus, marine ecosystem-based management promotes integrating coastal zone management, watershed management, ecosystem approaches to fisheries management, and climate adaptation measures.

NOAA’s Coral Program is guided by the principle to maximize conservation efforts to

reverse declines in coral ecosystem condition and the services they provide the American public, as established in the Coral Reef Conservation Act of 2000 (CRCA) (16 U.S.C. §6401 et seq.). NOAA’s Coral Program implements its mission by directly supporting or implementing ecosystem-based science, management and conservation across the Nation’s shallow-water coral reef ecosystems, as well as internationally, particularly in coral reef countries whose coral reefs are ecologically connected to our own. Few organizations are as well-poised as NOAA’s Coral Reef Conservation Program (also referred to as the Coral Program) to support ecosystem science, management and conservation across the entire expanse of coral reef ecosystems in the United States. Thus, the Coral Program represents a rare model critical for global leadership in ecosystem conservation and for global learning and refining our best practices in conserving ecosystems integral to societal, economic, and human well-being.

Domestically, the Coral Program funds and equips coral reef conservation activities by NOAA and its partners in the seven U.S. states and jurisdictions containing coral reefs (American Samoa, the Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawai`i, Puerto Rico, and the U.S. Virgin Islands), uninhabited islands including the northwestern Hawaiian Islands and the Pacific Remote Island Areas. Internationally, the Coral Program engages in coral reef conservation in four international priority regions, including efforts in the Pacific Freely Associated States of Palau, Republic of the Marshall Islands, and the Federated States of Micronesia. Effectively conserving coral reefs in the United States can only be achieved by domestic and international efforts, because nearly all U.S. coral reefs are ecologically connected to reefs abroad and some of the most significant threats are global in nature.



Figure 1: The Coral Reef Conservation Program focuses its efforts on seven U.S. coral reef jurisdictions indicated on the map above.

The Coral Program’s longstanding monitoring and assessment programs provide a comprehensive overview of the status and trends of coral reef ecosystems, invaluable for adaptive management. In the seven coral reef states and territories, the Coral Program supports management agencies’ priority needs in the coastal zone, protected areas, and fisheries management councils, and addresses capacity gaps through targeted technical assistance and supporting innovation. Institutionally, this matrix program encompasses the range of expertise and tools to achieve ecosystem-based management in drawing from NOAA’s Ocean Service, National Marine Fisheries Service, National Environmental Satellite and Information Service, and the Office of Oceanic and Atmospheric Research. The Coral Program also supports social science activities to better link communities, offer new tools, approaches, peer-exchanges, and partnerships in combatting the impacts of climate, fishing, and land-based sources of pollution; and provides

the imperative communication link to society through education and outreach.

The Coral Reef Conservation Act of 2000 (CRCA) (16 U.S.C. §6401 et seq.) requires NOAA to report to the U.S. Congress every two years regarding implementation of the National Coral Reef Action Strategy. This document, the fourth report on implementing the National Coral Reef Action Strategy, highlights NOAA activities and accomplishments for Fiscal Years 2010 and 2011 and emphasizes collaborative efforts between NOAA and partners in Federal, State and Territory agencies, non-governmental organizations (NGOs), and academic institutions, among others. A few highlights of accomplishments follow.

In 2010 and 2011, the Coral Program focused on providing information and capacity for the creation, implementation and improvement of Marine Protected Areas (MPA). This included evaluating the effectiveness of different types



Figure 2: At Maug, which is part of the Marianas Trench Marine National Monument, a NMFS PIFSC CRED diver in April 2011 conducts a Rapid Ecological Assessment survey of the benthos along a transect draped over corals of the genus *Porites*, which has been observed during Pacific Reef Assessment and Monitoring Program (Pacific RAMP) expeditions as a dominant part of the reef assemblage off the west coast of Maug's East Island. Photo Credit: Erin Looney, NOAA

of MPAs; identifying spawning aggregations for future protection; and collecting fishery-independent data to improve fishery management plans and provide context for fish population trends within MPAs. Minimizing destructive impacts from fishing and achieving responsible, ecosystem-based stewardship of reef fisheries pays lasting dividends to healthy coral reefs and to fishing livelihoods.

Coral reefs suffer major impairments from sediment runoff and from surges in algal cover caused by nutrient pollution. In 2010 and 2011, the Coral Program invested significantly in projects addressing land-based sources of pollution, including watershed management planning, building local capacity to address watershed issues, implementing best management practices to mitigate land based sources of pollution inputs, and monitoring the biological effects of land-based sources of pollution (e.g., biological surveys and analyses, measuring water chemistry and creating habitat

maps to locate sensitive areas). Identifying and controlling land-based sources of pollution are a win for coral reefs and the water quality of watersheds draining to them.

In 2010, Coral Program launched its International Program to strengthen and expand U.S. involvement in international coral reef conservation efforts. The Coral Program's international efforts prioritize its work in support of regional ocean governance initiatives (i.e., Coral Triangle Initiative, Micronesia Challenge) in four international priority regions: the wider Caribbean, Micronesia, Samoa and the Southwest Pacific, and the Coral Triangle.

The Coral Program recognizes the need to better manage data and information produced to ensure accessibility, archiving, and use by NOAA and other partners. As such the Program is developing a Data Management Policy and a Data Management Plan. Finally, to track and measure its outcome-oriented goals, the

Program designed a series of 18 performance measures to consistently and thoughtfully look at both intermediate and long-term outcomes. Thus, the Coral Reef Conservation Program can observe changes in the ecosystem measured through targeted monitoring and use this feedback in designing future strategies for coral reef conservation.

The CRCA also calls on NOAA to develop a national coral reef action strategy and to periodically review and revise the national action strategy and incorporate new and enhanced scientific understanding, increased management actions and the current condition of coral reef ecosystems, and relevant threats. The Coral Reef Conservation Program completed a strategic planning process in 2010 to refine the Program's performance and efficiency measures and realign the focus of Program resources and external funding to address the top three recognized global threats impacting the world's coral reef ecosystems; climate change, fishing, and pollution. The Coral Reef Conservation Program has also expanded its international presence by becoming more actively involved in coral conservation efforts in Micronesia, the Southwestern Pacific, the Coral Triangle, and the wider Caribbean. Given the social, economic, and political aspects of coral reef management, the Coral Reef Conservation Program is increasing its social science portfolio to strategically engage local communities, better assess community impacts of management measures, and enhance efforts in education and outreach activities. Given these broad scale programmatic changes, an updated and refined National Coral Reef Action Strategy was developed as a component of this report and is included in Appendix II.

The Coral Reef Conservation Program's multidisciplinary approach of supporting

cutting-edge coral reef monitoring, research, assessment, and education, outreach and community engagement is designed to improve the outlook for coral ecosystems worldwide and the people who depend on them. Coral ecosystems are valuable resources at risk and with effective leadership and management, healthy, resilient reef ecosystems can continue to provide a myriad of valuable services to current and future generations.



Goal Summary & Accomplishment Update

Healthy coral reef ecosystems are among the most biologically diverse and economically valuable ecosystems on earth, providing hundreds of billions of dollars in food, jobs, recreation opportunities, coastal protection, and other important services. A 2011 study commissioned by NOAA reveals that the American people value the goods and services provided by the coral reef ecosystems of the main Hawaiian Islands at \$34 billion. Yet despite their ecological and economic value, coral reefs are threatened by an increasing array of impacts, many of which are manmade.

To make the most effective use of resources and to have the largest impact to reverse general declines in coral reef condition, the Coral Reef Conservation Program narrowed the focus of its domestic program and shifted allocation of its resources to take on-the-ground and in-the-water action. In 2010, the Coral Reef Conservation Program began concentrating its efforts to understand and address the top three recognized global threats to coral reef ecosystems: impacts from climate change, fishing, and from land-based sources of pollution. In Fiscal Years 2010 and 2011, the Coral Reef Conservation Program strategically invested in numerous efforts to mitigate the impacts of these three primary threats and advance coral reef ecosystem science and conservation. The following sections highlight many projects and notable outcomes that are a result of the Coral Reef Conservation Program's concentrated efforts during this time period.

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IMPACTS FROM CLIMATE CHANGE AND OCEAN ACIDIFICATION

Climate change and ocean acidification were identified as the most important threats to coral reefs on a global scale. In 2007, the

Intergovernmental Panel on Climate Change (IPCC) noted that the evidence is now “unequivocal” that the earth’s atmosphere and oceans are warming and concluded that these changes are primarily due to greenhouse gases, especially the accelerating increase of carbon dioxide in the atmosphere. While reducing carbon dioxide and other greenhouse



Figure 3: Bleached fire coral observed in the Flower Garden Banks National Marine Sanctuary in 2010. Credit: NOAA

gas emissions is vital to stabilize the climate in the long term, excess carbon dioxide already in the atmosphere will continue to alter global climate patterns throughout the next century. Tropical ocean temperature has risen by 0.5°C since the late 19th century causing increasingly frequent and severe bleaching of corals around the world. At the same time, the ocean absorbs approximately one-third of the additional carbon dioxide generated every year by human activities, making the ocean more acidic (Caldeira and Wickett 2003, Sabine et al. 2004). The resulting change to the ocean chemistry has important consequences for coral reefs and other marine life. These changes have already had negative impacts on coral reef ecosystems and will continue to affect coral reef ecosystems globally over the coming century by causing mass coral bleaching events and slowing the growth of coral skeletons (Hoegh-Guldberg et al. 2007, De'ath et al. 2009). Infectious disease

outbreaks are also likely to be more frequent and severe as temperatures rise, increasing coral mortality. Climate change will have other impacts on marine systems such as sea level rise; altered frequency, intensity and distribution of tropical storms; altered ocean circulation with its effects on larval connectivity and productivity; and others. All of these impacts combine, often synergistically, to threaten important ecosystem function and reduce global biodiversity.

NOAA, with its partners, is targeting efforts to reduce local stressors, while monitoring the impacts of global-scale stressors. In many cases, however, it will not be enough to reduce non-climate stressors, so direct action is needed to reduce the impact that climate change and ocean acidification have on coral reefs. To address the problems of anthropogenic climate change and ocean acidification, four goals have

been identified by the Coral Reef Conservation Program to help coral reefs cope with climate change. These are:

- *Goal*

2011Aug 2 NOAA 60% Probability Coral Bleaching Thermal Stress for Aug-Nov 2011
 CFS-based, Experimental v1.0, 28-member Ensemble Forecast

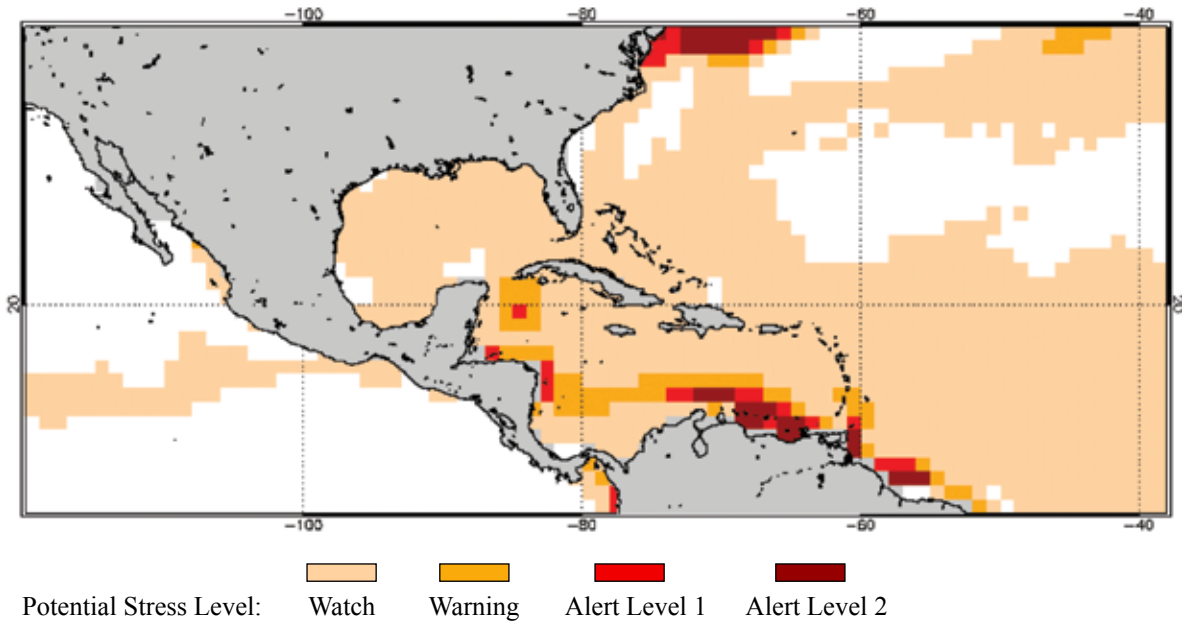


Figure 5: Areas that have a 60 percent or higher probability of reaching critical levels of thermal stress, with darker colors denoting areas with a potential for more severe coral bleaching events. Credit: NOAA

Developing Operational Seasonal Coral Reef Bleaching Forecasts for Coral Reef Management

High temperature events cause coral mortality from bleaching and disease. The Coral Reef Conservation Program is developing new outlook products that forecast coral bleaching events months before they occur. This system will expand existing bleaching forecasts by using water temperature predictions from the NOAA Weather Service’s operational Climate Forecast System. This improvement will provide greater ability to forecast impacts of climate events, such as El Niño, on the potential for coral bleaching, offering guidance similar to that used in seasonal climate forecasts of the U.S. and elsewhere. Results include a tool for managers and scientists to prioritize response alternatives; which may include early communication with reef users and stakeholders, reducing activities that compound stress to a coral reef, and/or monitoring to better

understand which reefs are resilient to bleaching events to inform protected area planning and design.

Improving Our Understanding and Monitoring of Coral Disease Outbreaks in Hawai’i

Coral susceptibility to disease has been linked to rising water temperature. In response to this threat, the Coral Reef Conservation Program: collated existing disease data from across the Hawaiian archipelago; conducted targeted disease surveys; identified outbreak causes; and subsequently developed a risk assessment tool for disease outbreak potential around the Hawaiian Islands. Over 800 individual disease surveys from the main and northwestern Hawaiian Islands were collated into a unified database that is now available to the research and management community. Knowing the risk of coral disease outbreaks allows managers to reduce other stressors, and provides the only

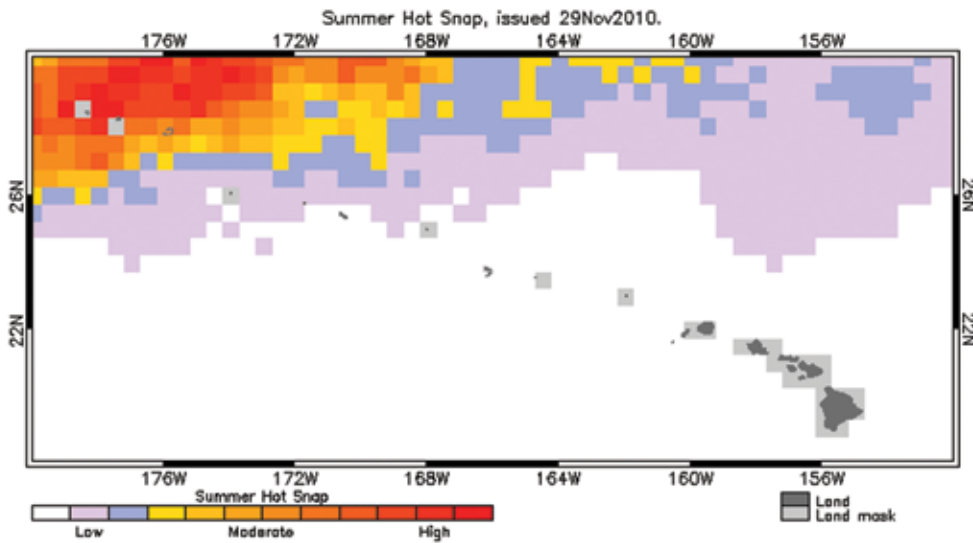


Figure 6: Satellite monitoring of Summer Hot Snap accumulation for 2010, one element of the disease outbreak risk assessment.

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timely information for remote regions of the archipelago. This disease prediction system contributes to a framework for early warning, communication, monitoring, research, and management response to protect coral reef ecosystems from disease events.

Predicting Impacts to Coral Reefs Based on Intergovernmental the Panel on Climate Change Fifth Assessment Report Scenarios

Quantifying the impacts of climate change on coral reefs is critical to making proactive decisions about the need to mitigate greenhouse gas emissions and enhance coral reef resilience to climate change. A collaborative effort between NOAA and academic partners involves projecting potential effects of climate change on the frequency of mass coral bleaching events and changes in coral cover – the amount of living coral in a specific area. On a local and regional level, these forecasts will guide broad conservation decisions and inform management

efforts to enhance coral reef resilience. The products resulting from this Coral Reef Conservation Program effort can help identify coral reefs and regions that may be more resistant or resilient to climate change, a key consideration in the design and management of MPAs. On a global level, the forecasts of bleaching frequency and trajectories of coral cover under different and future emission scenarios will help guide greenhouse gas management and policy decisions. Results of this effort are being designed to contribute to the next IPCC Assessment report and will provide input to U.S. and global coral reef status reports.

Measuring Differences and Long-Term Trends in Ocean Acidification Impacts on Coral Reef Ecosystems among U.S. Pacific Islands and Atolls

Much is unknown about how organisms living within coral reef ecosystems have and will cope with changing ocean chemistry. Current research suggests ocean acidification



Figure 7: The Atlantic Ocean Acidification Test-bed represents a nexus of Federal and academic research and monitoring efforts aligned to improve our understanding of how ocean acidification is impacting coral reef ecosystems. Credit: Ryan Moyer, U.S. Geological Survey and NOAA

will reduce live coral growth rates, and perhaps erode existing reef structure. The Coral Reef Conservation Program initiated a multifaceted approach to monitor the impacts of ocean acidification across the U.S. Pacific islands and atolls to study past, present, and future conditions. These data will serve as the baseline for current oceanographic and ecosystem conditions and will provide a tool for assessing coral reef condition and ecosystem response to changes in oceanic waters. Coral cores will be used to investigate the historical growth record. Coral growth often fluctuates with environmental stresses, such as heating events, ocean acidification or land use changes. By using this technique, scientists can understand how corals have behaved in the past under varying environmental conditions. This information will provide context for understanding current and future conditions and how corals are able to adapt to them, and assist in identifying areas that may provide future refuge to coral reefs.

Enhancing our Capacity to Monitor and Understand Ocean Acidification in Coral Reef Ecosystems

An increased understanding of ocean acidification and its impacts is needed to properly manage coral reef ecosystems for the long term. In 2009, the Coral Reef Conservation Program established the Atlantic Ocean Acidification Test-bed (AOAT) to observe and model ocean acidification impacts in the region. The test-bed is designed to characterize water chemistry changes in coral reef ecosystems; refine methods for monitoring ocean acidification impacts to coral reef ecosystems; and quantify ocean acidification status and trends to develop vulnerability risk indexes for coral reef ecosystems. These sustained observations have already revealed complexity in the conditions of the coral reef environment that differ from neighboring oceanic water conditions, and that biological processes affect water chemistry in ways that

may compromise reef health much sooner than anticipated. In addition, the AOAT serves as a vital venue to foster collaborative research efforts with other Federal agencies and academic partners to develop techniques and tools to monitor and quantify changes due to ocean acidification.

