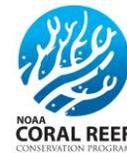




NOAA
CORAL REEF
CONSERVATION PROGRAM

Implementation of the Coral Reef Conservation Program
2017 – 2019

A Report on the National Oceanic and Atmospheric
Administration's Coral Reef Conservation Program Activities from
2017 to 2019



About the Coral Reef Conservation Program

Established in 2000, the Coral Reef Conservation Program (Coral Program) fulfills NOAA's responsibilities under the Coral Reef Conservation Act (16 U.S.C. §6401 *et seq.*) and Presidential Executive Order 13089 on Coral Reef Protection.

The program brings together expertise from across NOAA, through a matrix program, for a multidisciplinary approach to study these complex ecosystems and inform effective management activities. The Coral Program work involves NOAA scientists from the National Ocean Service, National Marine Fisheries Service, Office of Oceanic and Atmospheric Research, and National Environmental Satellite, Data, and Information Service.

Effective collaboration through the matrix also enables NOAA to uphold its other mandates to protect and conserve trust resources, including Endangered Species Act-listed species and their designated critical habitats, essential fish habitats mandated under the Magnuson-Stevens Fishery Conservation and Management Act, and underwater parks designated under the National Marine Sanctuaries Act and executive orders.

The Coral Program's multidisciplinary approach includes topic-based research, monitoring, mapping, social science, communications, and capacity building at local, national, and international scales. This cross-cutting work provides the necessary information and enabling conditions for effective coral reef conservation and management. The backbone of the Coral Program's monitoring efforts is the National Coral Reef Monitoring Program, which documents U.S. coral reef ecosystem status and trends. This program is a strategic framework for conducting sustained observations of biological, climatic, and socioeconomic indicators in U.S. states and territories in a consistent and integrated manner. This broad-scale monitoring in turn provides context for interpreting the results of localized monitoring. Inherent to all monitoring, assessment, and data-integration activities of the Coral Program is a sustained data management effort, including a formal archive of all the data collected.

The Coral Program also collaborates with other federal managers, state and territorial governments, academic institutions, non-governmental organizations, foreign governments and organizations, and community groups to implement actions to address local issues that impact coral reef ecosystems. These partnerships are essential to design and implement effective management and conservation solutions that span local, state, and federal authorities.

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About this Document

This report covers coral reef-related activities conducted by the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (Coral Program) during Fiscal Years 2017 through 2019. Activities are pursuant to the goals and objectives under the NOAA Coral Reef Conservation Program Strategic Plan. The goals described in each of the Strategic Pillars guided most of the funding and activities undertaken by the program from 2017-2019, and the content is organized accordingly.

Acknowledgements

This document highlights NOAA activities; 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.

Table of Contents

Executive Summary.....	4
Goal Summary and Accomplishments Update	5
Increase Resilience to Climate Change	6
Improve Fisheries’ Sustainability	11
Reduce Land-based Sources of Pollution.....	17
Restore Viable Coral Populations	24
Cross-cutting Highlights.....	32
Socioeconomics and Jurisdictional Capacity.....	33
National Coral Reef Monitoring Activities	35
Mapping.....	37
Grants and other Financial Assistance.....	39
Appendix I: Budget Table	41
Appendix II: Grants and Other Financial Assistance 2017-2019	42

Executive Summary

Healthy coral reefs provide valuable ecosystem services to the American public, in particular communities living along our coastlines. These services are valuable both culturally and economically including food security, opportunities for recreation and tourism, coastal protection, and raw materials used to create pharmaceutical products.

Among the most biologically diverse and economically valuable ecosystems on earth, coral reefs ensure the well-being of growing coastal communities and local economies. Covering just a tiny fraction of the earth's surface—less than 1 percent—shallow-water coral reefs sustain and protect human lives, livelihoods, and coastal property. A conservative estimate for the global value of reef tourism is \$36 billion per year. When food production and property protection are added, global services are estimated at \$172 billion per year.

Looking through a domestic lens, coral reefs in Southeast Florida, for example, have an asset value of \$8.5 billion, generating \$4.4 billion in local sales, \$2 billion in local income, and 70,400 full- and part-time jobs. NOAA's National Marine Fisheries Service estimates the annual commercial value of U.S. fisheries from coral reefs to be over \$100 million. Reef-based recreational fisheries likely generate another \$100 million or more. Coral reefs-derived materials are used for biopharmaceuticals to treat pain, infection, inflammation, asthma, and several cancers. In addition to these very tangible assets, reefs have tremendous aesthetic and cultural value to people.

Multiple threats are acting in synergy placing coral reefs and their ecosystem services at risk. Pollution, fishing impacts, a changing global climate, and other stressors have destroyed or severely damaged many of the world's reefs. Under the Endangered Species Act, twenty-two coral species are listed as threatened, and three are listed as endangered. Coral reefs subsequently experienced unprecedented losses during the third global bleaching event in 2014-2017.

The Coral Program is taking proactive measures to address these declines by leading efforts to understand and conserve these precious resources. As part of Coral Program's ongoing efforts to improve conservation efforts to adapt to increasing and new stressors, an updated Strategic Plan was developed and published in 2018. The goal of the plan is to reduce threats affecting coral reefs, particularly in U.S. waters, and to restore coral ecosystem function at an ecological scale. The plan uses a resilience-based management approach to focus on conservation that supports the ability of corals to withstand and recover from stress.

NOAA's Coral Program implements its mission by directly supporting and implementing ecosystem-based science, management, and conservation across the nation's shallow-water coral reef ecosystems, as well as internationally, particularly in countries whose coral reefs are ecologically connected to our own. The Coral Program also supports social science activities including new tools, education and outreach approaches, and peer-exchanges to

support coral reef conservation. Few organizations are as well-poised as NOAA's 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 federal 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 supports coral reef conservation activities implemented 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, Hawaii, Puerto Rico, and the U.S. Virgin Islands), and in uninhabited islands including the northwestern Hawaiian Islands and the Pacific Remote Island Areas. Internationally, the Coral Program engages in coral reef conservation technical assistance and capacity building in four international priority regions, including efforts in the Freely Associated States, the Caribbean, the Coral Triangle, and the central/western Pacific. Effective coral reef conservation in the United States can only be achieved by domestic and international efforts, as nearly all U.S. coral reefs are ecologically connected to reefs abroad.

This document summarizes the Coral Program's activities for Fiscal Years 2017 through 2019 and includes collaborative efforts between NOAA and partners in public, private, and academic sectors.

Goal Summary and Accomplishments Update

During fiscal years 2017-2019, the Coral Program strategically invested in numerous efforts to mitigate the impacts of the three primary threats of climate change, fisheries, and land-based sources of pollution as well as activities focused on coral restoration. The following sections align with the framework of the Coral Program's strategic plan and include summaries of projects that the Coral Program supported during this period.

Increase Resilience to Climate Change



The Coral Program is working with partners to address the impacts of climate change on coral reef ecosystems including ocean acidification and warming ocean temperatures. The Program’s conservation approach is resilience-based management. Resilience refers to the capacity of a system to resist and recover from disturbance, and maintain structure and function to provide ecosystem services. Resilience-based management has been adopted as an effective approach for integrating climate change considerations into coral reef management by several international and domestic partners.

During fiscal years 2017-2019, the Coral Program capitalized on existing efforts and partnerships to characterize physical and chemical changes in coral reef environments by conducting question-based monitoring. This information helped establish a baseline to assess climate change and ocean acidification impacts on coral reef ecosystems. The program focused on developing targeted decision-support tools for local managers to incorporate climate information. The efforts detailed below highlight ongoing work to monitor, understand, and better predict the impacts of climate change and ocean acidification on coral reef ecosystems and to use the results to inform management decisions.

Florida Keys BleachWatch (2017-2019)

The Florida Keys BleachWatch Program is designed to train and coordinate volunteers who regularly report on the occurrence or absence of coral bleaching, as well as basic environmental conditions of the reef. The observational data from BleachWatch volunteers are synthesized with existing NOAA’s “Coral Reef Watch” and “Coral Health and Monitoring”

programs that have developed remote sensing analysis and real-time monitoring data products to predict when conditions are favorable for coral bleaching. This information is then provided to resource managers as “Current Conditions” reports distributed throughout the warm summer months.

Climate and resilience-based decision-support tools to maximize coral transplant survivorship and reef recovery in Florida (2017)

Information from nursery operators and managers was used to develop a new scheme for identifying and ranking candidate coral restoration outplanting sites based on spatially explicit data for depth, substrate type, proximity to seagrass beds, distance to outfall pipes, ecological resilience potential, and projections of ocean acidification and coral bleaching conditions. This product informs managers regarding site selection for long-term survival of coral outplants.