Developing a NOAA Coral Reef Conservation Program Ocean Acidification Science Plan

The NOAA Coral Reef Conservation Program Ocean Acidification Science Plan was completed in 2011 and is intended to guide NOAA-funded coral reef ecosystem ocean acidification research for 2012-2016, including research conducted through extramural partners, grants, and contracts. The plan covers all shallow-water coral reef ecosystems under the jurisdiction of the United States and outlines national research needed to address the many management challenges in reducing threats to coral reefs, reversing coral reef declines, and promoting the resilience of coral reef

ecosystems. The science plan is designed to be a resource to help NOAA set priorities for ocean acidification research in coral reef ecosystems.

Next and Future Steps

The Coral Reef Conservation Program will continue to improve its strong science foundation that provides understanding of coral reef ecosystem function, structure and condition, supports development and evaluation of tools and approaches to assess the ecological and economic impacts of climate change and ocean acidification, and inform management actions. Future efforts will focus on: the development of tools and products that aid coral reef ecosystem management and decision making; monitoring and strategies to help protect coral reefs resilient to climate change; and building awareness about the impacts of climate change and ocean acidification. In addition, the Coral Reef Conservation Program contributed to the development of the National Fish, Wildlife, and Plants Climate Adaptation Strategy, and in reviewing the draft National

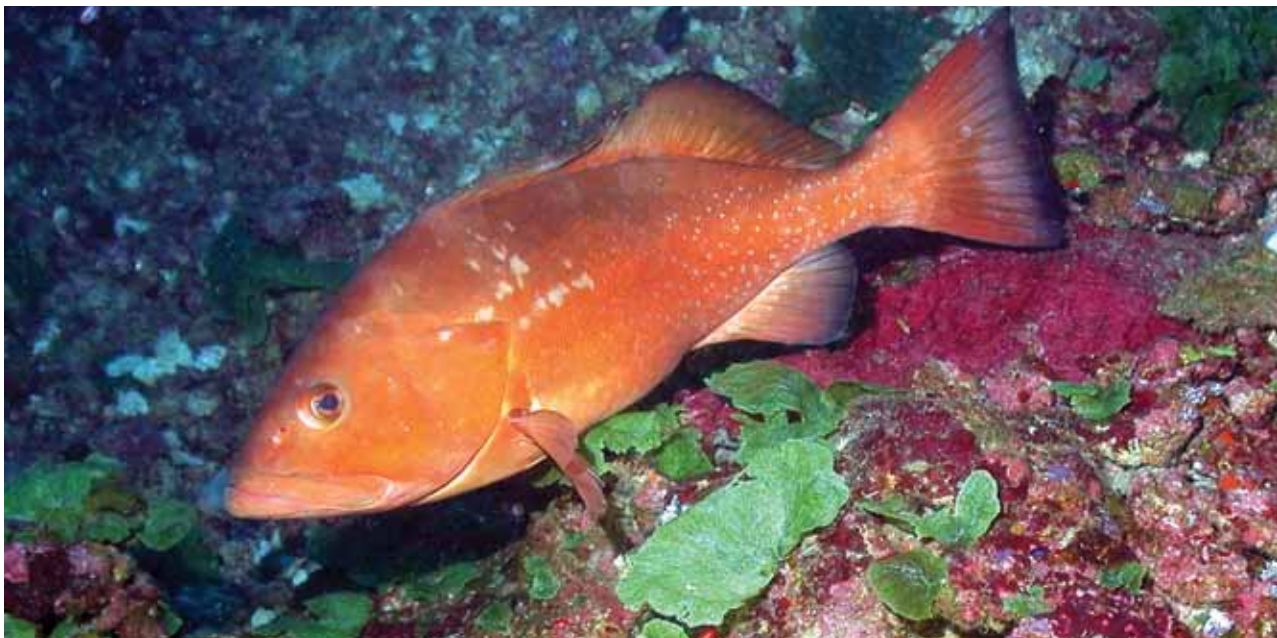


Figure 8: Red grouper (*Epinephelus morio*) on Pulley Ridge off southwest Florida. Credit: National Undersea Research Center, University of North Carolina Wilmington and NOAA



Figure 9: Derelict fishing net in the Oculina Habitat Area of Particular Concern off the east coast of Florida. Credit: NOAA

Ocean Policy and the Interagency Task Force on Climate Change Adaptation has considered how the activities outlined in those documents can align well with current and future priorities of the Coral Reef Conservation Program (see the Formal Partnerships section of this report for more information on the National Ocean Policy).

FISHING IMPACTS

Coral reef fisheries, though often relatively small in scale, may have disproportionately large impacts on the ecosystem if conducted unsustainably. Rapid human population growth, demand for fishery resources, use of more efficient fishery technologies, and inadequate management and enforcement have led to the depletion of key reef species and habitat damage in many locations. Regional fish assessments have demonstrated declines in reef fish abundance and correlations between reduced fish biomass and proximity to human population

centers (Williams et al. 2011). In addition, socioeconomic studies have documented fishers' perceptions that fish are less abundant and coral reef condition has declined (Griffith et al. 2007).

Minimizing negative fishing impacts throughout coral reef ecosystems is critical to revitalizing and protecting coral reef resources for current and future generations. A reduction in fishing pressure, such as achieved through the use of MPAs, not only has positive effects on commercially important fish species, but has also been shown to create positive effects for other species, including the coral reefs themselves (e.g., increasing algae-eating fish, controlling macroalgal cover and providing more habitat for coral reefs to recruit and grow) (Hughes et al. 2007).

Given the many entities with jurisdiction or expertise over U.S. coral reef resources, cooperation among partners is essential. The Coral Reef Conservation Program aims to

support collaboration among Federal, State, Territorial, Commonwealth, and other partners to achieve the below-referenced goals intended to address the impacts of fishing. Currently, the program has identified Goal 2 as an objective of emphasis.

- *Goal 1: Increase the abundance and average size of key coral reef fishery species to protect trophic structure and biodiversity, and improve coral reef ecosystem condition.*
- *Goal 2: Support effective implementation of MPAs and ecological networks of MPAs that protect key coral reef ecosystem components and functions.*
- *Goal 3: Increase stakeholder engagement and capacity to improve local compliance with and enforcement of fisheries management regulations that further coral reef ecosystem conservation.*

- *Goal 4: Utilize locally relevant education and communication strategies to increase public and policy maker understanding of fishing impacts in coral reef ecosystems and support for effective management options.*

Based on these strategic national goals and objectives, the Coral Reef Conservation Program has increased place-based management for coral reef ecosystems, continued to inform fishery management planning, and added technical capacity in the jurisdictions to support fisheries management and stakeholder engagement. In 2010 and 2011, the Coral Reef Conservation Program focused on providing information and capacity for the creation, implementation and improvement of MPAs. This included evaluating the effectiveness of different types of MPAs; identifying spawning aggregations for future protection; and collecting fishery-independent data to improve fishery management plans and provide context

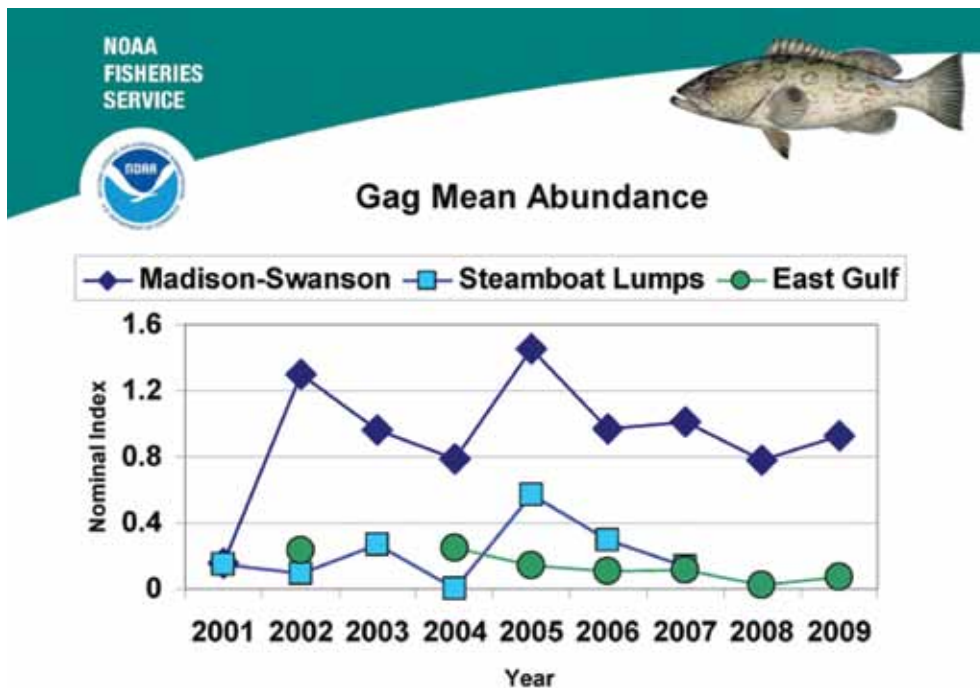


Figure 10: Mean Abundance of gag grouper within the northern Gulf of Mexico marine protected areas and the eastern Gulf. Credit: Chris Gledhill and Andrew David, NOAA

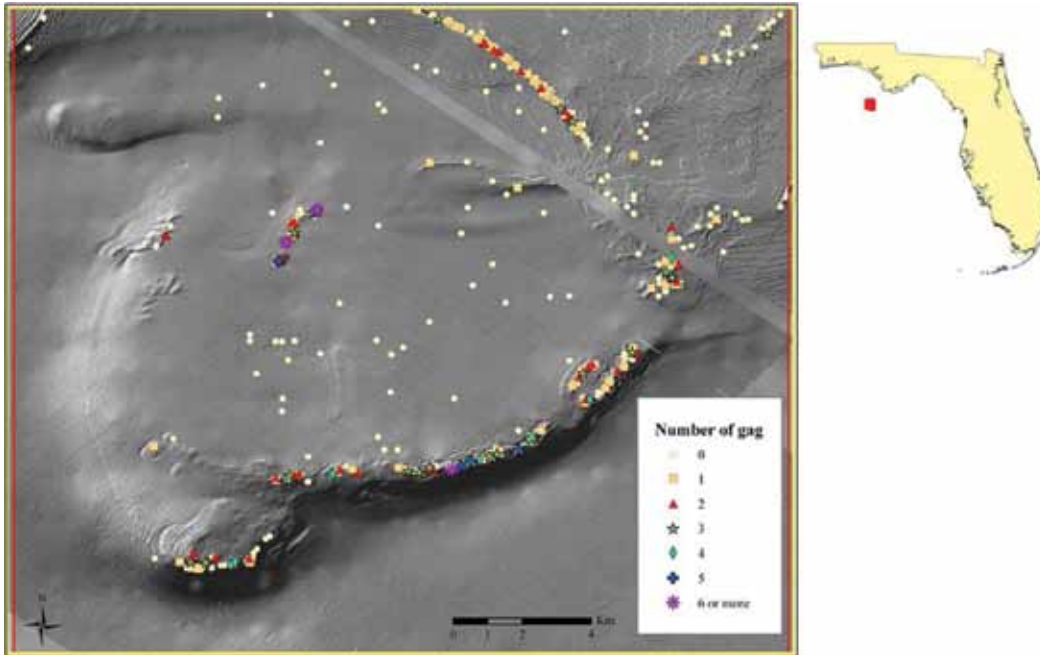


Figure 11: Location of gag grouper in the Madison-Swanson Marine Protected Area overlain on multibeam bathymetric map and location of marine protected area off northwest Florida. Credit: Marta Ribera, NOAA

for fish population trends within MPAs. Below are highlights of noteworthy work that was implemented in Fiscal Years 2010-2011 to reduce fishing impacts on coral reef ecosystems.

Science to Inform Creation, Implementation and Improvement of Marine Protected Areas

Gulf of Mexico Marine Protected Areas Provide Haven for Grouper

Madison-Swanson and Steamboat Lumps MPAs in the northeast Gulf of Mexico were established in 2000 to limit fishing in two areas thought to be spawning sites for gag grouper (*Mycteroperca microlepis*), a species highly susceptible to overfishing. Gag grouper is one of the highest value commercial and recreational fisheries in the Gulf of Mexico, with an estimated annual value between \$14 million to \$70 million. NOAA, in

partnership with the Gulf of Mexico Fishery Management Council, selected these MPAs to evaluate whether area closures effectively protect gag grouper spawning aggregations. Recent observations in Madison-Swanson indicate a stable population, while it has been decreasing in the eastern Gulf of Mexico overall, particularly in areas open to fishing. In contrast, the Steamboat Lumps MPA does not have the habitat preferred by gag grouper and therefore does not appear to offer them the same population benefits as Madison-Swanson. This research has informed the Gulf Council over the years to make key changes to the regulations of these MPAs, including: making the once experimental closures permanent; banning all fishing activities six months out of the year; and adding an additional seasonal closure in the area between the two original sites to expand the areas of protection for spawning aggregations.

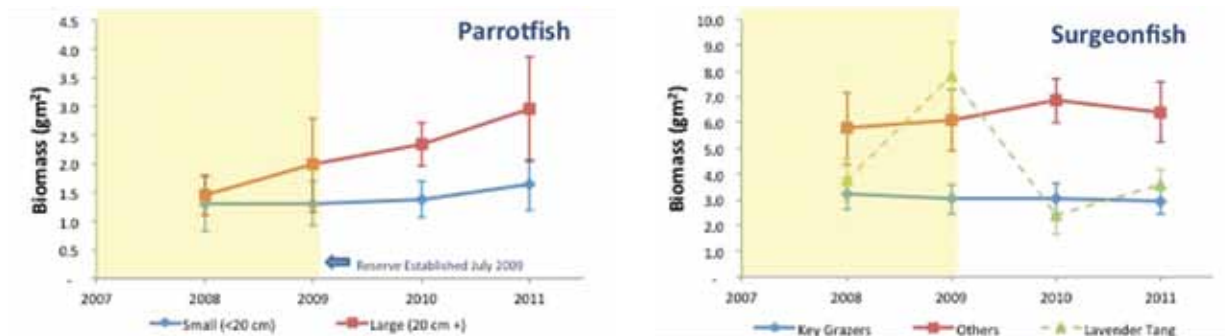


Figure 12: Trends in mean biomass of main herbivorous fish families, parrotfishes, and surgeonfishes at Kahekili Herbivore Fisheries Management Area, Maui. Data pooled by calendar year and across all habitats surveyed. Habitats weighted by their proportion of total area within the management area. Errors bars represent one standard error. Among surgeonfishes, ‘key grazers’ are species that feed almost entirely on benthic algae; ‘others’ are species that feed partially on benthic algae and partially on other food items such as plankton. Credit: NOAA

Scientific Support for Kahekili Herbivore Fisheries Management Area, Maui

As in other heavily-populated parts of the Hawaiian Islands, coral reefs around Kahekili have been impacted by blooms of invasive algae in recent years. Concern about the rapid decline of coral reefs and the desire to prevent a persistent change from coral- to algal-dominated systems led to the establishment of the Kahekili Herbivore Fisheries Management Area. Within the area, herbivorous fishes are protected, but other groups of fish can still be harvested. This unique management approach has proven to be much more acceptable to the public compared to full closure. If proven effective as a means of restoring herbivorous fish populations and preventing coral to algal phase-shifts, this management approach may be more widely adopted in Hawai’i and beyond. Already, there are initial signs of improvement in the local population of parrotfishes, particularly among the larger individuals that are the key grazing fish on Hawaiian reefs.

Assess and Monitor Coral Reef Marine Protected Areas in the Florida Keys

For the past 30 years, and with Coral Reef Conservation Program support since 2002, NOAA has monitored the status of reef fish populations in the Florida Keys. This program has been used for fishery stock assessments and MPA designation and evaluation to inform management by the South Atlantic Fishery Management Council and the Florida Keys National Marine Sanctuary, and integrates field operations and data sharing between NOAA and its many Federal, State, and university partners in the region. Since the program is one of the longest continuous marine monitoring programs in the world, it provides a unique opportunity to study how coral reef fish communities have changed over many decades in response to changes in fishing pressure, regulation, invasive species, hurricanes, and climate change. Recent analysis of the 30-year time series suggest that changes in fish communities have been largely driven by the rapid loss of live coral cover throughout the Caribbean and Florida Keys

beginning in the 1980s, and a slight increase in economically important species inside MPAs in the Florida Keys. A large portion of this work will be integrated into the National Coral Reef Monitoring Plan framework that the Coral Reef Conservation Program is developing (see National Coral Reef Monitoring Activities in the Crosscutting Highlights section of this report).

Identifying and Characterizing Key Fish Spawning Areas in the Florida Keys and Dry Tortugas

In 2010-2011, the Coral Reef Conservation Program continued support of efforts to identify and characterize existing and potential sensitive fish habitats in South Florida. The underwater habitats near the Florida Keys and Dry Tortugas are ideal for coral reef fish spawning aggregation sites, where unusually high densities of a single species of fish gather to reproduce. As such, these areas are particularly vulnerable to overfishing. Although the location of one historical coral reef fish spawning aggregation is now protected (Riley's Hump in the Dry Tortugas Ecological Reserve), many areas key to reef fish spawning are yet unknown and unprotected. The Coral Reef Conservation Program continued efforts to create detailed seafloor maps of reported coral reef fish spawning aggregation sites in the Florida Keys. Building upon these maps with visual surveys and models of spawning aggregation site characteristics, the Coral Reef Conservation Program has documented the location of black grouper and gray and mutton snapper aggregations, and is evaluating potential recovery due to reserve effects.

In the Dry Tortugas Ecological Reserve, the Coral Reef Conservation Program's monitoring efforts have documented an overall increase in mutton snapper and black grouper, two top-reef predators and prized fishery targets. Numbers of mutton snapper caught further up the Florida



Figure 13: Mutton snapper preparing to spawn in 2009.
Credit: Chris Parsons.

Keys have increased over time, possibly indicating the effectiveness of the reserve and other fishery management measures.

Identifying and Mapping Spawning Aggregation Sites in U.S. Virgin Islands and Puerto Rico

Since 2008, Coral Reef Conservation Program researchers have integrated fishery sonar surveys with coral reef ecosystem mapping around Puerto Rico and the U.S. Virgin Islands (see Mapping in the Crosscutting Highlights section of this report). In 2011, researchers located and confirmed spawning aggregations at Grammanik Bank in the U.S. Virgin Islands, and located two additional aggregations that may represent previously undocumented spawning grounds. Distribution of the fish density maps and interpretation of these data layers are planned for early 2012 and will be delivered to regional managers and academic research partners through a Geographic Information



Figure 14: Commercial and recreational fishing vessels targeting a mutton snapper spawning aggregation off Key West, FL in May 2011. Credit: Florida Fish and Wildlife Conservation Commission

resources of the local fishing communities, universities, resource managers, and existing habitat and socioeconomic data to execute the first spatially comprehensive survey in the region and did so in a cost-effective and cooperative manner. Six hundred trap stations were sampled with the input and participation of local fishers who built, deployed and retrieved sampling traps while scientific staff gathered data on each fish captured. Outcomes of this project will provide immediate guidance to the Caribbean Fisheries Management Council for addressing current fishery data-limitations in the U.S. Caribbean, and serve as a model for data collection and assessments.