Eastern Tropical Pacific coral reefs resilience to ENSO (2017)

This project integrated data describing naturally-high carbon dioxide conditions and periodic El Niño Southern Oscillation (ENSO) warming events with 40 years of monitoring data for the Eastern Tropical Pacific coral reefs to understand the combined effects of ocean warming and acidification on coral reef ecosystems. This long-term understanding provides an unparalleled context to interpret and predict the response of coral reefs to warming in a high-carbon dioxide world and examines how the resilience mechanisms documented through prior ENSOs actually translates to recovery of coral reefs.

Coral Reef Watch: satellite- and model-based products for coral reef ecosystem managers (2017-2019)

Coral Reef Watch (CRW) utilizes remote sensing and *in situ* data to develop tools for near-real-time and long-term monitoring, modeling, and reporting of physical environmental conditions of coral reef ecosystems. CRW provides managers, scientists, and other stakeholders with timely, reliable information on the physical environment of coral reefs. CRW has developed and operates the only global early-warning system to notify users of changing conditions and help them prepare, plan, and respond to environmental stressors to coral reef ecosystems. This project continues efforts to work with users to develop and implement next-generation tools and analyze data to answer key climate impact questions.

Assessing coral reef resilience along the South Kohala Coast of Hawaii (2017)

NOAA, Hawaii's Department of Land and Natural Resources, and external partners collaborated on a reef resilience assessment for the West Hawaii Habitat Focus Area. Data were collected at 40 sites and analyzed for indicators of resilience. An outreach strategy was developed to interpret the results and to facilitate the implementation of management recommendations with local resource managers, policy makers and community members. Other activities included additional surveys to create a three-year time series of post-

bleaching data and to work with the State of Hawaii to create a state management plan and coral bleaching response plan.

Climate change vulnerability analysis for U.S. Pacific reefs - integrating exposure, resilience, and social adaptive capacity (2017-2018)

This project synthesized existing assessments and other datasets to generate a regional climate change vulnerability assessment of U.S. Pacific coral reef resources, spanning exposure, resilience, and social adaptive capacity. Specifically it included measures and projections of reef exposure to anthropogenic threats, estimates of reef capacity for resistance to and recovery from threats (i.e., resilience), and, in populated areas, estimates of social adaptive capacity.

Integrating climate resiliency and adaptation into community marine spatial planning (2018-2019)

American Samoa currently has different management programs that work with village communities to address environmental conservation and threats to natural resources that influence the health of coral reefs. This project incorporates climate resilience and adaptation planning into the existing community fisheries management plans through an integrated community planning process to develop more comprehensive village-based plans and activities.

Integrating climate adaption into coral restoration planning (2019)

NOAA worked with the Environmental Protection Agency, The Nature Conservancy, and Tetra Tech to develop the "Managers' Guide to Coral Reef Restoration Planning and Design." This guide will be a critical component to a coral reef restoration workshop for the Pacific jurisdictions, which were identified as a priority need for managers. The materials will also have additional application to the Atlantic/Caribbean and other regions as needed.

Understanding the impacts of climate variability and climate change on living resources (2019)

This project assessed the exposure and sensitivity of Pacific coral reefs to ocean warming and ocean acidification through several analyses. The analysis of *in situ* temperature data evaluated reef exposure to temperature stress across different depths and provided insight into the existence of deep refugia for corals and associated organisms. The project assessed spatial variability in exposure to temperature stress and coral bleaching levels across the main Hawaiian Islands during two bleaching events, evaluated environmental and/or ecological factors that influence reef coral sensitivity to warming, and identified reef areas with particularly high bleaching resistance/resilience. It also synthesized carbonate chemistry data to document spatial and temporal patterns in carbonate chemistry across U.S. Pacific coral reefs and variability in reef exposure to ocean acidification. This information will be critical to the State of Hawaii in informing its 30X30 initiative and for restoration planning.

Assessing coral reef resilience through improved vital rates measurements (2019)

The project aimed to operationalize repeat photomosaic surveys to develop robust approaches for modelling coral colony vital rates (growth, survival, and mortality). This involved conducting local field trials and statistical analyses to improve photomosaic survey design and characterize benthic community responses to bleaching, herbivory, and other disturbances.

Reef persistence evaluator: a decision-support tool for management interventions to preserve essential habitat (2019)

Due to large losses in coral cover over the past 40 years, most Caribbean coral reefs are in accretionary stasis or are net erosional, meaning the remnant and dwindling populations of corals in the Caribbean are struggling to maintain reef structure integrity and are eroding faster than they can create new skeletal material. This decision-support tool allows managers to determine if their reef(s) are presently eroding or accreting, structurally complex, and if/when they may become erosional in the future due to impacts of climate change and ocean acidification. The tool will also allow managers to assess the efficacy of counteractive measures to maintain reef structure.

Modeling contribution to IPCC Sixth Assessment Report WG II (2017)

This project provided data and information to the Intergovernmental Panel on Climate Change Sixth Assessment cycle. The Panel produced the Sixth Assessment Report and the Working Group II produced a report on the impacts and vulnerabilities of climate change. A new generation of global climate models was produced to update projections of the impact of climate change on coral reefs. These new models operate on higher resolution than the previous generation and include more processes with new emission scenarios.

Using autonomous underwater vehicles to evaluate reef resilience and restoration sites in Kaneohe Bay (2018)

Coral and coral reefs within Kaneohe Bay are routinely subjected to a number of stressors including elevated sea surface temperatures, land-based sources of pollution, vessel strikes, and others. This project categorized and analyzed the effects, severity, and locations of impacts as well as the corals' relative resilience to these stressors which will be instrumental to informing future coral restoration efforts in Kaneohe Bay.

Molecular mechanisms of heat tolerance in the threatened coral Orbicella faveolata from the Florida Keys (2018)

This project focused on understanding whether the inshore-offshore dichotomy in heat resistance is due to acclimatization or adaptation and measured gene expression associated with the different genotypes of *O. faveolata* in the experiments. This helped determine the physiological molecular mechanisms that are associated with acclimatization and adaptation

to heat stress in this threatened coral species. Understanding the genetic basis of how certain coral genotypes can cope with heat stress is the first step towards management and recovery of this critical species with respect to climate change.

Ocean and Atmospheric Research Coral Reef Program Coordinator (2017-2019)

The Ocean and Atmospheric Research Coral Reef Program Coordinator supports coordination with the Office of Oceanic and Atmospheric Research component of the Coral Program. Funding supports management of the Coral Reef Fellowship Program, implementation of Coral Program activities, and improved coordination between NOAA line offices to effectively manage coral reef activities.

Coral Program Climate Coordinator (2017-2019)

The Climate Coordinator provided leadership and coordination on climate issues within the Coral Program on projects and initiatives in both the Caribbean and Pacific coral reef jurisdictions, as well as in international priority regions.

Support for a Caribbean extension of the Coral Reef Early Warning System (CREWS) Network (2017-2018)

This project supports the Caribbean Community Climate Change Center collaborative effort for installing CREWS buoys in many Caribbean countries. Stations are located in Little Cayman, Belize, St. Lucia, Barbados, Tobago, and Dominican Republic, with many countries set to come on line in the next several years. Researchers supply information systems support including website display of near-real-time data and ecological forecasts, as well as data logger programming expertise.

Improve Fisheries' Sustainability



Sustainable fisheries management under the Magnuson-Stevens Fishery Conservation and Management Act is an adaptive process that relies on sound science, innovative management approaches, effective enforcement, meaningful partnerships, and robust public participation. Sustainable fisheries play an important role in the nation's economy by providing opportunities for commercial, recreational, and subsistence fishing, as well as sustainable seafood for the nation. To support sustainable coral reef fisheries, the Coral Program is working closely with the fisheries management agencies of the seven jurisdictions, four regional fishery management councils, and NOAA Fisheries, as well as fostering engagement of fishers, local communities, and other key stakeholders.

During the 2017-2019 period, the Coral Program continued its support for improving data collection on fishing effort and dependence, continued to inform fishery management planning, added technical capacity in the jurisdictions to support fisheries management and stakeholder engagement, and provided information and capacity for the creation, implementation, and improvement of marine protected areas. Below are highlights of noteworthy work that was implemented in fiscal years 2017-2019 to reduce fishing impacts on coral reef ecosystems.

Develop and implement the Guam Community Coral Reef Monitoring Program (2017-2019)

This project facilitated a community monitoring and education program focusing on Guam's marine preserves and priority watershed areas. The coordination of the community monitoring program included development of education and outreach materials and liaison with the local community to facilitate meaningful exchange of information between the community and resource managers. This program has trained over 1,500 Guam community

members in coral reef ecology and biophysical monitoring and has expanded to include support for the Manell-Geus Habitat Focus Area, monthly information sharing events with stakeholders, socioeconomic monitoring, a community early warning program for acute reef impacts, and provision of service learning and internship opportunities for students.

Quantifying processes that underpin recovery at Kahekili Herbivore Fisheries Management Area (HFMA) (2017-2018)

The Kahekili HFMA was established to reverse downward trends in coral reef condition and to test the effectiveness of herbivore management as a means to promote coral reef resilience. This project provided cooperative biological monitoring surveys inside the HFMA to examine herbivore biomass and crustose coralline algal cover since the HFMA's closure in 2009 and analyzed results to determine the impact on coral cover. Observations and preliminary analysis indicate HFMA's are an effective coral conservation tool.