Intensive Fish Surveys around Guam

Coral reef fish communities around Guam were intensively surveyed during 2011 to generate a comprehensive assessment of coral reef fish assemblages and to quantify any differences in fish communities between coral reefs inside and outside of Guam's system of MPAs. The methods used were identical to those utilized for NOAA's biennial surveys of U.S.-affiliated coral reefs in the Pacific (see National Coral Reef Monitoring Activities in the Crosscutting Highlights section of this report), which allowed for the data to be combined, nearly tripling the number of sites normally monitored on a biennial basis, and project results placed in the wider context of the entire Marianas. Overall, fish biomass in MPAs was more than twice that of coral reefs outside of the protected areas, and differences were greatest for large fish, which tend to have disproportionate ecological and economic importance. Results show that coral reef communities within MPAs around Guam were comparable to survey totals from the remote and virtually unpopulated islands in the northern portion of the chain. These results will provide local managers with valuable information on the effectiveness of

System (GIS) web portal. These new data will guide further ecosystem management and research efforts, inform conservation measures such as MPA design and assessments, and contribute to outreach and enhancing ocean literacy.

Informing Stock Assessments and Fishery Management Plans

Development of Cooperative Fishery Independent Surveys in the U.S. Caribbean

Fisheries managers in the U.S. Caribbean are currently assessing stocks for the new annual catch limit requirements of the reauthorized Magnuson-Stevens Fishery Conservation Act; however, there is consensus that data limitations preclude a comprehensive stock assessment of most species. A Coral Reef Conservation Program-funded pilot project in St. Croix, U.S. Virgin Islands utilized the



Figure 17: Sedimentation along the southwestern coast of Guam near Anae Island. Credit: Dave Burdick

IMPACTS FROM LAND-BASED SOURCES OF POLLUTION

Within the U.S. and its jurisdictions, there are numerous locations where coral reef ecosystems are highly impacted by coastal development, watershed alteration and runoff (Bellwood et al. 2004, Pandolfi et al. 2003, Richmond et al. 2007). The suite of problems facing coral reef ecosystems from land-based sources of pollution is broad and includes sediment, nutrients, and other pollutants, including chemical and bacterial contaminants, from a variety of land-based activities that are transported in surface waters, runoff, groundwater seepage, and atmospheric deposition into coastal waters.

The process of sedimentation, typically results in higher levels of suspended sediment in overlying waters, and is commonly acknowledged to be one of the primary

causes of coral reef ecosystem degradation (e.g., Rogers 1990, Field et al. 2008). The combination of suspended, re-suspended and deposited sediment act to limit coral growth, feeding patterns, photosynthesis, and recruitment and survivorship, as shown by numerous studies in a variety of settings (Fabricius 2005). Sediments can also smother and abrade coral tissues (Rogers 1990). Sediments can bind to and transport pollutant sources such as pesticides, petroleum hydrocarbons, pharmaceuticals, heavy metals, pathogens, and excess nutrients to coral reefs. These pollutants can cause or exacerbate the negative effects of land-based sources of pollution on coral reefs (Richmond 1993). Excess nutrients from wastewaters, including sewage and fertilizers, promote the growth of algae that compete with juvenile and adult corals for space on benthic reef surfaces, affect the success of coral settlement (Sammarco 1996) and in extreme cases can result in eutrophication of reef waters.

The condition of many U.S. coral reef ecosystems depends on the effective management of land-based activities in adjacent coastal and upland regions. The Coral Reef Conservation Program is committed to work in strong partnership with local jurisdictions, Federal agencies, academics and NGOs to strategically enhance ongoing efforts and identify new opportunities to decrease the sources of and impacts from land-based sources of pollution on coral reef ecosystems. The Coral Reef Conservation Program's three primary goals to address land-based sources of pollution are:

- *Goal 1: Reduce pollutant loading from watersheds to priority coral reef ecosystems.*
- *Goal 2: Promote in-water management activities to restore priority coral reef ecosystems that have been adversely impacted by accumulated sediments, nutrients, chemical contaminants, and algae.*
- *Goal 3: Build and sustain management capacity at the local level through local, State, regional and Federal coordination of financial, institutional, and human resources to reduce and prevent the impacts from land-based sources of pollution on coral reef ecosystems.*

The Coral Reef Conservation Program's land-based sources of pollution technical expertise, combined with the institutional capacity of contributing NOAA offices, has positioned the program to provide technical assistance, guidance, monitoring and assessment, capacity building, and multilateral coordination to meet these strategic goals. In 2010 and 2011, the Coral Reef Conservation Program invested significantly in land-based sources of



Figure 18: Sediment from land-based sources of pollution covers coral at North Kohala, Hawaii Island. The combination of suspended, re-suspended, and deposited sediment act to limit coral growth, feeding patterns, photosynthesis, recruitment, and survivorship. Credit: Bill Walsh, NOAA

pollution targeted projects across the seven jurisdictions. They include: watershed management planning, building local capacity to address watershed issues, implementing best management practices to mitigate land-based sources of pollution inputs, and monitoring for the presence of chemical contaminants and biological effects of land-based sources of pollution (e.g., biological surveys and analyses, measuring water chemistry and creating habitat maps to locate sensitive areas). Results from these studies provide coral reef managers with the information and tools needed to establish baseline conditions, develop practices and policies to reduce land-based sources of pollution and improve coastal health, and measure the efficacy of those activities. These activities are implemented in specific coral reef priority watersheds as identified by State and territory partners. The following examples highlight programmatic work that was implemented in 2010 and 2011.

Development of the Coral Reef Conservation Program's Land-Based Sources of Pollution Implementation Plan

In order for the Coral Reef Conservation Program to be effective in conserving coral reef ecosystems, the program developed a Land-based Sources of Pollution Implementation Plan that articulates the Coral Reef Conservation Program's role and approach to address land-based sources of pollution threats to U.S. coral reefs, identifies areas of collaboration, and directs future land-based sources of pollution funding decisions over the next five years (2011-2015). This plan will help the Coral Reef Conservation Program narrow its focus to be more effective in conserving coral reef ecosystems. Over the next five years the Coral Reef Conservation Program will target the impacts of land-based sources of pollution on coral reef ecosystems to:

- 1. Support the development and implementation of watershed management plans to improve water quality and enhance coral reef ecosystem resilience;*
- 2. Build partnerships among local, State, Federal, and NGO entities to identify, leverage, and apply financial and other resources to facilitate improved coastal and upland watershed management to protect coral reef ecosystems from the impacts of land-based sources of pollution;*
- 3. Determine the efficacy of management activities through coordinated baseline (e.g., assessment of chemical stressors and biological condition) and performance monitoring to assess progress and adapt management actions as needed; and*
- 4. Enhance coral reef jurisdiction capacity to develop and implement management*

plans, assess water quality and coral reef ecosystem condition, enforce regulations, and evaluate performance.

Building Capacity of Pacific Island Jurisdictions to Manage Watersheds

In June 2011, over 80 attendees throughout the Pacific Islands participated in the first Pacific Island Watershed Institute workshop. Tailored for State and Territorial staff, officials, watershed leaders, and watershed and storm water professionals, the workshop offered lectures, group activities, and outdoor assessments to facilitate networking and collaboration. Demonstration projects to improve on-the-ground management of island watersheds, particularly in priority coral reef watersheds were identified and will be initiated in American Samoa, the Commonwealth of Mariana Islands, Guam and Hawai'i in 2012.

Supporting Watershed Planning to Address the Impacts of Land-Based Sources of Pollution on Coral Reefs in St. Croix's East End Marine Park.

Partnering with the U.S. Department of Agriculture (USDA), The Nature Conservancy, and U.S. Virgin Islands environmental resource managers, the Coral Reef Conservation Program developed a comprehensive watershed management plan for St. Croix's East End Marine Park and the north shore. The plan includes watershed characterizations and baseline assessments for over 7,800 acres and management actions to address impacts of land-based sources of pollution on coral reef resources, engage local residents and businesses in watershed stewardship activities, and demonstrate restoration actions that can be applied throughout the U.S. Virgin Islands.



Figure 19: Pacific Island Watershed Institute was attended by over 80 participants from throughout the Pacific Islands. Credit: NOAA

An Integrated Approach to Assess the Impacts of Land-Based Sources of Pollution in the St. Thomas East End Reserves

For the past two years, Coral Reef Conservation Program scientists have collaborated with local, academic, and Federal partners to assess land use and address land-based sources of pollution to conserve and restore the marine reserves and wildlife sanctuaries within the St. Thomas East End Reserves, U.S. Virgin Islands. In 2012, biological surveys, characterizations of marine resources, and assessments of chemical contaminants, nutrients, and sediments will be correlated to provide a holistic view of living resource conditions within the St. Thomas East End Reserves. Products developed from these collaborative



Figure 20: Pacific Island Watershed Institute participants learning about innovative erosion control practices. Credit: NOAA

projects will provide critical baseline information on the St. Thomas East End Reserves and enable local resource managers to assess the efficacy of future restoration activities within the reserves and surrounding watershed.



Figure 21: Photo of the St. Thomas East Marine Reserves. The non-vegetated hill in the distance is the Bovoni Landfill, which is one of the greatest contributors of land-based sources of pollution to the marine reserve. Credit: Rob Ferguson, NOAA

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Figure 22: Scientists collecting sediment samples in the St. Thomas East End Reserves. The samples collected will be analyzed for over 140 chemical contaminants, and is part of a project to characterize land-based sources of pollution and effects in the reserves. Credit: NOAA

Characterizing the Impacts of Land-Based Sources of Pollution on Guánica, Puerto Rico's Coral Reefs

Puerto Rico's Guánica watershed, the first watershed partnership site among U.S. Coral Reef Task Force members, is the focus of a multi-year project to evaluate, design, and implement watershed restoration projects to reduce the effects of land-based sources of pollution (see the Formal Partnerships section of this report). Fieldwork was initiated in 2009 and is expected to be completed in 2012. Analyses of biological and contaminants data are being shared with Territorial partners and other Federal agencies to reduce the amount of sediment and nutrient loading to nearshore coral reefs and develop comprehensive restoration plans to restore the Guánica Lagoon.



Figure 23: Coral reef near Guánica Bay, Puerto Rico. Surveys were conducted to assess fish populations and benthic communities across a range of habitat types. Photo credit: NOAA



Figure 24: NOAA diver samples mustard hill coral (*Porites astroides*) tissue outside of Guánica Bay, Puerto Rico. Tissues were analyzed for a suite of over 100 contaminants, such as heavy metals, pesticides, and PAHs. Photo credit: NOAA

Next and Future Steps

Currently, the Coral Reef Conservation Program is engaging Federal agencies, jurisdictional partners and academia to identify a scientifically sound sediment load methodology that will determine the efficacy of implemented management activities to reduce sedimentation and improve coral reef health. Over the next five years, Coral Reef Conservation Program efforts to address the impacts of land-based sources of pollution on coral reef ecosystems will include completing watershed management plans in other priority locations, implementing best management practices in places with finalized plans, and increasing local capacity to tackle erosion control. In addition, the Coral Reef Conservation Program will

continue to engage local partners to foster the place-based U.S. Coral Reef Task Force Partnership Initiatives in Guánica, Puerto Rico, and West Maui, Hawai'i.



International Summary

U.S. efforts to conserve coral reefs internationally are critical not only to the Nation's primary diplomatic and development strategies of promoting food security, human health and well-being, and democratic governance worldwide, but also to effectively conserve U.S. coral reefs for future generations. Coral reefs and the services they provide are in decline and threaten the estimated 500 million people globally who depend upon coral reefs for daily sustenance and survival. Ensuring the perpetuity of reefs requires both domestic and international efforts because nearly all U.S. coral reefs are ecologically connected to reefs abroad (e.g., nursery grounds) and because some of the most significant threats to reefs are global in nature (e.g., climate change and ocean acidification).

In 2010, the Coral Reef Conservation Program launched its International Program to strengthen and expand U.S. involvement in international coral reef conservation efforts. With an overarching focus of providing ecosystem-based management capacity building, Coral Reef Conservation Program International prioritizes its efforts in support of regional ocean governance initiatives (i.e., Coral Triangle Initiative and Micronesia Challenge) in four priority regions: the wider Caribbean, Samoa and the Southwest Pacific, Micronesia, and the Coral Triangle. The program's 2010-2015 strategy is based on the following goals:

- *Goal 1: Work with regional initiatives to build MPA networks and strengthen local management capacity to improve and maintain resilience of coral reef ecosystems and the human communities that depend on them.*
- *Goal 2: Develop and implement tools and practices to more effectively observe,*

predict, communicate, and manage climate change impacts in priority international areas.

- *Goal 3: Strengthen local and national capacity and policy frameworks to reduce impacts of fishing on coral reef ecosystems.*
- *Goal 4: Strengthen policy frameworks and institutional capacities to reduce impacts to coral reef ecosystems from pollution due to land-based sources of pollution.*

To meet these goals, Coral Reef Conservation Program International provides technical assistance and capacity building based on a particular country's needs, such as in MPA management and planning, socioeconomic and biophysical monitoring, ecosystem-based approaches to fisheries management, and climate adaptation planning, among others. Additionally, Coral Reef Conservation Program International provides access to global forums, such as the Gulf and Caribbean



Figure 25: It is estimated that 500 million people globally depend upon coral reefs for daily sustenance and survival. Credit: NOAA

Fisheries Institute and the International Coral Reef Initiative, as well as facilitates the coordination of programs, learning networks, and partnerships. The following regional projects and accomplishments highlight the Coral Reef Conservation Program International’s strides toward achieving its goals in 2010 and 2011.

Micronesia: In support of the Micronesia Challenge

Regionally implemented and locally supported, the Micronesia Challenge is the Coral Reef Conservation Program’s most established international engagement. Supporting the Freely Associated States, Guam, and the Commonwealth of the Northern Mariana Islands, the Micronesia Challenge aims to conserve 30 percent of nearshore marine resources and 20 percent of terrestrial resources by the year 2020. During 2010-2011, the Coral Reef Conservation Program International provided a co-coordinator for the Pacific Island Managed and Protected Area Community; established a three-year cooperative



Figure 26: *The CRCP International Strategy: 2010-2015* guides the program to enhance international leadership and to focus programmatic involvement in four priority regions (Micronesia, Samoa/Southwest Pacific, Coral Triangle, and the Wider Caribbean), where programs focus on building management capacity and combating threats to coral reefs, and particularly in support of existing regional ocean governance initiatives.

agreement with the Micronesia Conservation Trust; and via a cooperative agreement with The Nature Conservancy, coordinated technical workshops on enforcing MPAs, adapting to climate change, and conducting socioeconomic monitoring.

Caribbean: Capacity Assessment for Marine Protected Area Management

In 2010-2011, the Coral Reef Conservation Program and the Caribbean MPA Management Network interviewed site managers at 27 MPAs to develop a region-wide assessment of MPA management capacity to help identify and prioritize needs and approaches to capacity building in the region. The assessment was completed in August 2011 and addressed criteria ranging from MPA management planning and governance, monitoring, education, fisheries management, and resilience to climate change. In addition, the Coral Reef Conservation Program and the United Nations Environment Program-Caribbean Environment Program continued funding a full-time coordinator for the Caribbean MPA Management Network to build MPA capacity across the region.

Samoa and the Southwest Pacific: Biogeographic Assessment and Initiating Support to the Two Samoas Initiative

In 2010-2011, the Coral Reef Conservation Program completed *A Biogeographic Assessment of the Samoan Archipelago*, an important step toward improving coral reef management in Samoa and the Southwest Pacific Region. Coral Reef Conservation Program International, in partnership with NOAA's Office of National Marine Sanctuaries' International MPA Capacity Building Program, initiated a needs and capacity assessment of coral reef conservation and management in the independent State of Samoa. Results from the

assessment include a comprehensive map of the seafloor habitats of Tutuila that is already being used to delineate boundaries for proposed new national marine sanctuary sites and to support the territorial initiative of establishing 20 percent of reef areas as no-take preserves. Coral Reef Conservation Program International also established a cooperative agreement with the Government of Samoa to support the development of a strategic policy framework for a pan-archipelago initiative (Two Samoas Initiative) to regionally manage coral reef and nearshore ecosystems across American Samoa and Independent Samoa. Learning exchanges and monitoring efforts conducted by the Samoan government are expected to strengthen local community participation in managing and monitoring marine resources and enforcing regulations.

Coral Triangle: Expansive Partnership Supporting Marine Protected Area, Fisheries Management and Enforcement and Climate Adaptation Technical Needs of the Coral Triangle Initiative

The U.S. Coral Triangle Initiative is a \$42 million, five-year program funded by the United States Agency for International Development (USAID) and Department of State. Through U.S. Coral Triangle Initiative, NOAA and partners aim to improve the management of millions of hectares of the Coral Triangle's coastal and marine ecosystems to protect food security and strengthen resilience to climate change for the 363 million people of the Coral Triangle region. NOAA engagement in U.S. Coral Triangle Initiative is a coordinated partnership across NOAA program offices and involves a number of targeted activities, including development of comprehensive and integrated toolkits, case studies and curricula to support climate change adaptation planning, MPA management, and ecosystem approaches to fisheries management.



Figure 27: Coral cover in American Samoa. Samoan managers and decision makers are already using data and analyses from A Biogeographic Assessment of the Samoan Archipelago, published in 2011, to delineate boundaries for potential marine protected areas and to support a territorial initiative to protect 20 percent of reefs. Credit: NOAA

In 2011, the Coral Reef Conservation Program established a new five-year program with USAID in Timor-Leste to build capacity to manage coral reefs and enhance climate adaptation. The Coral Reef Conservation Program and USAID are currently discussing a plan for a new, multi-country partnership to address the impact of climate change and ocean acidification on fisheries management. To address gaps in knowledge and management practices, Coral Reef Conservation Program International is establishing the first ocean acidification baseline in the region (in the Philippines and Timor-Leste), as well as science-for-decision making trainings for marine managers.

Next and Future Steps

The Coral Reef Conservation Program will continue to build the breadth and depth of

ecosystem-based management capacity in its four priority regions. It will also seek to build cadres of local trainers in ecosystem-based management, and institutionalize these capacities in learning networks and organizations that will replicate trainings across each region. Coral Reef Conservation Program International looks forward to the 2012 launch of the five-year program in Timor-Leste; to identifying capacity building needs in the Southwest Pacific Region in 2012; and building partnerships. In the coming years, Coral Reef Conservation Program International will continue to expand and enhance partnerships in the U.S. government, with international partners, and with peer agencies and institutions in coral reef countries worldwide.



Crosscutting Highlights

SOCIAL SCIENCE

Coral reefs are vital to the livelihood and well-being of millions of people throughout the world and generate billions of dollars annually in value to the U.S. economy. It is critical that the Coral Reef Conservation Program ensures that research and management activities intended to protect coral reefs do not have negative consequences on the well-being of those dependent on the reefs. It is equally critical that the Coral Reef Conservation Program has efforts in place to assist its partners with the use of social science tools to increase public engagement and provide transparent processes by which stakeholders can participate in the coral reef management process.

To meet these needs, the Coral Reef Conservation Program Social Science Program was established in 2006 and has expanded in the five years since its inception. Components of the Coral Reef Conservation Program Social Science Program include: (1) strategic planning and coordination; (2) technical assistance; (3) socioeconomic research; and (4) capacity building. Key highlights from 2010 and 2011 include:

Development of the Coral Reef Conservation Program Social Science Strategy

The Coral Reef Conservation Program developed a Social Science Strategy to identify and prioritize its social science portfolio and direct the use of social science to improve coral reef management by engaging local communities and better assessing community impacts of management measures. The Social Science Strategy was

completed in 2010 and has been utilized during both 2010 and 2011 to guide Coral Reef Conservation Program investments in social science-related projects and initiatives. The development of the Coral Reef Conservation Program Social Science Strategy also resulted in the formation of a Coral Reef Conservation Program social science team, which has increased coordination among the program's social science principal investigators. The Social Science Strategy has resulted in more targeted and strategic use of social science to accomplish coral reef conservation in each of the coral reef jurisdictions.

Publication of the U.S. Virgin Islands Coral Reef Economic Valuation Study

Coral reefs of the U.S. Virgin Islands provide a wide range of ecosystem services including tourism services, recreational uses, fisheries, coastal protection, amenity value, and education /research services. Based on the Coral Reef Conservation Program's completion of an economic valuation study, these services were valued at \$202 million dollars. The study on the total economic valuation of services from the U.S. Virgin Islands' reefs provides a solid basis for future economic studies on coral reef-related decisions as they arise and generates a reference point with which to compare development and conservation plans. In addition, information in the study will aid in preserving U.S. Virgin Island's coral reefs by establishing damage compensation, setting fees for permit applications, and/or determining potential user fees for residents and tourists.



Figure 28: Coral reef fish are commonly sold in the Saturday morning fish market on St. Thomas, U.S. Virgin Islands. Credit: Christy Loper, NOAA

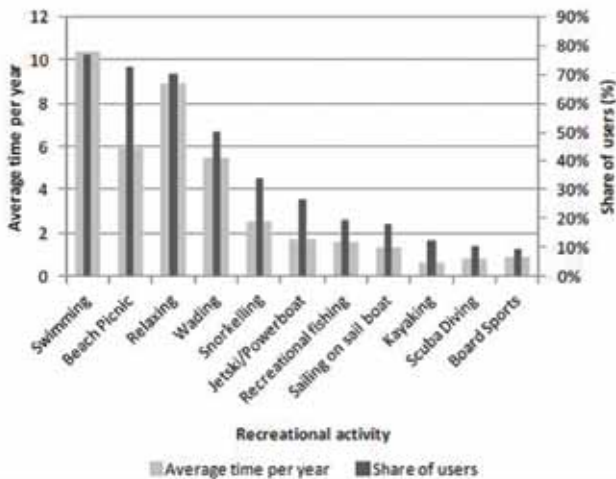


Figure 29: Percentage of U.S. Virgin Island residents participating in coral reef related activities. Credit: Christy Loper, NOAA

Development of the NOAA Coral Reef Coastal Use Mapping Partnership

The Coral Reef Conservation Program Coastal Use Mapping Project fills a critical information gap in ocean management by involving multiple partner agencies to map significant human uses of the nearshore ocean areas. First initiated in the Kawaihae-Keāhole region of Hawai'i, a priority site for the Coral Reef Conservation Program and its partners, the project has expanded to other priority sites in Maui, Hawai'i and the U.S. Virgin Islands. To better understand the spatial range and intensity of key human activities in priority regions, information is gathered from pre-existing digital sources, and through participatory mapping workshops where local resource users, scientists, and stakeholders develop maps of ocean uses. Data, maps, and analytical products are

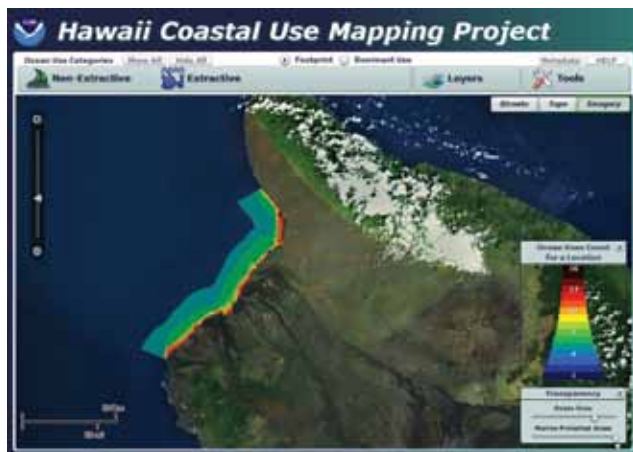


Figure 30: Hawaii Coastal Use Mapping Project. Credit: Christy Loper, NOAA

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made available to local community groups, State and Federal agencies, NGOs and, other interested parties to inform management decisions to better protect the ecosystem, minimize impacts on those who depend on marine resources and reduce user conflict.

Development and Successful Implementation of a Micronesia Social Science Capacity Building Program

In response to requests for capacity building assistance from coral reef management partners in the Micronesia region, the Coral Reef Conservation Program supported three locally-led, innovative workshops to train local coral reef managers in social science strategies and build the capacity of a cadre of regional trainers to reduce the need for external technical assistance. Six regional trainers from Palau, Marshall Islands, Chuuk State, and Pohnpei State are now fully trained. In addition, training

on Parem Island, Chuuk State resulted in a socioeconomic assessment for the island of Parem, which is being considered for Chuuk's first legislated MPA.

Next and Future Steps

The Coral Reef Conservation Program Social Science Program has shown great success in incorporating socioeconomic factors in decision making through implementation of individual projects. Social science is, however, several years behind biophysical science in terms of implementing a long-term monitoring program to track socioeconomic indicators related to coral reef importance, use, and management. In 2011 and 2012, the Coral Reef Conservation Program developed a national coral reef monitoring framework that will include a suite of socioeconomic indicators to be implemented in 2013 (see National Coral Reef Monitoring Activities in the Crosscutting Highlights section of this report). Measurement of these indicators will provide important information, including an understanding of whether more or fewer people are dependent on coral reefs for their livelihoods and well-being, as well as impacts of specific management measures. Integration of socioeconomic factors will strengthen national monitoring and improve the Coral Reef Conservation Program's ability to determine how effective its Program is benefitting society and the economy.

COMMUNICATIONS, EDUCATION, AND OUTREACH

The Coral Reef Conservation Program recognizes that addressing the root causes

of issues such as climate change, land-based sources of pollution, and fishing impacts to coral reef ecosystems is best achieved with an engaged public taking part in the solutions. The program has identified the following four national-level target audiences:

1. *Educators: Formal and informal science educators (K-12);*
2. *National Policy Makers: National policy makers and those that influence key policy makers (e.g., NGOs, Federal and State agencies, and constituents);*
3. *Resource Managers: State and Territory coral resource managers, including management support staff; and*
4. *Conservation Public: People who know and care about environmental issues.*

The Coral Reef Conservation Program's education and outreach efforts take a strong place-based approach. Support for coral reef education and outreach is provided by long-term and strategic partnership between the Coral Reef Conservation Program and its seven U.S. State or Territory partners. The majority of the projects funded by the program covered a wide range of approaches to advance coral reef conservation: from funding a community-led coral bleaching network of citizen scientists in Florida and Guam, to community "ship days" during mapping missions where local school students and policy makers are introduced to coral science and instrumentation aboard docked NOAA vessels, and ongoing science translation efforts to broaden the reach of the research projects funded by the program. Below are select examples of outreach and education efforts undertaken by the program during 2010-2011.

Development of Strategy for Communications, Education, and Outreach

The Coral Reef Conservation Program developed a National Communications, Education, and Outreach Strategy (National CEO Strategy) in order to provide overarching guidance to better focus, integrate, and synchronize the activities of the program and its partners in formal and informal education programs, strategic communications activities, social marketing campaigns, and outreach activities. The Coral Reef Conservation Program's broadest goals for healthy coral reef ecosystems can only be realized with support from informed, inspired and engaged individuals in communities throughout reef regions and across the globe.

Upgraded and Redesigned Coral Reef Conservation Program Public Web Site

The Coral Reef Conservation Program updated and redesigned its public web site to facilitate public awareness of coral reef ecosystems, conservation efforts and Coral Reef Conservation Program activities. Expanded content areas on coral biology, values, threats and conservation techniques, deep-sea corals, and resources for students and teachers have been added.

Ocean Acidification Data-in-the-Classroom Educational Module

Given the recent rise of ocean acidification as a recognized phenomenon, the Coral Reef Conservation Program incorporated NOAA data obtained from scientific monitoring into educational modules for high school classrooms. Part of NOAA's Data-in-the-Classroom project, the modules are a free resource for educators and the interested public nationwide and enable students to build



Figure 31: Screen grab of the Coral Program web site homepage. Credit: NOAA

80 participants, representing middle and high school educators, park rangers, dive instructors, and state employees, enrolled in the workshops, and over 200 educators were trained in the Ocean Acidification Module as part of larger education events.

Coral App – Mobile Application to Access Local Data and Reporting

The Coral Reef Conservation Program developed a Coral App to deliver coral information and recreational fishery regulations directly to mobile phone users based on their location and time. The mobile app also provides NOAA ocean data; allows citizens to submit information on observed coral bleaching and marine debris to alert and assist response efforts by local agencies; and includes a “Measure Your Fish” feature that utilizes a phone’s camera to estimate fish size and support management of recreational fisheries.

Coral Reef Management Fellowships

The NOAA Coral Reef Management Fellowship program provides State and Territorial coral reef management agencies with candidates whose education and work experience meet each jurisdiction’s specific needs the national goals of the Coral Reef

their understanding of ocean acidification and design their own investigations.

Educator Workshops on Ocean Acidification

In 2010, the Coral Reef Conservation Program collaborated with State partners to train Florida educators in ocean acidification and its effects on coral reef ecosystems. Over

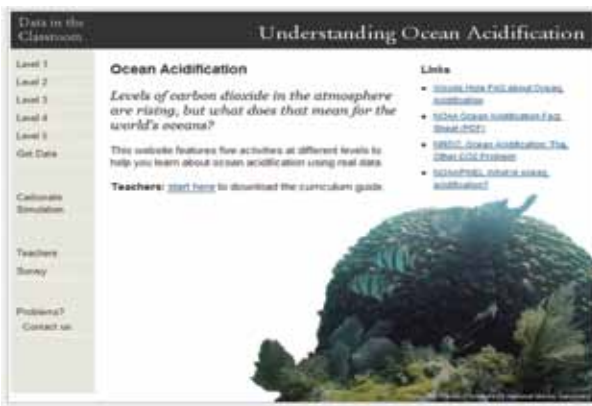


Figure 32: Screenshot of the ocean acidification Data-in-the-Classroom page. Credit: NOAA



Figure 33: Key West: Florida Keys National Marine Sanctuary Eco-Discovery Center Workshop. Credit: NOAA



Figure 34: Ft. Lauderdale: Workshop participants tour NOVA National Coral Reef Institute facilities. Credit: NOAA



Figure 35: Coral fellows in the Commonwealth of the Northern Mariana Islands participate in the Talakhaya Watershed Revegetation Project. Credit: Aric Bickel, Division of Environmental Quality, Commonwealth of the Northern Mariana Islands

Conservation Program, while offering the fellows a professional experience in coral reef resource management. By design, each position addresses a unique set of local needs, as determined by the Coral Reef Conservation Program in partnership with the jurisdiction. In 2010-2011, the program placed seven individuals in local host agencies in U.S. coral reef jurisdictions.

Program participants worked on a wide range of projects to advance regional management plans. Examples of 2010-2011 projects completed by the fellows include:

(1) *Commonwealth of the Northern Mariana Islands: Led volunteer revegetation efforts that resulted in over 40,000 tree and grass seedlings planted to prevent soil erosion into the sea and the large coral reef below the Talakhaya Watershed.*

- (2) *Florida: Worked as part of the State's Maritime Industry and Coastal Construction Impacts team to create a more effective data and permitting process to minimize impacts of shoreline activities to coral reefs.*
- (3) *Puerto Rico: Involved the local community in the newly established Tres Palmas Marine Reserve and assisted in the creation of a grassroots Friends of the Reserve network to involve the community in maintaining and sustaining the reserve.*
- (4) *U.S. Virgin Islands: Developed a sustainable tourism plan for St. Croix' East End Marine Park and St. Thomas East End Reserves, and led a community fundraising event to assist in the long-term sustainability and self-financing of these parks.*

- (5) *Hawai'i: Assisted the Coastal Uses Mapping Project in Maui and engaged local hotels and communities in the Maui Makai Watch program, a grassroots-level effort that raises awareness for local marine ecology and volunteer-led observation of marine sites.*
- (6) *Guam: Assisted with public outreach campaigns against the illegal burning of grasslands and translated NOAA scientific products into island-specific materials.*
- (7) *American Samoa: Coordinated the development of the Climate Change Adaptation Framework for American Samoa, and guided the development for the Coral Bleaching Response Plan for the island, preparing local agencies for future bleaching events.*

Next and Future Steps

The Coral Reef Conservation Program will produce a Coral Bleaching Data-in-the-Classroom educational module for 2012. This new module will integrate a scalable curriculum with real-time NOAA data and historical, long-term records of sea surface temperatures collected by satellites, adding educational value to the scientific infrastructure that already provides valuable data to coral reef managers. The Program will also continue to streamline and better track, communicate and coordinate coral reef educational and outreach efforts at regional levels, and place a new group of seven regional staff support in local agencies for each of the coral jurisdictions to advance coral reef conservation by working on climate change adaptation (American Samoa and the Commonwealth of the Northern Mariana Islands), coral reef monitoring (Guam); fishermen outreach and training (Hawai'i and

Puerto Rico); marine debris removal (Florida); and advancing sustainable use of marine parks (U.S. Virgin Islands).

NATIONAL CORAL REEF MONITORING ACTIVITIES

Management responsiveness to changing environmental conditions depends on a scientifically-robust national program to monitor and assess the status and trends of U.S. coral reef ecosystems. As part of this effort, it is also imperative that resulting data are made readily available to resource managers and the general public.

The Coral Reef Conservation Program began to develop a National Coral Reef Monitoring Plan in 2010. The National Coral Reef Monitoring Plan builds upon a decade of Coral Reef Conservation Program-supported monitoring, and recommendations from the Coral Reef Conservation Program External Review (2007), regional monitoring workshops (2008 and 2009), and other strategic planning efforts over the past four years. A NOAA working group is charged with developing a monitoring plan focused on four core variables - coral/benthos, fish, climate, and human dimensions. These will be measured long-term in a consistent and comparable manner across U.S. coral reef ecosystems, and integrated to assess status and trends in a periodic national-level report. The Coral Reef Conservation Program will continue planning efforts through 2012, with the goal of implementing sustained, long-term National Coral Reef Monitoring Plan activities in 2012/2013. Data collected as part of this program will provide the necessary context for evaluating local management actions. While strategic planning for monitoring is ongoing, the Coral Reef Conservation



Figure 36: Sundown showing Coral Reef Early Warning System station at Little Cayman, Cayman Islands. Credit: Myfanwy Rowlands



Figure 37: Stringing underwater cables on a Coral Reef Early Warning System station. Credit: NOAA

Program has continued to invest in monitoring and assessment activities across the U.S. Atlantic/Caribbean and Pacific regions, providing a diverse suite of long-term ecological and environmental observations over a broad range of spatial and temporal scales. Coral Reef Conservation Program data and information products help coral reef scientists and managers understand coral reef ecosystem condition and processes, and assist managers in making improved and timely ecosystem-based management decisions to conserve coral reefs. Outcomes from observing networks, warning systems and monitoring programs that are part of the Coral Reef Conservation Program’s current monitoring effort are described below.

Real-time Marine Environmental Monitoring Programs Provide Support to Managers

The Coral Reef Conservation Program continued to support the development of specialized in situ monitoring instrumentation platforms and software to assist resource managers’ efforts to conserve, protect, and manage coral reef ecosystems. Coral Reef Early Warning System platforms measure

environmental conditions which are relayed via satellite to NOAA and software produces assessments and ecological forecasts of coral reef conditions. Six Coral Reef Early Warning System stations have been established in the Caribbean region (U.S. Virgin Islands, Puerto Rico, Florida, Cayman Islands, Bahamas, and Jamaica) and in 2010; the Coral Reef Conservation Program supported the installation of a new Coral Reef Early Warning System station in Saipan, Commonwealth of the Northern Mariana Islands, a first-of-its-kind monitoring platform for the Pacific region.

The stations are one component of the larger Integrated Coral Observing Network that monitors environmental conditions via satellite at more than 120 virtual sites around the world. The hallmarks of the observing network are near real-time multi-source data integration, the utilization of these integrated data into ecological forecasts, the field testing of new instrumentation to forecast coral bleaching and modeling ocean currents, and the application of their real-time data to answer new research and managerial questions.

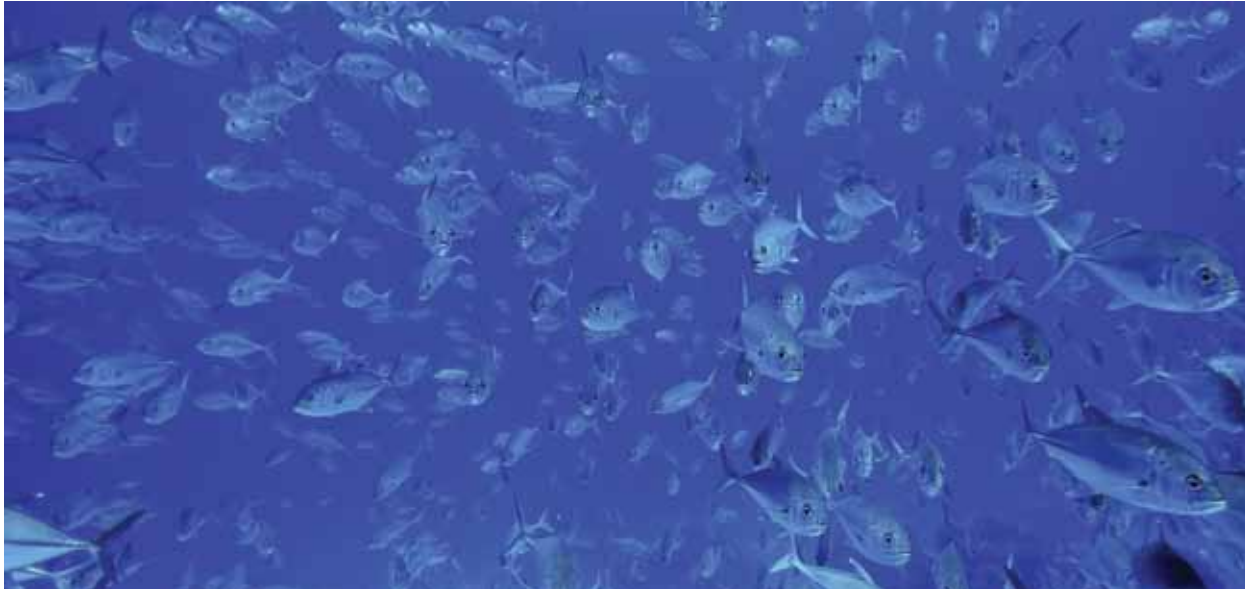


Figure 38: A school of bigeye jack (*Caranx sexfasciatus*) seen during a Pacific Reef Assessment and Monitoring Program cruise at Wake Atoll, a remote coral atoll located in the central Pacific between Guam and the Hawaiian Archipelago. Large, predatory fishes, such as jacks and sharks, are infrequently seen at reefs close to human populations but comprise a large portion of total fish biomass estimated from visual surveys at remote coral reefs. Credit: Kevin Lino, NOAA

Providing Vital Information for Coral Reef Ecosystem-Based Management in the Pacific

Collaborating with Federal, regional and local organizations and agencies, NOAA-led Pacific Reef Assessment and Monitoring Program cruises map, monitor, and assess spatial and temporal patterns at island, regional, and basin-wide scales to study coral reef ecosystems. Since 2000, the Coral Reef Conservation Program has supported biennial integrated monitoring of coral reef ecosystems throughout Hawai'i, Guam, American Samoa, Commonwealth of the Northern Mariana Islands, and the Pacific Remote Island Areas.