Hawaii Fisheries Extension Program (2017-2019)

This project continues support for the Hawaii Fisheries Extension Agent and the ongoing projects the position has supported the past several years. Projects strengthen relationships among the coral reef fishing community, marine resource managers, and scientists in Hawaii; develop education and outreach materials to improve compliance with fishing regulations; and foster community involvement in the decision-making processes affecting coral reefs.

Defining spawning dynamics to manage and conserve reef fish populations (2017)

Large predators are important in healthy coral reef ecosystems; however, many large predator populations are depleted in the U.S. Caribbean. Commercially important species (e.g., large groupers) that gather annually to spawn are highly susceptible to overfishing, and managers need better data regarding aggregation locations and dynamics to effectively manage these resources. This project collaboratively monitored and assessed spawning aggregation sites off western Puerto Rico, using methods with demonstrated effectiveness to locate, assess, and monitor grouper spawning aggregations in the Northeast Reserves of Puerto Rico, confirming locations, species, aggregation timing and species abundances.

Impacts of fishing on parrotfish grazing in St. Croix: a case study on the ecological impacts of fishery management actions (2017)

This project developed a quantitative framework to predict the impacts of fisheries on parrotfishes and the capacity of these key herbivores to remove algae and maintain habitat suitable for the settlement and growth of reef-building corals in St. Croix, U.S. Virgin Islands. This research resulted in specific recommendations for managers by identifying management strategies that can maintain high levels of grazing that benefit reef-building corals while also supporting a sustainable fishery.

Strengthening sustainable socioeconomic monitoring of reef-dependent communities in Micronesia (Guam and Hawaii) (2017)

This project continued to build capacity and provide technical assistance for strengthening and sustaining socioeconomic monitoring in reef-dependent communities at site, jurisdictional, and regional levels in Micronesia and Hawaii. Training was built on key survey results and site needs. Based on results of the socioeconomic assessment of the Habitat Blueprint site Manell-Geus, a draft integrated monitoring plan was developed to ensure the complementarity of biophysical and socioeconomic data and improve coral reef management and conservation.

Assessing performance and connectivity of St. Croix MPAs (2017)

Marine protected areas (MPAs) can be highly effective tools for conserving habitats, populations, and sustainable fisheries. A network of reserves, as in St. Croix, can enhance performance. The National Park Service hosted a collaboration of researchers assessing effectiveness of MPA boundaries, species movements, and identifying gaps in protection for a wide range of shark, turtle, and reef fish species. Building upon previous work, this project tagged queen conch, an important but threatened reef fishery species, examining time spent in MPAs and migrations to open fishing areas, spawning grounds, and nursery habitats.

Limits of acceptable change pilot study in the Northeast Reserves and Culebra to support the development of management actions (2017)

The project was conducted in response to Puerto Rico's need to characterize a proposal to extend conservation efforts from the Northeast Ecological Corridor Natural Reserve to the Cordillera and Luis Peña Reserves. The project assessed human uses and use patterns, user knowledge and perceptions, resource use, social conditions, and use conflicts to address data gaps essential to effective management and determine limits of acceptable change to inform the management of this area.

MPA boundary efficacy and biotic movement in Salt River Bay (2017-2018)

This project assessed nursery function of the natural and restored mangroves in the Salt River Bay system, mangrove connectivity with the reef and canyon outside the bay, and broader connections to other reef areas and spawning locations more widely around St. Croix. The overarching goal was to provide managers with data and information needed to understand the Salt River Bay ecosystem, the residence time of fish that area found there, and the system's connections and relationship to other coral reef areas around St. Croix.

Quantifying condition of coral reef communities in the Kahana and Honokahua priority watersheds, West Maui (2017)

This project was a collaboration with the State of Hawaii and the West Maui Ridge-to-Reef Initiative to collect data and report on the status and trends of coral reef fish and benthic communities in the Kahana and Honokahua watersheds. The objectives were to quantify the

status of the reefs in the entire watershed and incorporate the data into a Watershed Reef Status and Trends Report.