This time series of biological, oceanographic and habitat data collected over the past decade is now robust enough to identify important

pan-Pacific trends in coral-reef ecosystem health, including the extent of human impacts on coral reef fish assemblages at local and larger scales and the prevalence of coral bleaching patterns over time. For example, analysis of these data demonstrate that Pacific reefs isolated from human population centers have 15 times the biomass of large predatory fishes compared to reefs more accessible to humans. Beginning in 2012, this program will transition from biennial to triennial cruises and continue long-term ecosystem monitoring to understand and differentiate between natural and human-induced changes. Working across different oceanographic and climatic regions and varying gradients of human population enables more effective implementation of ecosystem approaches to management.

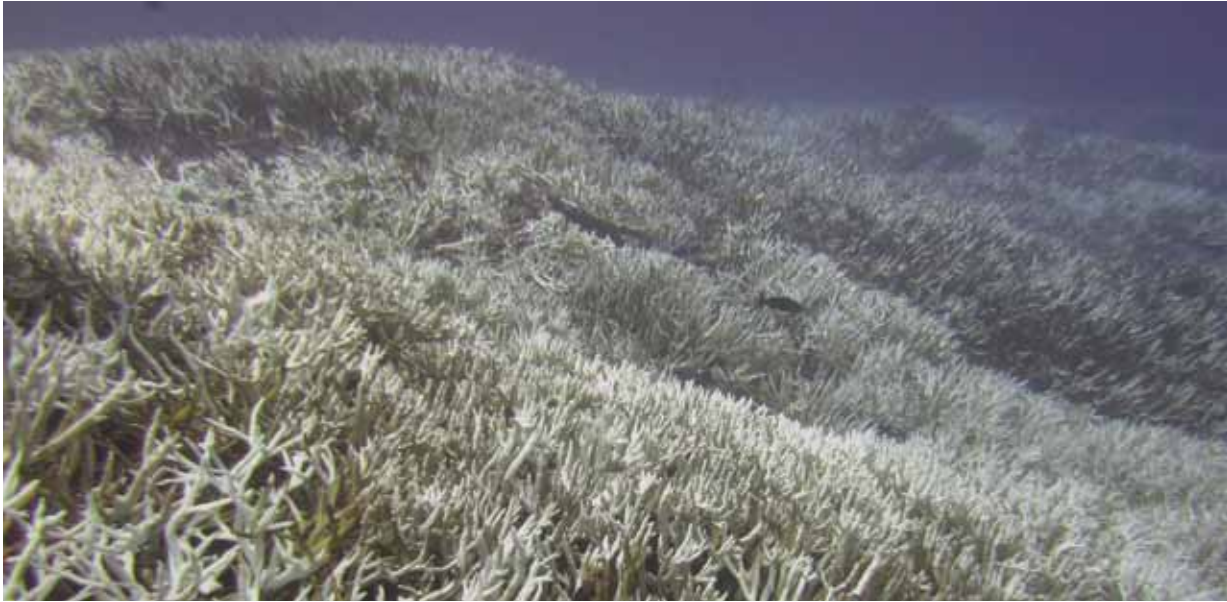


Figure 39: Bleached corals of the genus *Acropora* were observed during surveys conducted around Howland Island during the 2010 Pacific Reef Assessment and Monitoring Program expedition. This event was the first documented mass bleaching episode at Baker and Howland Islands, both part of the Pacific Remote Islands Marine National Monument. Credit: NOAA

Monitoring Coral Reef Ecosystems and Evaluating Trends to Support Management throughout the U.S. Caribbean

Since 2000, the Coral Reef Conservation Program has supported the Caribbean Coral Reef Ecosystem Monitoring Project, a NOAA-led collaboration with other Federal and local government management agencies, NGOs, and universities. Project missions spatially characterize and monitor the distribution, abundance, and size of reef fish and seafloor organisms and establish the knowledge base necessary for making management decisions. For example, these data were used to support recommendations that the National Park Service shift the boundaries of the Virgin Islands National Coral Reef Monument to include areas of

relatively high coral cover. These data were also used to estimate the spatial extent and economic value of live coral damaged by vessel groundings within the monument, which helped determine the level of and compensatory damages to be paid by the responsible party.

In 2010 and 2011, 420 sites and 380 sites, respectively, were surveyed in Puerto Rico and St. John and St. Croix, U.S. Virgin Islands. By regularly monitoring these areas, changes in ecosystem metrics following adaptive management or restoration activities may be detected. In addition, identifying potential “hot spots” of species abundance, richness, and diversity in the seascape provides answers about the effectiveness of alternative marine zoning strategies.



Figure 40: A NOAA Caribbean Coral Reef Ecosystem Monitoring diver collects data on coral reefs and associated fish, invertebrates and algae in St. Croix, U.S. Virgin Islands to evaluate ecosystem conditions and monitor trends. Photo credit: NOAA

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Next and Future Steps

The Coral Reef Conservation Program will continue developing the National Coral Reef Monitoring Plan in 2012, with implementation beginning in 2012/2013. Program activities will focus on shallow water coral reefs (within 30-meter depths) within the Coral Reef Conservation Program’s geographic priorities for monitoring. The draft plan details an integrated approach focused on these core themes:

- *Monitoring of coral, benthos, and reef fish;*
- *Climate change and ocean acidification monitoring; and*

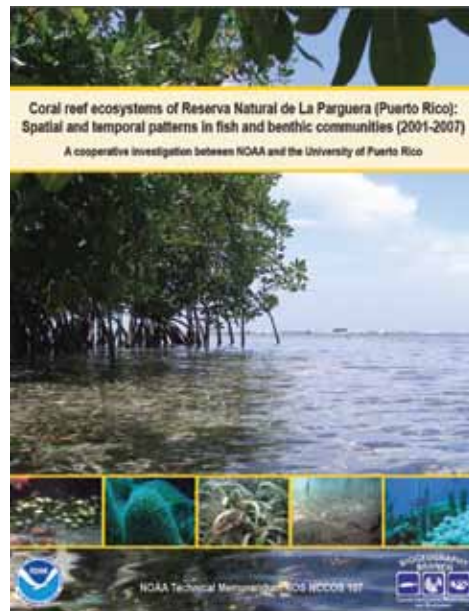


Figure 41: A recent report (Pittman et al. 2010) analyzed seven years of Caribbean Coral Reef Ecosystem Monitoring data collected in and around the La Parguera Nature Reserve in Puerto Rico to provide a biological baseline to support future management decision making. Photo credit: NOAA

- *Socioeconomic monitoring focused on human uses of, interactions with, and impacts to coral reefs.*

The timing and location of monitoring activities is still to be determined, but the Coral Reef Conservation Program will strive for biennial to triennial monitoring of core variables in each geographic region. When fully implemented over the course of several monitoring cycles, the National Coral Reef Monitoring Plan will provide critical information needed to understand the status and trends of U.S. coral reef ecosystems – and the communities that depend on them. This information will support adaptive investments and strategies to ensure that the Coral Reef Conservation Program and partners’ conservation goals and objectives are achieved.



Figure 42: 3-D Satellite Image of Kaneohe Bay draped over NOAA multibeam data collected in 2010 and U.S. Army Corps of Engineers LiDAR data.

MAPPING

The Coral Reef Conservation Program has provided basic geospatial services, including characterizations, charts, and maps since its inception. Accurate seafloor habitat maps provide coastal managers with the tools and methods to adaptively manage coastal ecosystems. These maps assist in safe navigation, defining management boundaries for MPAs, assess potential damage from accidents and natural disasters, identifying possible sites for mitigation, and creating scientifically valid sampling designs. With considerable collaboration from numerous other NOAA offices and Federal and State agencies, the Coral Reef Conservation Program has been able to produce seafloor habitat maps from satellite imagery and in situ optical data in 51 percent (12,625 km²) of the shallow (0-30 m or less) coral reefs and adjacent areas.

In 2010, scientists engaged in the Coral Reef Conservation Program mapping authored a report, *Coral Reef Conservation Program Mapping Achievements and Unmet Needs*, to compile and summarize these statistics and to advise Coral Reef Conservation Program management on priorities for future mapping activities. Based on this report and in recognition of the importance of mapping for scientific and management activities, the Coral Reef Conservation Program allocated five percent of its annual budget towards mapping activities in 2010 and 2011. Important 2010 and 2011 outcomes from this mapping program in the Pacific, Caribbean, and Atlantic include:

Characterization of Coral Reef Areas in Kaneohe Bay, Oahu, Hawai'i

In 2010, Coral Reef Conservation Program sponsored a multi-beam survey to obtain comprehensive bathymetric data of Kaneohe Bay, Hawai'i. The data set has been shared



Figure 43: Mesophotic coral ecosystem in the Au'au Channel off Maui at a depth of approximately 85 m. The larger colonies of the dominant coral species seen here, *Leptoseris hawaiiensis*, are larger than the two-gallon bucket lid that marks the start of a benthic transect. Credit: NOAA

with Hawai'i Department of Land and Natural Resources to assist its work with removal of invasive alien algae that threaten coral reef condition and with U.S. Army Corps of Engineers partners, who sponsored additional data collection.

Identification and Analysis of Major Mesophotic Coral Ecosystems

Mesophotic corals are light dependent coral communities in water depths between 30-150 or more meters. Since mesophotic corals may provide refuge from thermal stress and anthropogenic stressors and be a source of coral larvae to replenish degrading and shallow reefs, NOAA and partners in Hawai'i collaborated on a series of cruises to explore the extent of mesophotic reef complexes, particularly in the channels surrounding Maui. Through this work, NOAA scientists have contributed to describing mesophotic coral ecosystems in Hawai'i and

around Tutuila in American Samoa, and to the general understanding of the geomorphology of mesophotic coral ecosystems.

Shallow-water Benthic Habitats of Palmyra Atoll

Through a partnership between NOAA, U.S. Fish and Wildlife Service and The Nature Conservancy, mapping of shallow coral reef ecosystems of Palmyra Atoll were completed and made available for further conservation of this unique location. Palmyra Atoll is one of six locations established in 2009 as part of the Pacific Remote Islands Marine Monument. The condition, extent and composition of coral reef habitats were mapped using high resolution commercial satellite imagery to provide managers with needed spatial products to better understand and manage resources at this sentinel location.



Figure 44: Seafloor habitat maps of Palmyra show the location and distribution of different underwater habitats. Credit: NOAA

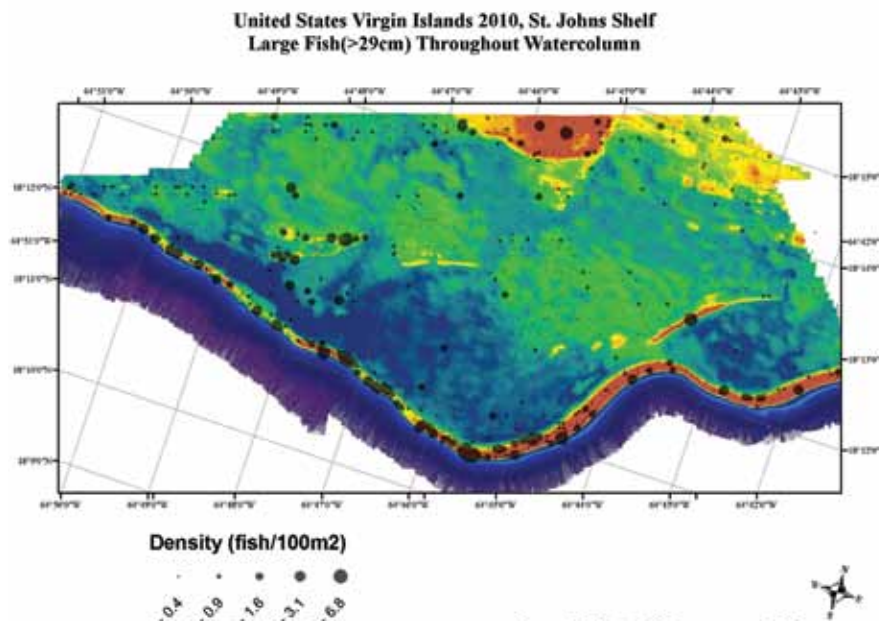


Figure 45: NOAA scientists mapped large areas of the St. John shelf, U.S. Virgin Islands and other areas to shed light on the condition of fish communities and underwater habitats. Credit: NOAA

Understanding the Condition of Benthic Habitats and Fish Communities in the U.S. Caribbean

At the request of local partners in St. John and St. Thomas, U.S. Virgin Islands, Coral Reef Conservation Program-funded scientists mapped over 145 km² of seafloor habitats that are impacted by fishing pressure, boat

traffic, pollution, and sedimentation. Sonar data and more than 50 remotely operated vehicle deployments located nearly 50 derelict fishing traps and captured the presence of coral disease. In addition, six uncharted shipwrecks were discovered. Seafloor habitat maps will be used to quantify the number of derelict traps, locate sensitive habitats, and



Figure 46: Michael Lameier with Berna Gorong, one the Pacific Island Managed and Protected Area Community Mentors hired and her husband Thomas Gorong, who is the manager of the Nimpal Conservation Area in Yap. Credit: NOAA



Figure 47: Marine Protected Area Checklist Interview, Riken Marine Protected Area Yap. Credit: NOAA

aid in ecosystem-based management decisions. Shipwreck sighting data were delivered to local maritime history authorities and will be used to update area nautical charts.

Mapping the Florida Reef Tract

The Coral Reef Conservation Program continued efforts to produce a unified habitat map of the South Florida reef tract, the third longest reef tract in the world. Approximately 90 percent of coral reefs have been mapped by NOAA and Florida stakeholders and partners. Over the next several years, maps of the entire reef tract will be complete and provide vital information to support threatened and endangered species critical habitat designations, ongoing and pending zoning activities, and other Federal and State conservation and management activities.

Next and Future Steps

The Coral Reef Conservation Program mapping efforts form the backbone for scientific and

management activities that conserve U.S. coral reef ecosystems. Investments from 2010-2011 are providing context for archipelago-wide management efforts in the Samoas, highlighting potential refuges for coral reef ecosystem species in Hawai'i, supporting pending zoning activities in Florida, and characterizing fish populations and habitat condition in the U.S. Caribbean.

CONSERVATION THROUGH EFFECTIVE MARINE PROTECTED AREA MANAGEMENT

Strengthening MPA management to conserve coral reef resources and the human communities that depend on them remains a priority of Coral Reef Conservation Program efforts both domestically and internationally. The program continued to enhance the management of



Figure 48: Caribbean Marine Protected Area Capacity Assessment Interviews in Grenada. Credit: Emma Doyle

MPAs in the Caribbean and the Pacific through existing partnerships with the United Nations Caribbean Environment Program, the Gulf and Caribbean Fisheries Institute, and regional capacity building programs and learning networks, such as the Pacific Island Managed and Protected Area Community and Caribbean MPA Management Network and Forum.

In 2011, the Coral Reef Conservation Program developed an MPA Management Assessment Checklist as a simple tool to assess the management of MPAs in priority coral reef sites in U.S. jurisdictions and international areas. This checklist allows the Coral Reef Conservation Program to better understand the needs of its partners in the MPA management community and help managers build and/or maintain the capacity necessary for successful implementation of their MPA goals and objectives. The Coral Reef Conservation Program applied this tool in 20 priority domestic coral reef MPAs in six of the seven

U.S. coral reef jurisdictions, 18 sites throughout Micronesia, and 27 sites in the international Caribbean.

Through a cooperative agreement with The Nature Conservancy, the Coral Reef Conservation Program supported completion of conservation action plans and MPA management plans, evaluation of MPA effectiveness, and identification of sustainable finance mechanisms for the continued support of MPA management efforts in Micronesia and the Caribbean. Additional efforts undertaken in 2010 and 2011 to enhance MPA activities are described below.

Assessing the Management Capacity of Caribbean Marine Protected Areas

In 2011, the Coral Reef Conservation Program worked with the Caribbean MPA Management Network and Forum to complete an assessment of MPA management capacity in 10 Caribbean



Figure 49: Rinken Faluw or Traditional Men's House, which is used for surveillance of the community's marine protected area which is in the background. Credit: NOAA

nations. A final report was completed in August 2011 and provides information on priority needs of selected Caribbean MPAs. The report findings will guide the work of NOAA and other organizations that contribute technical support, training, and funding to MPA management capacity building.

Marine Protected Area Success in the U.S. Virgin Islands

Since 2002 the Coral Reef Conservation Program has been working in partnership with the U.S. Virgin Islands Department of Planning and Natural Resources to establish and manage the St. Croix East End Marine Park. A Coral Reef Conservation Program cooperative agreement with the department supports a park coordinator and biologist, a community outreach coordinator, and two interpretive rangers. In 2011, the department, The Nature Conservancy, and the Coral Reef Conservation Program supported the installation of a series of marker buoys to delineate the St. Croix East End Marine

Park boundary and management zones. These marker buoys allow the department to actively enforce the approved rules and regulations of the park including the implementation of management zones.

Key Achievements for the Pacific Islands Managed and Protected Area Community Capacity Building Program

Over the past two years, the Pacific Island Managed and Protected Area Community's adaptive management approach, linking management planning, biological and socioeconomic monitoring, enforcement, and climate change adaptation, has demonstrated success in building MPA management capacity in the Micronesian region. Updates to the region's management plan occurred in 2011 and two former trainees became Pacific Island Managed and Protected Area Community trainers. Over the next two years, the trainers will collaborate with regional partners and communities to complete management plans



Figure 50: Floating enforcement raft at Nimpal Marine Protected Area Yap. Credit: NOAA

and conduct capacity building trainings in MPA enforcement and climate change adaptation for small island communities. While much work still remains, the achievements indicate significant progress towards establishing greater regionally-based management capacity within Micronesian Challenge jurisdictions.

Next and Future Steps

In the Caribbean, NOAA and the Caribbean MPA Management Network and Forum are using assessment results to organize peer-to-peer learning exchanges to bring together coral reef managers from around the region to share experiences and examine best practices on priority management capacity themes. The first such exchange, held in Puerto Morelos, Mexico in November, 2011, focused on sustainable financing, a top regional priority. Additional peer-to-peer learning exchanges are planned for 2012 and 2013.

Pacific Island Managed and Protected Area Community mentors will conduct climate change adaptation workshops in all Micronesian locations domestically and internationally. Additionally, enforcement trainings in Palau will assist MPA enforcement officers to develop standard operating procedures and help advance management plans towards completion and implementation. Additional work will focus on implementing actions from the climate change adaptation plans to make MPA sites more resilient to climate change events. Finally, the Coral Reef Conservation Program is using the results of the MPA management checklist assessments of 20 domestic and several international coral reef MPAs to inform all future investments in these areas and to evaluate the performance of the Coral Reef Conservation Program in increasing management effectiveness at these sites.



Figure 51: Run-off during rain events is one of the main threats to coral reef health in LaoLao Bay, Saipan. Photo credit: NOAA



Figure 52: Run-off discharge point, LaoLao Bay, Saipan. Photo credit: NOAA

OTHER NOAA CORAL-RELATED HIGHLIGHTS AND ACTIVITIES¹

American Recovery and Reinvestment Act

In February 2009, NOAA received \$167 million from the American Recovery and Reinvestment Act of 2009 to restore coastal habitat and help jump-start the nation's economy by supporting thousands of jobs. After a rigorous selection process, NOAA funded 50 high priority coastal restoration projects in 22 States and Territories. Of those 50 projects, five projects were selected to restore or mitigate threats to degraded coral reefs (see Table 3 in Appendix I for 2009 Recovery Act federal funding details by project). These projects were located in the U.S. Virgin Islands, Puerto Rico, Florida, Hawai'i, and the Commonwealth of Northern Marianas Islands. Key project outcomes spanning 2009 to 2011 are described below:

LaoLao Bay Road and Coastal Management Improvement

In 2009, the Commonwealth of Northern Mariana Islands Division of Environmental Quality received Recovery Act funds to implement the LaoLao Bay Road and Coastal Management Improvement project. LaoLao Bay, located on the southeast coast of Saipan, contains diverse, highly dimensional coral reef structures and is under constant threat from upland erosion, land-based sources of pollution, and other factors. The project addressed some of the key threats to the marine resources of LaoLao Bay by paving and grading a coastal, dirt road prone to erosion and installing concrete stream crossings at critical erosion points. In addition, project participants re-planted denuded uplands with native vegetation to further inhibit erosion into the bay. To prevent damage by personal vehicles to endangered sea turtle nesting habitat, bollards were installed at beach access points. Finally, NOAA and the

¹ The following activities were coordinated with the Coral Reef Conservation Program and contribute to the program's goals and objectives, but were largely funded outside the Coral Reef Conservation Program's budget.



Figure 53: Project area set up with erosion control fabric. Note the dry conditions due to drought. Photo credit: Kohala Watershed Partnership

Commonwealth worked to inform the public about best practices for interacting with the marine environment to protect the nearby coral reefs.

Pelekane Bay Watershed Restoration Project

In 2009, NOAA awarded the Kohala Center Recovery Act funds to implement the Pelekane Bay Watershed Restoration project. In 2010 and 2011, the project addressed serious erosion problems by installing fencing to exclude feral goats and cattle from critically eroded areas. In addition, infrastructure was added to catch sediment in runoff and over 30,000 native trees, shrubs, and other plants were planted to control erosion. More than 6,000 acres in the watershed were restored and an additional 5,000 acres were protected that feed into Pelekane Bay's coral reefs.



Figure 54: Sediment plume in Pelekane Bay following a rain event. Photo credit: Kohala Watershed Partnership



Figure 55: Project staff installing erosion control fabric in the watershed. Photo credit: Kohala Watershed Partnership



Figure 56: Time series of aerial photos taken between October 2009 and May 2011 showing the project site and areas cleared. Photo credit: The Nature Conservancy



Figure 57: Volunteers removing alien algae from Maunalua Bay. Photo credit: The Nature Conservancy

The Maunalua Bay Reef Restoration Project

The Coral Reef Conservation Program awarded The Nature Conservancy Recovery Act funds to remove invasive alien algae to restore coral and seagrass meadows in the nearshore environment of Maunalua Bay, located in eastern Oahu, Hawai'i. Nearly 70 paid workers, in addition to community volunteers, helped to manually remove 1,460 tons of invasive alien algae from Maunalua Bay. Removing these slow-growing invasive alien algae will encourage new coral recruitment and expansion of seagrass into cleared areas.

Threatened Coral Recovery in Florida and the U.S. Virgin Islands

The Nature Conservancy received Recovery Act funds to aid in the recovery of populations of threatened coral species. Acroporid corals serve as the main building blocks on reefs in Florida, Puerto Rico, and the U.S. Virgin Islands. The project expands previous restoration efforts to restore acroporid corals using nurseries. Fragments of corals were genetically typed to ensure a

diverse gene pool, grown in nurseries, and transplanted to more than 30 reefs in eight distinct areas. The project also enhances important habitat for fishery resources that benefit recreational divers and snorkelers, commercial fishers, dive tour operators, and recreational anglers. The Coral Reef Conservation Program is providing support in 2012 to continue portions of this work once the Recovery Act grants are complete.

Virgin Island Watershed Stabilization Project Grant under the Recovery Act

The Virgin Islands Resource Conservation and Development Council, Inc. received Recovery Act funds to implement watershed management and stabilization techniques in Coral Bay and Fish Bay on St. John and East End Bay, St. Croix, U.S. Virgin Islands. The project will reduce sediment quantity and flow to coral reef habitats by stabilizing trails, improving roads, and protecting vegetation from visitors. The projects have improved drainage across three watersheds and diminished the sediment load washing into nearshore habitats by approximately 130 tons per year. Terrestrial and marine monitoring data are still being gathered and analyzed to quantify the impact of this project, but local residents have noticed that the water, particularly in Coral Bay, is running clear into the bay for the first time in years.

Endangered Species Act Activities

In March 2003, NOAA was petitioned to list two species of corals under the Endangered Species Act (ESA). In May 2006, the Caribbean elkhorn (*Acropora palmata*) and staghorn corals (*Acropora Cervicornis*) were listed as threatened throughout their ranges due to



Figure 58: Tissue from wild colonies is collected and transported to the nursery where it is grown out and fragmented. Photo credit: Meaghan Johnson, The Nature Conservancy



Figure 59: Nursery corals provide important habitat in the Broward county nursery. Photo credit: Caitlin Lusic, The Nature Conservancy



Figure 60: A typical line nursery set-up in the Upper Keys nursery. Photo credit: Ken Nedimyer, Coral Restoration Foundation



Figure 61: Healthy corals hanging on a line nursery in Upper Keys nursery. Photo credit: Ken Nedimyer, Coral Restoration Foundation



Figure 62: Bioretention Pond in Coral Bay during an afternoon rain with sediment rich water. Photo credit: NOAA



Figure 63: East End Bay from new parking lot with boulders to restrict vehicle access at trail head. Photo credit: Julia Royster, NOAA



Figure 64: Trail stabilization technique at East End Bay. Photo credit: NOAA



Figure 65: Visitor platform to beach at East End Bay built to reduce erosion. Photo credit: NOAA

a combination of threats, including climate change, diseases, and hurricane damage. Elkhorn and staghorn were the first corals to be listed under the ESA. Since the time of their listing, NOAA has led conservation actions for the species, including promulgating protective regulations, designating critical habitat, and initiating the drafting of a recovery plan.

Status Review of 82 Species of Corals under the Endangered Species Act

On October 20, 2009, NOAA received a petition from the Center for Biological Diversity to list 83 species of coral under the ESA. A positive 90-day finding for 82 of the 83 species was published on February 10, 2010. Most of the 82 species can be found in the United States, its territories (Puerto Rico, U.S. Virgin Islands, Navassa, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and Pacific Remote Island Areas) or its Freely Associated States, though many occur more frequently in other countries. Seven of the species occur in the Caribbean Sea and 75 occur in the Pacific Ocean. NOAA is reviewing the status of all 83 species to determine if they warrant listing as threatened or endangered under the ESA.

Monitoring Actions for Endangered Species Act-Listed Caribbean *Acropora* Corals

NOAA, the Florida Fish and Wildlife Conservation Commission, the Puerto Rico Department of Natural and Environmental Resources, the University of Puerto Rico, the U.S. Virgin Islands Department of Planning and Natural Resources, and the University of the Virgin Islands conduct demographic monitoring of *Acropora* corals in Florida, Puerto Rico, U.S. Virgin Islands, Navassa, and Curacao. These projects provide cross-



Figure 66: SECORE scientists make final adjustments to land-based nursery after newly fertilized larvae are added to the aquarium.
Photo credit: Paul Selvaggio

jurisdictional data on the status and trends of the species, lead to the development of maps of the occurrence of the species, facilitate enforcement, and assist in recovery. Further, the Florida Fish and Wildlife Conservation Commission developed and maintains a GIS on the presence and absence of the species throughout U.S. jurisdictions.

Acropora Response and Restoration

NOAA funded and implemented scientific research, enhancement, and restoration activities directed at elkhorn and staghorn corals in Florida, Puerto Rico, and the U.S. Virgin Islands and provided technical support and funding for emergency response and restoration activities on coral reef ecosystems affected by vessel groundings where there is a threat of an oil spill. During 2010 and 2011, NOAA responded to eight vessel groundings by identifying

sensitive resources, providing technical advice to salvage operators, negotiating with responsible parties, and providing damage assessments and emergency restoration of damaged coral.

Acropora Active Propagation

SECORE (Sexual Coral REproduction), a non-profit initiative of public aquariums and coral scientists, received funds from NOAA to establish and maintain a land-based nursery for *Acropora* corals reared from sexually-produced wild larvae. SECORE has also built an ex situ population of *Acropora* in public aquaria around the world and their nursery facilitates the development of effective restoration techniques to enhance wild populations of *Acropora* corals. There are also several field-based coral nurseries for *Acropora* corals throughout Florida and the U.S. Virgin Islands. The goal of both the



Figure 67: Diver securing a collector over an elkhorn coral (*Acropora palmata*) expected to spawn in a few hours. The released egg and sperm bundles are buoyant and float into a jar at the top of the collector. Photo credit: NOAA



Figure 68: Newly transplanted staghorn coral (*Acropora cervicornis*) fragment at the Aquarius Reef Base off Key Largo, Florida. Photo credit: NOAA

land-based and field-based nurseries is to enhance the wild populations of *Acropora* corals to facilitate natural reproduction.

Acropora Spawning Research Activities

NOAA conducted research on characterizing spawning success of *Acropora* and *Montastraea* corals in the Florida Keys. NOAA researchers collected coral eggs and sperm, cultured the larvae in the lab, and initiated experiments to better understand factors that may enhance the likelihood of larvae successfully settling and surviving to adults. Experiments were also conducted on the likely impacts of climate change and acidification on these vulnerable early life stages of corals.

Acropora Transplantation Experiments

NOAA’s Aquarius Coral Restoration/Resilience Experiments test the performance of differently sourced corals in a long-term transplant experiment and examine potential impacts between “foreign” and “local” transplants. Experiments during 2010 focused on discerning potential disease transmission among coral transplants by fireworms. One major outcome of these experiments is the finding that transplantation of *Acropora* throughout the Florida Reef Tract poses little genetic risk; thus transplantation can be responsibly used as a recovery action.



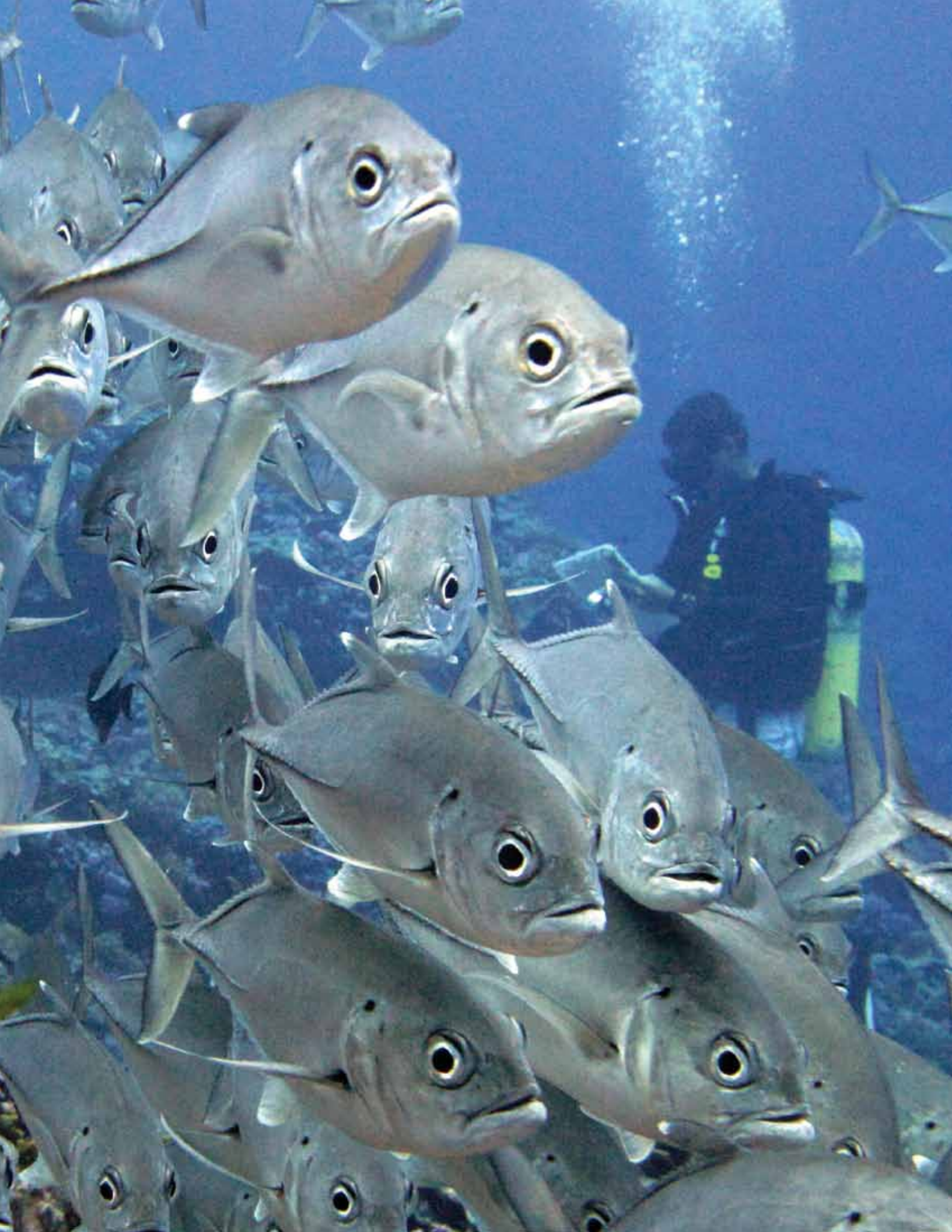
Figure 69: Elkhorn coral (*Acropora palmata*) reef at Vega Baja, Puerto Rico, one of the most robust populations of elkhorn coral in U.S. jurisdiction. Photo credit: Tom Moore, NOAA

An Integrated Assessment of Healthy Coral in Northwest Puerto Rico to Characterize Tolerant Populations of *Acropora* Species

The northwest coast of Puerto Rico has one of the most robust populations of elkhorn corals under U.S. jurisdiction and was identified by NOAA as a potential priority area needing protection and/or study. Recent observations of these near-shore reefs have detected significant change (i.e., recent mortality, algae overgrowth) in portions of the population; however, there is little available evidence for determining causation. This site provides an ideal case study for conducting an environmental assessment to pinpoint stressors and provide guidance to resource managers for their mitigation within a discrete watershed. The goal is to address impacts on reefs within the vicinity of Vega Baja, Puerto Rico. These findings also can be used as a model for informing watershed plans and to help identify best management practices for their area.

Next and Future Steps

NOAA will continue to provide for the conservation of ESA-listed corals through the promulgation of necessary regulations and implementation of recovery actions. NOAA anticipates the release of the *Acropora* Draft Recovery Plan and the determination of the ESA-listing status of the 82 candidate species in 2012. As Recovery Act funding ends, the Coral Reef Conservation Program is providing support to continue a limited portion of the work in LaoLao Bay and the coral recovery nurseries in the Caribbean. NOAA will also continue to work with Recovery Act award recipients to implement restoration projects that benefit corals and focus their attention on the development of lessons learned from the Recovery Act projects that can be used to inform future restoration needs.



Grants and Other Financial Assistance

CRCA provides authority and guidance for the Coral Reef Conservation Program to provide financial assistance for coral reef conservation projects. No less than 40 percent of funds shall be awarded for coral conservation projects in the Pacific Ocean within the maritime areas and zones subject to the jurisdiction or control of the U.S. Likewise, no less than 40 percent of the funds available shall be awarded for coral conservation projects in the Atlantic Ocean, the Gulf of Mexico, and the Caribbean Sea, with the remaining funds to be awarded for projects that address emerging priorities or threats, including international priorities or threats.

To meet these requirements, the Coral Reef Conservation Program initially developed a grants portfolio that awarded funding through six competitive funding programs administered by various offices across the agency to accomplish the objectives of the 2002 National Coral Reef Action Strategy (see Appendix II of this report for an updated and revised strategy). In response to the 2007 external program review, the grants portfolio was realigned in 2009-2010 to streamline and focus investments on the program's priority goals and objectives adopted as part of the new direction. Based on the outcomes of the grants realignment process, the Coral Reef Conservation Program grants portfolio was transitioned in 2011 to a new structure that includes: 1) four competitive funding opportunities administered by NOAA; 2) two multi-year cooperative agreements administered by NOAA; and 3) three competitive funding opportunities administered through the Coral Reef Conservation Program's public-private partnership with the National Fish and Wildlife Foundation.

Competitive Funding Opportunities (~\$6.2 M annual financial assistance)

- (1) *Coral Reef Conservation Program Domestic Coral Reef Conservation Grants: a small domestic grants program to support the involvement of academic partners, NGOs and community groups, and others in coral conservation projects (~\$500K annually);*
- (2) *Coral Reef Conservation Program State and Territorial Coral Reef Conservation Cooperative Agreements: multi-year cooperative agreements with the seven U.S. States and Territories containing coral reefs to support a broad range of priority management and monitoring objectives (~\$4M annually);*
- (3) *Coral Reef Conservation Program Fishery Management Council Coral Reef Conservation Cooperative Agreements: multi-year cooperative agreements with the four fishery management councils with jurisdiction over U.S. coral reefs to support*

council efforts to develop and improve fishery management plans for reef-associated species and reduce fishing impacts on U.S. coral reefs (~\$1M annually); and

- (4) *Coral Reef Conservation Program International Coral Reef Conservation Cooperative Agreements: multi-year cooperative agreements with international partners, including universities and NGOs that are engaged in coral conservation efforts in key international regions (~\$700K annually).*

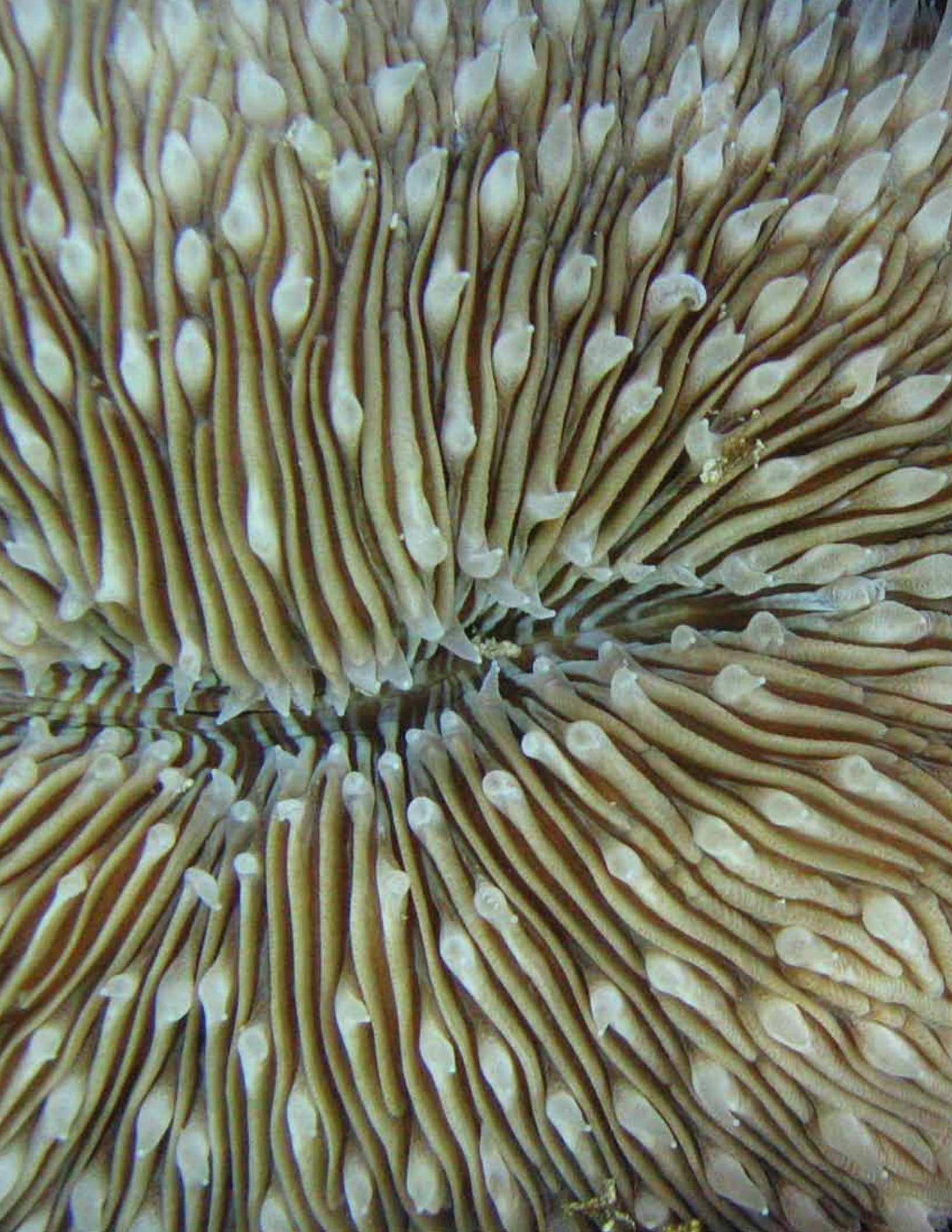
Cooperative Agreements (~\$1.2M annual financial assistance)

Multi-year cooperative agreements are also in place to provide capacity-building support for coral conservation in the seven U.S. States and Territories and social marketing and strategic communication efforts intended to engage the public in conservation and stewardship of coral reefs. Capacity-building support for coral conservation is provided through a four-year, \$3.6M cooperative agreement with The Nature Conservancy, which is providing 1:1 non-federal matching funds in support of the partnership. The cooperative agreement includes projects in Hawai'i, Florida, Puerto Rico, U.S. Virgin Islands, and the Pacific Islands and supports some global coral conservation efforts through development of specific training and exchange programs and online coral reef conservation resources. A three-year cooperative agreement between the Coral Reef Conservation Program and SeaWeb provides \$850,000 of Federal funds to support social marketing and strategic communications campaigns aimed at communicating the value of coral reefs and inspiring behavioral change

among populations living near reefs in the Commonwealth of the Northern Mariana Islands, Hawai'i, and the U.S. Virgin Islands. SeaWeb is matching the Coral Reef Conservation Program's investment and will contribute \$865,000 of non-Federal funds.