Building GIS long-term capacity: technical assistance for the State of Hawaii DAR and other U.S. Pacific Jurisdictions (2017)

This project supported geospatial capacity building in the state of Hawaii to provide basic Geographic Information Systems (GIS) training on ESRI's ArcGIS software to scientists and staff in Hawaii's Division of Aquatic Resources. Staff learned how to create and share a GIS map, find and organize geographic data and other content for a mapping project, accurately display features on a GIS map, and access information about map features. The training also covered performing spatial analyses to answer questions, updating key data layers, and sharing GIS maps and analytical results to desktop, web, and mobile device users.

Improve management of economically and ecologically valuable reef fishes in the USVI (2018-2019)

This project provided the first ecosystem snapshot of reef fish population dynamics and related life history on mesophotic reefs in U.S. Virgin Islands and provided the data to NOAA Fisheries to complete island-based assessments.

Scientific assessment of scope for herbivores to promote persistence of U.S. Pacific coral reefs (2019)

Biological monitoring surveys inside the Kahekili Herbivore Fisheries Management Area (KHFMA) demonstrated increases in herbivore biomass and crustose coralline algal cover since KHFMA's closure in 2009, but thus far only small increases in coral cover have been detected. This project maintains cooperative monitoring of the KHFMA with the state of Hawaii's Division of Aquatic Resources.

Collaborative analysis of national and local survey data to support coral reef management (2019)

To better understand ecosystem dynamics and relationships, particularly in the face of climate change, this project assessed the status and trends of marine communities in response to multiple ocean warming events at scales useful for management. In order to best characterize such responses, the project combined the spatially and temporally large-scale national data with finer-scale data collected by local institutions and U.S. jurisdictional partners. The combined datasets enabled formulation of a more comprehensive time series of surveys across a variety of coral reef locations and habitats in the Pacific to facilitate detection of ecological changes after discrete thermal events.

Improve habitat maps of southern Florida reef tract to support management (2019)

This project continues to manage and create benthic habitat maps from new multibeam and LIDAR (light detection and ranging) surveys within the Florida Keys National Marine Sanctuary

(FKNMS). New underwater video from drop cameras and remotely operated vehicles, as well as still camera images from SCUBA surveys are managed, used as groundtruthing for mapping, and incorporated into the FKNMS Digital Atlas. Recent surveys after Hurricane Irma have provided improved data for the reef map. Products improve detection and location of patch reefs for disease work, improve habitat classification for reef fish visual and habitat assessments, and provide updated benthic imagery for ecosystem management.

Fish movements in MPAs on St. Croix and St. Thomas (2019)

This project quantified the movements of reef fish from the no-take zone within the East End Marine Park (EEMP), St. Croix, U.S. Virgin Islands, to areas open to fishing. Spillover from the no-take zones of the EEMP was one of the anticipated benefits of the boundary design; however, this had not been documented yet.

Refinement of benthic habitat map for southern Florida reef tract with clarification of habitat use patterns of exploited and non-target reef fish species (2019)

The project produced a refined benthic habitat map for the southern Florida reef tract based on quantitative habitat metrics at a spatial scale of 50 x 50 m map units. The objectives were to compile and synthesize high-resolution bathymetric data and substrate hardness mapping products for the southern Florida reef tract, to apply analytical tools to compute quantitative metrics of reef substrate characteristics, and to apply resource-selection methods for analyzing spatial productivity of managed species for incorporation into Ecosystem-Based Fisheries Management models.

Support for implementation of NOAA Fisheries ecosystem-based fishery management roadmap implementation plan (2019)

The initiative is a national process to implement a more holistic approach to management of living marine resources. The Caribbean Fishery Management Council is working with NOAA Fisheries and other NOAA and non-NOAA partners to develop an ecosystem-based fishery management plan for the U.S. Caribbean region. This project supported essential first steps in the process, including development of an engagement strategy and other logistical support to develop a roadmap to create a Fishery Ecosystem Plan.

Assessing socioeconomic data and indicators to improve resource management in the U.S. Pacific islands (2018)

This project complemented the National Coral Reef Monitoring Program (NCRMP) socioeconomic indicator refinement process, helped assess how the socioeconomic data have met the needs of the program and the management users in the U.S. jurisdictions in the Pacific island region, and guided any future modifications of the indicators, data collecting tools, approaches, and communications of results. Results helped determine the feasibility of integrating NCRMP biophysical and socioeconomic data. The results of the project also benefited the larger global SocMon Program and other interdisciplinary research initiatives.

NOAA Fisheries Coral Reef Program Coordination (2017-2019)

The Fisheries Coral Reef Program Coordination project provides overall coordination for the NOAA Fisheries shallow coral components of the Coral Program.

NOAA Fisheries regional coral coordination and support for local action strategies in Pacific and Atlantic-Caribbean (2017-2019)

Seven NOAA Fisheries positions provide coastal resource managers from Florida, Puerto Rico, U.S. Virgin Islands, Hawaii, Guam, The Commonwealth of the Northern Marianas Islands, and American Samoa with additional capacity to implement fishery local action strategies developed to protect coral reefs. This includes jurisdictional priority setting, sustainable management of coral reef fisheries, and broader NOAA and regional priorities. Work plans are tailored to be locally appropriate, to include reef fish and habitat field studies, community and resource management plan development, education and outreach and trainings, and assistance to local and federal managers.

Reduce Land-based Sources of Pollution



Land-based sources of pollution include sediment, nutrients, and other pollutants transported in surface waters, runoff, groundwater seepage, and atmospheric deposition into coastal waters.

The health of U.S. coral reef ecosystems depends on effective management activities in adjacent coastal and upland regions. The Coral Program uses an integrated watershed management approach that includes comprehensive management plans to identify pollution sources, baseline characterizations to understand the full suite of impacts, prioritized management responses, and detailed plans regarding partner roles and responsibilities.

The program continues to support the implementation of best management practices and providing technical assistance for performance monitoring and assessments, capacity building, and multilateral coordination to advance watershed management efforts within the jurisdictions. Results from the projects described below 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 projects highlight work that was implemented during 2017-2019.

Implementation of priority watershed projects in the Manell-Geus Watershed, Guam (2017-2018)

This project supported actions identified in the Manell-Geus Watershed Conservation Action Plan and Habitat Blueprint Implementation Plan. Activities for this priority site include

watershed restoration projects, such as stormwater retrofitting, vegetative buffer strips, riparian restoration, afforestation, and revegetation of badland areas in the Manell-Geus Watershed, and reef restoration projects including installation and maintenance of a coral nursery in Cocos Lagoon, sexual and asexual coral propagation experiments, and support for coral gardening trials. This project benefited the Achang Reef Flat Marine Preserve and Cocos Lagoon, as well as the community, by reducing sedimentation and flooding.

Guánica Watershed Coordination (2017-2019)

This project supported efforts to lead, coordinate, and oversee numerous projects and partnerships as part of a comprehensive watershed management plan to reduce land-based sources of pollution discharged to coral reef habitats surrounding the Guánica/Rio Loco watershed, which is a jurisdictional priority region and U.S. Coral Reef Task Force Priority Initiative watershed in Puerto Rico.

Cocos Island passive water sampler study (2017)

This project provided an assessment of polychlorinated biphenyls (PCBs) in the waters surrounding Cocos Island located in Cocos Lagoon, Guam, using PED (polyethylene device) passive water samplers developed and provided by the Environmental Protection Agency. The project helped assess whether PCBs are migrating from Cocos Island into the water column and subsequently into the fish. This information helps inform resource managers regarding their next steps in restoration activities in the area.

Input of sediments and nutrients into Cocos Lagoon and surrounding areas from the Manell-Geus watershed, Guam (2017)

This project characterized turbidity, suspended sediment concentration (SSC), and nutrient dynamics in two rivers in the Manell-Geus watershed that drain to the Achang Reef Flat Marine Preserve in Cocos Lagoon, at the southern tip of Guam. The Manell-Geus watershed is a Habitat Focus Area, and sediments and nutrients likely contribute to degraded water quality in the area, particularly in the Achang Preserve. Monthly and weekly collections of water samples were analyzed for nutrients and SSC, and turbidity was measured using a hand-held turbidity meter and one or more turbidity loggers for unattended monitoring. Chemical contaminants were also measured in sediments near the river mouths.

Technical support of inception of FDEP Coral Reef Nutrient Monitoring Program (2017)

This project provided technical expertise in nutrient monitoring and assessment on the coral reefs of the northern third of the Florida Reef Tract. Assistance included sampling design, inter-laboratory comparison, and spatial/statistical analysis for Florida's Department of Environmental Protection (FDEP). At the completion of the project, operations of the monitoring program fully transitioned to FDEP.

Eutrophication impacts on coral ecosystem health in Vatia, American Samoa (2017)

Nutrient pollution in Vatia Bay has been hypothesized by jurisdictional managers to have an adverse effect on the coral reefs via benthic algal blooms. NOAA scientists initiated monitoring in Vatia Bay in order to quantify dynamics in Vatia Bay and establish a baseline against which to compare changes in the benthic algal and coral assemblages in response to nutrient fluxes. Local scientists were trained to continue the water quality sampling on a monthly basis. Monthly sampling continued, and a trial sampling was conducted for tracers of human waste (caffeine/sucralose). This project continued the nutrient and tracer sampling (based on preliminary data gathered) focusing on storm chasing rather than monthly sampling.