Public-Private Partnership: Coral Reef Conservation Fund (~\$650K annual financial assistance)

The competitive funding programs administered cooperatively by the Coral Reef Conservation Program and the National Fish and Wildlife Foundation through the public-private partnership include grants to a variety of domestic and international recipients through the Coral Reef Conservation Fund, as well as targeted funding to support collaborative coral reef conservation efforts in two watersheds selected by the U.S. Coral Reef Task Force (see the Formal Partnership section of this report). Building on a long history of successful collaboration, the Coral Reef Conservation Program and the National Fish and Wildlife Foundation work together to issue an annual request for proposals to solicit, review, and select coral reef conservation projects proposed by a wide variety of applicants in the U.S. and internationally. Approximately half of the funding is awarded to proposals located in the U.S. and half is awarded to international applicants. Topic areas include direct action projects such as the installation of mooring buoys to prevent reef damage from anchoring, as well as efforts to establish and implement MPAs and conduct socioeconomic studies to determine how reef condition may influence the well-being of adjacent human populations.



Formal Partnerships

The U.S. Coral Reef Task Force was established in 1998 by Presidential Executive Order 13089 to lead, coordinate, and strengthen U.S. government actions to conserve coral reef ecosystems; both domestic and international. The Executive Order recognizes the value of coral reef ecosystems and directs U.S. government agencies to work independently “to ensure actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.” To fulfill this mission, the U.S. Coral Reef Task Force develops national strategies, targeted initiatives, and new partnerships to strengthen stewardship of the coral reef ecosystems in the U.S. and internationally. The U.S. Coral Reef Task Force is comprised of 12 U.S. government agencies, two States, five Territories, and three Freely Associated States.

The U.S. Coral Reef Task Force has succeeded in bringing together government entities with diverse and potentially conflicting mandates and leveraging available expertise to identify common national goals and to foster work at the regional and State /Territory level that addresses both local and national coral reef conservation priorities. This approach allows Coral Reef Task Force members to tailor their goals and activities to address local issues and support on-the-ground action. The following examples highlight specific activities in 2010 and 2011.

Domestic Partnership

National Ocean Policy Engagement

In light of the new National Ocean Policy and the launch of the National Ocean Council (see Executive Order of July 19, 2010 on Stewardship of the Ocean, Our Coasts, and the Great Lakes and the Final Recommendations of the Interagency Ocean Policy Task Force), the U.S. Coral Reef Task Force has focused its activities on effectively engaging with the National

Ocean Council to ensure that coral reef ecosystem conservation is an integral part of the National Ocean Policy. Given its 12-year history of intergovernmental engagement, the U.S. Coral Reef Task Force can provide leadership to the National Ocean Policy for efforts to protect and restore coral reef ecosystems. The U.S. Coral Reef Task Force has identified three National Ocean Policy priority objectives that align with its current priorities and efforts:

- *Resiliency and Adaptation to Climate Change and Acidification (priority objective 5);*
- *Regional Ecosystem Protection and Restoration (priority objective 6); and*
- *Water Quality and Sustainable Practices on Land (priority objective 7).*

The U.S. Coral Reef Task Force identified specific activities that can be undertaken in relation to these three priority objectives, which are proposed for inclusion in the National Ocean Council Implementation Strategy currently under development.

U.S. Coral Reef Task Force Watershed Partnership Initiative

Recognizing that the threat of land-based sources of pollution on coral reef ecosystems crosses multiple jurisdictional boundaries and authority and responsibility to address it falls to a multitude of governmental and jurisdictional levels, the U.S. Coral Reef Task Force initiated a Watershed Partnership Initiative in 2009. The intent of this partnership is to coordinate agency resources and expertise to implement geographically specific and integrated activities, while also promoting consistent and strengthened application and enforcement of laws and authorities intended to address land-based sources of pollution.

The U.S. Coral Reef Task Force Watershed Partnership Initiative includes two distinct components: (1) individual Federal and State/Territory agency contributions through direct application of resources, technical assistance, and/or program expertise and (2) a competitive funding opportunity that awards Federal funds to local organizations and individuals to implement small to mid-scale projects. This fund is administered

through the National Fish and Wildlife Foundation. The U.S. Coral Reef Task Force is implementing this partnership approach in two watersheds, Guánica Bay/Río Loco in Puerto Rico (2009) and Ka'anapali in West Maui, Hawai'i (2010), with a third watershed in American Samoa (2012).

Guánica Bay Puerto Rico

Since 2009, USDA's Natural Resources Conservation Service has contributed Environmental Quality Incentive Program funds for 31 farmers to implement core and supporting conservation measures throughout the lower, mid, and upper watershed areas. NOAA Coral Reef Conservation Program is funding work to assess habitat restoration feasibility options, providing capacity and community coordination support, and conducting in-water sediment monitoring. The U.S. Fish and Wildlife Service is working to support the transition of sun grown coffee plantations to shade grown coffee plantations. Between 2010 and 2011 the U.S. Fish and Wildlife Service has contributed through the Partners for Fish and Wildlife Program and the Coastal Program to produce 30,000 native trees of which 11,400 have been planted to convert 316 acres of sun coffee production into shade coffee production in 16 private lands. In 2011, 22 new landowners joined the program. The U.S. Environmental Protection Agency has conducted water quality monitoring in the bay and is working with other Federal agencies and the local community to develop a decision support tool for determining management and restoration strategies. Agencies involved that are directly contributing resources, expertise and other technical assistance include Natural Resources Conservation Service, NOAA, U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency.

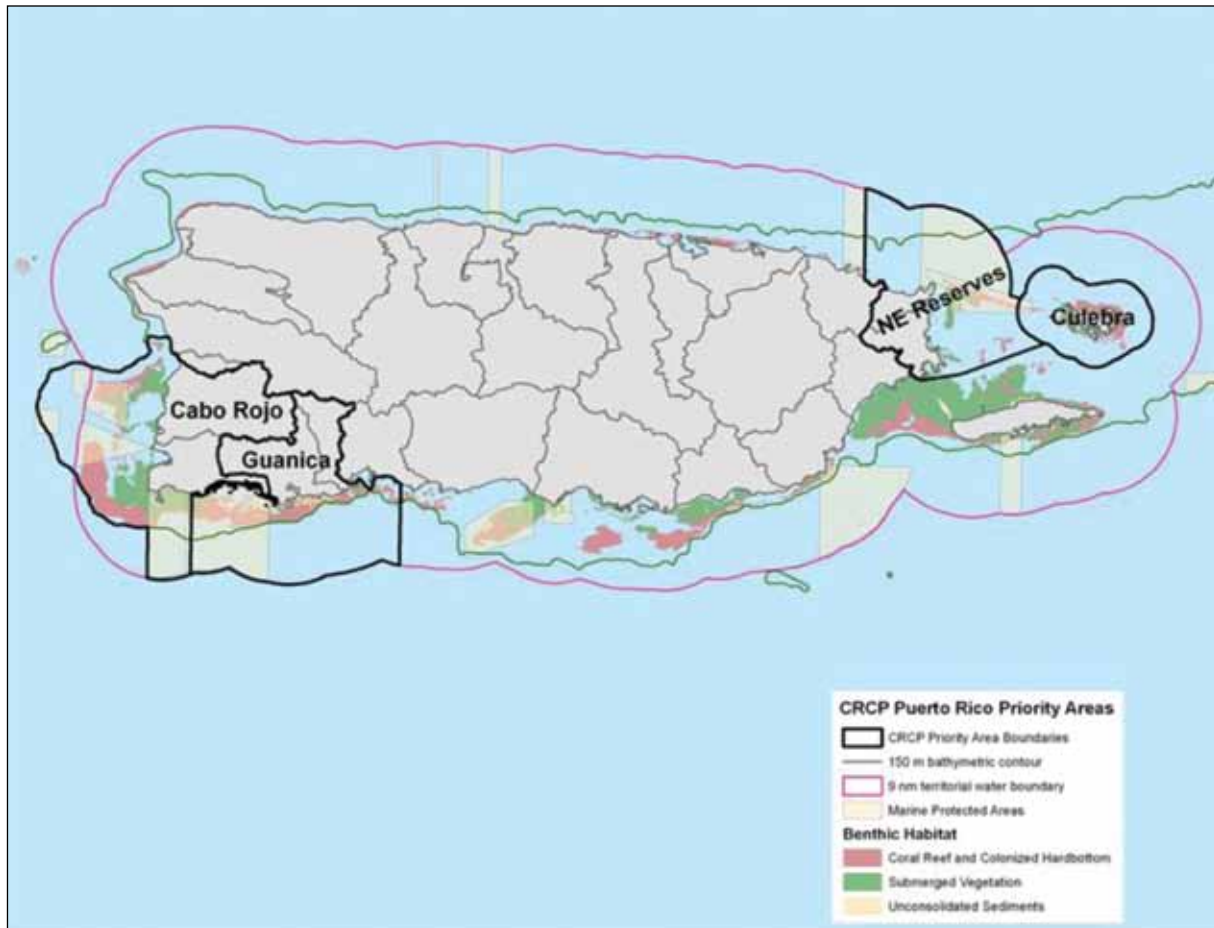


Figure 70: CRCP Puerto Rico Priority Areas.

Ka'aanapali, Maui Hawai'i

In the Ka'aanapali watershed, NOAA is developing a watershed management plan that incorporates coral reef protection measures for the two priority watersheds within Ka'aanapali (Honokowai and Wahikuli). In addition, in the true spirit of a ridge to reef approach to coral reef ecosystem management, NOAA is supporting fisheries research in the Kahekili Herbivore Enhancement Area (see the Fishing Impacts section for more details on this project). U.S. Environmental Protection Agency is conducting a range of water quality monitoring studies, most significantly a wastewater plume tracer study to determine time of travel between



Figure 71: Guánica Bay, Puerto Rico. Credit: Tom Moore, NOAA

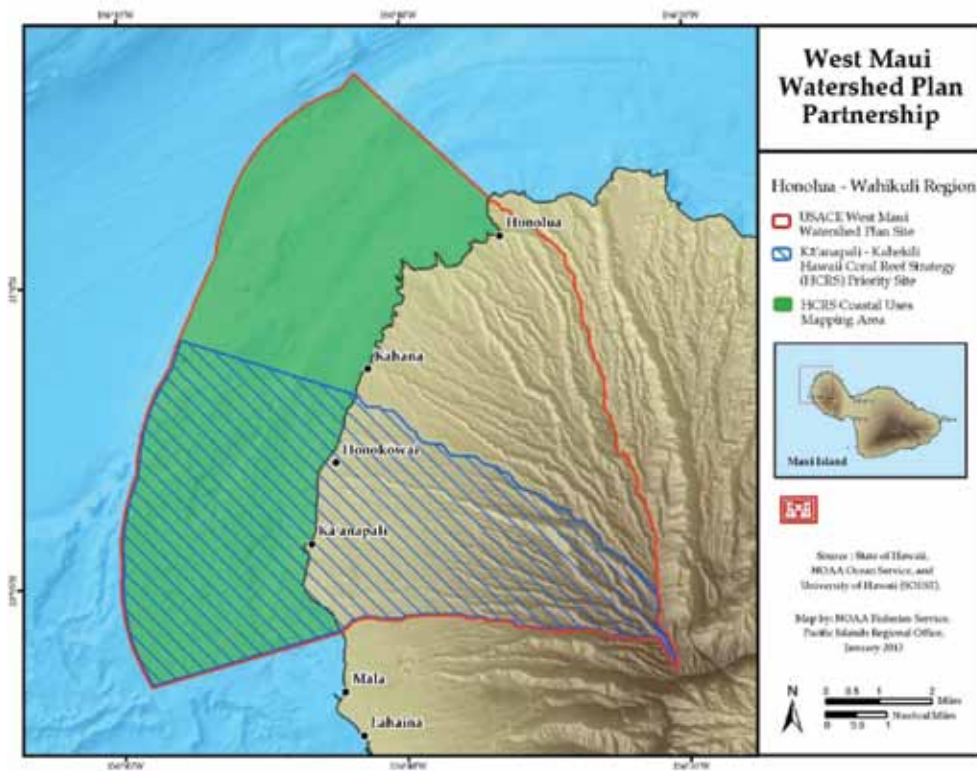


Figure 72: CRCP Hawai'i Priority Areas and West Maui Watershed Plan Partnership Maps. Ka'aanapali Map

injection well and ocean seeps, which includes measurement of groundwater flux and nutrient flux. USDA is working to engage local landowners in volunteer land conservation programs. The U.S. Geological Survey has conducted submarine groundwater discharge efforts and studies of coastal circulation along west Maui, including assessing the location, quantity, and chemistry of fresh water discharges in the area. This body of work will contribute to a holistic and adaptive management approach to understanding and restoring Ka'aanapali and the surrounding watersheds.



Figure 73: Ka'aanapali Photo



Figure 74: Palolo Deep Marine Reserve near Apia. Credit: Matt Kendall, NOAA

Next and Future Steps

The U.S. Coral Reef Task Force will continue to promote national programmatic partnerships effectively directed towards on-the-ground conservation actions and solutions and will build on this strong foundation to develop and advance new and innovative opportunities for collaboration among Federal agencies and coral reef jurisdictions. The U.S. Coral Reef Task Force will work to better utilize individual member authorities, programs, and expertise at the national and local level to respond more effectively to those threats that the U.S. Coral Reef Task Force has the capacity to address.

International Partnership

In the international arena, formal international partnerships (e.g., bilateral or multilateral science and technology agreements; U.S. government diplomatic and development programs) help establish the strategic

framework within which U.S. policies are achieved and international coral reef conservation is realized. Only in concert with international partnerships can we effectively conserve coral reefs domestically, as most U.S. coral reefs both depend ecologically on coral reefs outside of U.S. jurisdiction (e.g., larval connectivity) and are subject to threats that are global in nature (e.g., ocean acidification, global climate change). Formal international partnerships typically involve close collaboration with the U.S. Department of State, USAID, and across NOAA. Together, such U.S. government cooperation ensures that international engagement is both technically and diplomatically sound and strategic.

Examples of formal partnerships include NOAA's contribution to the following U.S. government efforts, in on-the-ground programs like the Coral Triangle Initiative, and in government-to-government

engagement like the first U.S./Australia Science and Technology Agreement.

Global Platforms: International Coral Reef Initiative

Through the International Coral Reef Initiative, NOAA provides substantial technical contributions to the decentralized global networks that report on the quadrennial status of the world's reefs and people along the world's tropical coasts: the Global Coral Reef Monitoring Network for reef monitoring and socioeconomic monitoring of people of the world's tropical coasts.

On-the-Ground U.S. Government Efforts in International Conservation and Development: NOAA/USAID Partnerships in the Coral Triangle Region, Indonesia, Philippines, and Timor-Leste

The Coral Reef Conservation Program International manages and provides significant technical input into the most expansive NOAA/USAID interagency partnerships today that provide on-the-ground, technical assistance, and capacity building in the global epicenter of marine biological diversity. These programs include: (1) the Coral Triangle Initiative, the five-year, \$42 million program funded by the USAID and the U.S. Department of State to support the six-country region's efforts to protect food security and climate resilience for the region's 363 million people; (2) bilateral engagement in Indonesia to support this country's leadership in marine resource management; and (3) a newly launched program in Timor-Leste to assist this Coral Triangle country in establishing marine management and governance in one of the world's youngest nations.

U.S. and Australia Science and Technology Agreements

In 2011, the governments of the U.S. and Australia entered into the first U.S./Australia Science and Technology Agreements, establishing bilateral policy and partnership. Marine science represented one of the six major thematic areas, with coral reef biodiversity, climatology and remote sensing, cooperation supporting ecosystem-based management, and the Coral Triangle Initiative, featured prominently in U.S./Australia Science and Technology discussions. In early 2011, several significant policy outcomes have been achieved, for example, the Coral Reef Conservation Program Coral Reef Watch supports a memorandum of agreement with the Australian Institute of Marine Sciences that is designed to encourage marine and climate change science and monitoring. In addition, as a result of the U.S./Australian Science and Technology agreement, President Obama recently announced a new partnership between the U.S. and Australia in the Coral Sea. As part of this new partnership, NOAA and Australian counterparts will cooperate on reef biodiversity research, maritime archaeology, and in support of the Coral Triangle Initiative in the Solomon Islands and Papua New Guinea.

The Coral Reef Conservation Program, working with the Department of State, USAID, and international partners, is demonstrating with clear successes how U.S. government partnerships in international coral reef conservation directly meet the President's diplomatic and development agenda goals of promoting food security, human health and well-being, and adaptation to climate change.

APPENDIX I: BUDGET

Table 1: Total Coral Reef Conservation Program and other NOAA funding focused on coral reefs by jurisdiction.

Jurisdiction	FY2010 Funding	FY2011 Funding
Hawai'i	\$6,296,717	\$4,182,562
NOAA Coral Reef Conservation Program	\$3,769,355	\$3,086,700
NOAA Other	\$2,527,362	\$1,095,862
Guam	\$2,008,295	\$1,689,200
NOAA Coral Reef Conservation Program	\$1,427,703	\$1,414,362
NOAA Other	\$580,592	\$274,838
Commonwealth of the Mariana Islands	\$1,888,131	\$1,687,758
NOAA Coral Reef Conservation Program	\$1,888,131	\$1,687,758
NOAA Other	\$0	\$0
American Samoa	\$1,641,869	\$2,244,987
NOAA Coral Reef Conservation Program	\$1,560,915	\$2,044,614
NOAA Other	\$80,954	\$200,373
Florida (including Flower Garden Banks National Marine Sanctuary)	\$7,492,935	\$8,630,168
NOAA Coral Reef Conservation Program	\$3,944,588	\$3,727,808
NOAA Other	\$3,548,347	\$4,902,360
U.S. Virgin Islands	\$3,508,787	\$2,926,566
NOAA Coral Reef Conservation Program	\$3,159,179	\$2,537,150
NOAA Other	\$349,608	\$389,416
Puerto Rico	\$2,980,851	\$2,666,965
NOAA Coral Reef Conservation Program	\$2,515,074	\$2,100,036
NOAA Other	\$465,777	\$566,929
International	\$2,942,608	\$2,589,986
NOAA Coral Reef Conservation Program	\$1,815,600	\$2,338,750
NOAA Other	\$1,127,008	\$251,236
National Program/Other	\$23,295,566	\$21,567,136
NOAA Coral Reef Conservation Program	\$8,919,455	\$7,808,822
NOAA Other	\$14,376,111	\$13,758,314
Total	\$52,055,759	\$48,185,328
Coral Reef Conservation Program Total	\$29,000,000	\$26,746,000

Table 2: Total Coral Reef Conservation Program and other NOAA funding focused on coral reefs directly addressing the top three threats to coral reefs. Amounts listed as other include program and national-level support of coral reef conservation.

Threat	FY2010 Funding	FY2011 Funding
Negative Impacts from Fishing	\$4,373,876	\$5,456,529
NOAA Coral Reef Conservation Program	\$3,341,094	\$4,072,292
NOAA Other	\$1,032,782	\$1,384,237
Climate Change and Ocean Acidification	\$4,299,015	\$7,364,928
NOAA Coral Reef Conservation Program	\$1,893,401	\$4,528,913
NOAA Other	\$2,405,614	\$2,836,015
Land-Based Sources of Pollution	\$3,596,078	\$4,185,709
NOAA Coral Reef Conservation Program	\$1,883,517	\$2,630,623
NOAA Other	\$1,712,561	\$1,555,086
Other	\$39,786,790	\$31,178,162
NOAA Coral Reef Conservation Program	\$21,881,988	\$15,514,172
NOAA Other	\$17,904,802	\$15,663,990
Total	\$52,055,759	\$48,185,328
Coral Reef Conservation Program Total	\$29,000,000	\$26,746,000

Table 3: The following five projects, as described earlier, received Federal American Recovery and Reinvestment Act funding to restore or mitigate threats to degraded coral reefs. Organization, locations, and dollar amount are listed by project. All funds are from 2009.

American Recovery and Reinvestment Act Project Name	Organization	Location	Funding
The Maunalua Bay Reef Restoration Project	The Nature Conservancy	Oahu, Hawai'i	\$3,408,848
Threatened Coral Recovery and Restoration	The Nature Conservancy	Florida, Puerto Rico, and U.S. Virgin Islands	\$3,361,243
Virgin Islands Watershed Stabilization Project	Virgin Islands Resource Conservation and Development Council, Inc.	Coral Bay, Fish Bay, and East End Bay, U.S. Virgin Islands	\$2,841,281
Laolao Bay Road and Coastal Management Improvement	Commonwealth of the Northern Mariana Islands	Saipan, CNMI	\$1,133,391
Pelekane Bay Watershed Restoration Project	The Kohala Center	Hawai'i, Hawai'i	\$2,905,065

APPENDIX II: CORAL REEF NATIONAL ACTION STRATEGY

A REVISED AND UPDATED STRATEGY, 2012

The NOAA Coral Reef Conservation Program has completed a strategic planning process to realign the focus and allocation of Program resources and funding to address the top three recognized global threats impacting the world's coral reef ecosystems. Due to this, the Coral Reef Conservation Program has updated the National Coral Reef Action Strategy as called for in CRCA.

Background

Coral reef ecosystems, value of coral, and threats they face

Healthy coral reefs are among the most biologically diverse and economically valuable ecosystems on earth, providing hundreds of billions of dollars in food, jobs, recreational opportunities, coastal protection, and other important services. Yet reefs are threatened by an increasing array of impacts – primarily from the adverse effects of fishing, pollution, and global climate change. According to the Reefs at Risk Revisited (Burke et al. 2011), approximately 75% of the world's coral reefs are currently threatened by a combination of local and global pressures. This includes recent impacts from climate change, which causes rising ocean temperatures, ocean acidification, and coral bleaching. The most immediate and direct threats arise from local sources, which currently threaten more than 60% of reefs. Local threats include overfishing, destructive fishing, coastal development, and pollution. The decline and loss of coral reefs have significant social, cultural, economic, and ecological impacts on people and communities in the United States and around the world. However, with effective leadership and management, healthy, resilient reef ecosystems can continue to provide these valuable ecological, economic, and cultural services to current and future generations.

Executive Order 13089 on Coral Reef Conservation

In 1998, the United States Coral Reef Task Force was established by Presidential Executive Order 13089 on Coral Reef Conservation to coordinate government efforts to protect, restore, and sustain coral reef Freely Associated States – oversees implementation of the Executive Order and Federal responsibility it sets forth. In 2000, the U.S. Coral Reef Task Force adopted the *National Action Plan to Conserve Coral Reefs (National Action Plan)*, the first national blueprint for U.S. domestic and international action to address the growing coral reef crisis. The National Action Plan calls for U.S. action toward 13 broad goals in order to better understand, protect, and conserve valuable coral reef ecosystems.

Coral Reef Conservation Act and Coral Reef Conservation Program

In 2000, Congress passed CRCA (16 U.S.C. 6401 et seq.), which established the NOAA Coral Reef Conservation Program. The intent of the law is:

(1) to preserve, sustain, and restore the condition of coral reef ecosystems; (2) to promote the wise management and sustainable use of coral reef ecosystems to benefit local communities and the Nation; (3) to develop sound scientific information on the condition of coral reef ecosystems and the threats to such ecosystems; (4) to assist in the preservation of coral reefs by supporting conservation programs, including projects that involve affected local communities and nongovernmental organizations; (5) to provide financial resources for those programs and projects; and (6) to establish a formal mechanism for collecting and allocating monetary donations from the private sector to be used for coral reef conservation projects.

NOAA's Coral Reef Conservation Program was established to help fulfill NOAA's responsibilities under the CRCA and Presidential Executive Order 13089 on Coral Reef Protection. The mission of the Coral Reef Conservation Program is to support effective management and sound science to preserve, sustain, and restore valuable coral reef ecosystems for future generations.

The CRCA calls on NOAA to develop a national coral reef action strategy. In 2002, NOAA, with its U.S. Coral Reef Task Force partners, developed the *U.S. Coral Reef National Action Strategy (National Action Strategy)*. The National Action Strategy and the National Action Plan have served as the guiding documents for both the U.S. Coral Reef Task Force and the Coral Reef Conservation Program since their inception. Finally, the CRCA calls on NOAA to report to Congress every two years regarding implementation of the *National Action Strategy*, “describing all activities undertaken to implement the strategy...including a description of the funds obligated each Fiscal Year to advance coral reef conservation”. NOAA, with assistance from the task force, has completed three reports, *The Report to Congress on Implementation of the Coral Reef Conservation Act of 2000 and the National Action Strategy to Conserve Coral Reefs*, for activities that span 2002-2003, 2004-2006, and 2007-2009.

Coral Reef Conservation Program Strategic Review and Need for Updating the National Coral Reef Action Strategy

In 2007, the NOAA Coral Reef Conservation Program conducted a self-assessment and arranged for an expert panel external review of the Program's effectiveness over a five year period (Fiscal Years 2002-2006) in implementing the CRCA and *National Action Strategy*. The external review provided the Program with a final assessment and recommendations for the future direction. In response, the Coral Reef Conservation Program has narrowed the focus of its U.S. domestic program and has shifted allocation of Coral Reef Conservation Program resources to more on-the-ground and in-the-water action. To narrow its range of activities, the Coral Reef Conservation Program is emphasizing efforts on understanding and addressing the top three recognized global threats to coral reef ecosystems: climate change impacts, fishing impacts, and impacts from land-based sources of pollution. The Coral Reef Conservation Program has also expanded its international presence by becoming more actively involved in coral conservation efforts primarily in the Pacific, the Coral Triangle region, and the Caribbean. In addition, the Coral Reef Conservation Program is increasing its social science portfolio to strategically improve coral reef management by engaging local communities, better assessing community impacts of management measures, and enhancing efforts in education and outreach activities. Finally, the Coral Reef Conservation Program conducted a realignment of the external funding programs (competitive grants and cooperative agreements) to streamline and focus investments to further support the new direction of the Program.

The CRCA provides guidance to periodically review and revise the *National Action Strategy*, which should incorporate new and enhanced scientific understanding, increased management pressures, and the current condition of coral reef ecosystems and relevant threats. Given these broad scale Coral Reef Conservation Program programmatic changes, an updated and refined *National Action Strategy* was deemed necessary.

This updated *National Action Strategy* is not a single, static, document; it is a compilation of independent but inter-related documents providing extensive information on how NOAA will implement the CRCA. Each of these independent documents should be viewed as components of the revised *National Action Strategy*.

National Coral Reef Action Strategy: Updated Goals and Objectives

How the realigned Coral Reef Conservation Program will meet the requirements in CRCA

As outlined in the CRCA, [t]he action strategy shall include a statement of goals and objectives as well as an implementation plan, including a description of the funds obligated each Fiscal Year to advance coral reef conservation. The action strategy and implementation plan shall include discussion of:

- (1) *Coastal uses and management*
- (2) *Water and air quality*
- (3) *Mapping and information management*
- (4) *Research, monitoring and assessment*
- (5) *International and regional issues*
- (6) *Outreach and education*
- (7) *Local strategies developed by the States or Federal agencies, including regional fishery management councils, and*
- (8) *Conservation, including how the use of marine protected areas to serve as replenishment zones will be developed consistent with local practices and traditions*

The Coral Reef Conservation Program fulfills the above CRCA requirements through the Program's updated guiding documents developed as a result of the 2007 External Review and subsequent strategic planning process. These guiding documents are highlighted below as they relate to the national coral reef action strategy components outlined in the CRCA. Reference sites are included to access the full text of these guiding documents.

The Coral Reef Conservation Program developed Coral Reef Conservation Program [Goals and Objectives 2010-2015](#) (20-year strategic goals and 5-year targeted objectives) that emphasize efforts on understanding and addressing the top three recognized global threats to coral reef ecosystems: climate change impacts, fishing impacts, and impacts from land-based sources of pollution. The Coral Reef Conservation Program engaged a community of experts from other Federal agencies, the State and Territory management and scientific community, non-governmental organization and academic partners, among others, to help identify the 20-year strategic goals and five-year objectives. The Coral Reef Conservation Program, in partnership with the coral reef management community, will address strategic management needs and place increased emphasis on place-based management. The Coral Reef Conservation Program is committed to continually refining its efficiency and outcome measures to improve program effectiveness and better evaluate overall Coral Reef Conservation Program performance.

In addition, as NOAA does not have clear legislative authority to address the threat of land-based sources of pollution, the Program has developed a [Land-Based Sources of Pollution Implementation Plan](#) that clearly articulates the NOAA Coral Reef Conservation Program niche and approach to address this threat. It addresses land-based sources of pollution, identifies areas of collaboration, and ultimately helps inform future land-based sources of pollution funding decisions.

Activities to address these three priority threats - climate change impacts, fishing impacts, and impacts from land-based sources of pollution - will fulfill the requirement to address (1) *Coastal uses and management* and (2) *Water and air quality*.

Since the Program's inception, producing current, accurate and consistent maps of shallow coral reef ecosystems and establishing a nationally coordinated long-term monitoring program to assess the condition of U.S. coral reef ecosystems has been a priority. While the external review recommendations called for a decreased emphasis on these types of activities to allow greater focus on implementing on-the-ground management activities, mapping, monitoring, and assessing coral reef condition will remain a key component of the Coral Reef Conservation Program. To more effectively, and holistically target these activities, the Coral Reef Conservation Program is developing a **National Coral Reef Monitoring Plan** and has completed a [Mapping Achievements and Unmet Needs](#) guidance document. In addition, the Program recognizes the need to better manage data and information produced to ensure accessibility, archiving, and use by NOAA and other partners. As such the Program is developing a **Data Management Policy and a Data Management Plan**.

The Coral Reef Conservation Program has identified the need for enhanced research on climate change impacts and threats, specifically surrounding ocean acidification. The Federal Ocean Acidification Research and Monitoring Act, passed by Congress in 2009, further supports this need. To help target Program research investments, the Coral Reef Conservation Program has completed an **Ocean Acidification Science Plan**. Continuing these efforts in a more strategic fashion will fulfill the requirements to address (3) *Mapping and information management and (4) Research, monitoring, and assessment*.

Recognizing that most coral reef ecosystems in U.S. waters are interconnected with, depend on, and affect coral reefs in other countries, the Coral Reef Conservation Program has expanded its international presence by becoming more actively involved in coral conservation efforts, primarily in Micronesia, the Southwest Pacific, the Coral Triangle region, and the Caribbean. Coral Reef Conservation Program efforts to promote healthy coral reefs internationally are critical to U.S. diplomatic and development strategies to promote economic and food security; social stability; democratic governance; improved human health, disaster and climate change mitigation; and biodiversity conservation in many countries. To effectively target the Coral Reef Conservation Program's international activities, the Program developed an [International Strategy](#). Activities conducted under the auspices of this International Strategy will fulfill the requirement to address (5) *international and regional issues*.

The Coral Reef Conservation Program appreciates the value of an informed and engaged public that is empowered to act in partnership for coral reef conservation. The Coral Reef Conservation Program developed a **Communication, Education, and Outreach Strategy** that outlines efforts to reach key target audiences and utilize new and innovative tools to increase awareness and stewardship of coral reef resources. The Coral Reef Conservation Program work in communication, outreach, and education will expand on current Coral Reef Conservation Program activities and fulfill the requirement to address (6) *Outreach and education*.

The Coral Reef Conservation Program works in close partnership with the coral reef management community at the State, Territory and Federal level in each of our partner jurisdictions (American Samoa, Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawai'i, Puerto Rico, and the U.S. Virgin Islands). The Coral Reef Conservation Program is committed to addressing local strategic management needs and is placing increased emphasis on place-based management. To help direct Program activities and investments locally, the Coral Reef Conservation Program worked with the management community in each jurisdiction to articulate a set of strategic management priorities which are outlined in jurisdiction-specific [Coral Reef Management Priority](#) documents. Activities conducted to advance these local management priorities will fulfill the requirements of (7) *Local strategies developed by the States or Federal agencies, including regional fishery management councils*, as well as contribute to regional activities as called for in (5) *International and regional activities*.

Strengthening marine protected area (MPA) management to conserve coral reef resources remains a pillar of NOAA's Coral Reef Conservation Program efforts both domestically and internationally. A priority goal of the Coral Reef Conservation Program is to support effective implementation and management of MPAs and enhance ecological networks of MPAs that protect key coral reef ecosystem components and functions. The Coral Reef Conservation Program developed the [MPA Management Assessment Checklist](#) as a tool to assess the management of MPAs in priority coral reef sites in U.S. jurisdictions, and in international areas important to the Coral Reef Conservation Program and jurisdictional partners. This checklist will allow the Coral Reef Conservation Program to better understand the needs of its partners in the MPA management community and help managers build and/or maintain the management capacity necessary for successful implementation of their MPA management goals and objectives. Information gathered through use of the **MPA Management Assessment Checklist** will help the Coral Reef Conservation Program better target our activities and resources and will fulfill the requirements of (8) *Conservation, including how the use of marine protected areas to serve as replenishment zones will be developed consistent with local practices and traditions*

As recommended by the Coral Reef Conservation Program external review, the Coral Reef Conservation Program is focused on increasing the strategic use of social science tools in U.S. coral reef jurisdictions and has developed a [Social Science Strategy](#) to help prioritize those social science activities and information needs that should be facilitated by the Coral Reef Conservation Program to further coral reef management in the jurisdictions. The Coral Reef Conservation Program's social science portfolio includes collection of critical baseline data, including socioeconomic assessments and coastal use mapping, and activities to enhance understanding of the social and economic implications of new and existing management measures. Activities conducted to further social science efforts will fulfill the requirements of (4) *Research, monitoring, and assessment*, (5) *International and regional issues*, (6) *Outreach and education* (7) *Local strategies developed by the States or Federal agencies, including regional fishery management councils*, and (8) *Conservation, including*

how the use of marine protected areas to serve as replenishment zones will be developed consistent with local practices and traditions.

The CRCA also states that, subject to the availability of funds, NOAA shall provide grants of financial assistance for projects for the conservation of coral reefs. The Coral Reef Conservation Program developed a competitive grants program to meet these requirements of the CRCA, which, following the Coral Reef Conservation Program 2007 external review, was realigned to streamline and focus investments to further support the new direction of the Program. The Coral Reef Conservation Program grant program now consists of four competitive funding opportunities with awards that are administered by NOAA, two multi-year cooperative agreements administered by NOAA, and three competitive funding opportunities administered through the Coral Reef Conservation Program's public-private partnership with the National Fish and Wildlife Foundation. The Coral Reef Conservation Program's four competitive funding opportunities include (1) small domestic grants to support the involvement of academic partners, non-governmental organizations, and community groups in coral conservation projects; (2) cooperative agreements with the seven U.S. States and Territories containing coral reefs to support a broad range of priority management and monitoring objectives; (3) cooperative agreements with the four Fishery Management Councils with jurisdiction over U.S. coral reefs; and (4) cooperative agreements with international organizations engaged in coral conservation efforts in key international regions. Multi-year cooperative agreements are also in place to provide capacity-building support for coral conservation in the seven U.S. states and territories and social marketing and strategic communication efforts intended to engage the public in conservation and stewardship of coral reefs.

To track and measure its outcome-oriented goals, the Program designed a series of 18 performance measures that target the new Program Goals & Objectives. By consistently and thoughtfully looking at both intermediate and long-term outcomes, the Coral Reef Conservation Program can observe changes in the ecosystem measured through targeted monitoring and use this feedback in designing future strategies for coral reef conservation.

Conclusion

In response to the 2007 strategic review and current coral reef conditions, the Coral Reef Conservation Program has focused its efforts on three top priority threats to domestic and international coral reefs: climate change impacts, fishing impacts, and impacts from land based sources of pollution. These three threats currently guide Coral Reef Conservation Program involvement in coral reef science, management strategies, and community outreach. The documents highlighted in this updated National Action Strategy represent a compilation of independent but inter-related guidance documents providing extensive information on how NOAA will implement the CRCA and work toward protecting, conserving, and managing coral reefs worldwide.

APPENDIX III: ACRONYMS

AOAT	Atlantic Ocean Acidification Test-bed
CRCA	Coral Reef Conservation Act (of 2000)
USEPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
MPAs	Marine protected areas
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Services
SECORES	Sexual COral REproduction
USAID	United States Agency for International Development
USDA	U.S. Department of Agriculture

APPENDIX IV: REFERENCES

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