Capacity building and sampling in The Commonwealth of the Northern Mariana Islands for microbial source tracking and metagenomic sequencing (2017)

This project provided technology transfer training support to the Bureau of Environmental and Coastal Quality of The Commonwealth of the Northern Mariana Islands to help build analytical capacity to improve the ability to monitor and source track land-based sources of pollution in Saipan Lagoon and other coastal waters. The improved ability for source tracking of land-based sources of pollution is one of the critical needs identified for the jurisdiction for coral reef conservation.

Reducing LBSP threats from unpaved roads on Culebra Island (2017-2019)

This project piloted an effort in Culebra to combat sedimentation from unpaved roads, a priority threat throughout the Caribbean. Specifically, this project established coordination within an interagency group to identify and leverage opportunities for management, identified watershed restoration targets for funding and opportunities for interagency collaboration, stabilized three miles of unpaved roads, evaluated performance of unpaved road stabilization projects, and developed an unpaved road guidance document for use by the interagency group and the broader Caribbean.

Ocean color product for monitoring the threat of land-based sources of pollution to coral reefs (2017-2018)

This project developed near-real time tools to provide managers with oceanic turbidity and chlorophyll levels in coastal waters produced by an operational color algorithm. Coordination with local managers in American Samoa, Hawaii, and Puerto Rico to develop remote sensing tools for each jurisdiction allowed managers to assess land-based sources of pollution threats to their coral reefs.

Assessment of contaminant levels in Salt River Bay, St. Croix (2018-2019)

This project addressed concerns over levels of contaminants in water, sediments, and marine organisms in the coral reef ecosystem of Salt River Bay. Degraded habitats and chemical contaminants can contribute both to human health risks from consumption of local marine

resources and the loss of health and resilience in the impacted coral reef ecosystem. The research assessed contaminant levels in the Salt River watershed along an inshore-offshore gradient in the tissues and shells of selected marine organisms, and determined if the recent passage of hurricanes Irma and Maria generated exposure peaks from resuspension of sediments.

Salt River chemical contaminants in sediments assessment of Salt River Bay, USVI (2018)

The purpose of this project was to collect surface sediments and a sediment core from Salt River Bay, St. Croix, USVI, for chemical contaminant analysis. The samples were analyzed for a suite of over a 150 chemical contaminants. In addition, a sediment core was taken and analyzed to assess chemical contamination in deeper, older sediments that may reflect past land use and associated inputs of chemical contaminants.

Assessing Futiga dump on Fagatele Bay, American Samoa (2018)

This project determined the potential impacts of the Futiga dump site (landfill) on the coral reef ecosystem resources of the Fagatele Bay unit of the National Marine Sanctuary of American Samoa.

Rapid assessment and repairs to Green Cay Gut restoration project, USVI (2018)

This project conducted a rapid assessment of damages to the Green Cay Gut restoration project due to the two hurricanes and included emergency repairs to stabilize the erosion and sediment control practice. Maintenance at this priority location was needed to ensure that sedimentation was stabilized and minimized to reduce impacts to coral reefs.

Development of stressor threshold values for protection of Pacific coral species (2019)

Watershed managers in Hawaii identified the need for data that can quickly lead to management actions and results on the ground. One of the necessary pieces of information to aid coastal managers in making key decisions are stressor thresholds for ambient concentrations of contaminant stressors above which deleterious impacts to coral reef species would be expected. Without this information, it is impossible to make effective management decisions based on sound scientific information. This project developed stressor threshold values for contaminants relevant to Pacific coral reef species to address this knowledge gap.

Reduce land-based sources of pollution in West Hawaii (2019)

This project built on prior work to assess nutrients contributing to water quality impacts in Pauoa and Kukio Bay. The objective is to use the water quality and nutrient assessment to work with coastal resorts to implement land use changes and to continue to work with resorts to develop a conservation fund.

American Samoa best management practices effectiveness (2019)

This project focused on work with the community in enhancing their knowledge about the land-based sources of pollution impacts on coral reefs through the sharing of information that can be used by the villagers to present to other villages using examples and scenarios from Aua. The project team will assist the community in developing and translating the information to be very informative and easy to understand. The project team will also engage the only elementary school in Aua to work on a school-based project to install a raingarden to demonstrate how such tool is important for pollution control, flooding protection, and water conservation.

Initiate development of land-based sources of pollution geographic information system (GIS) layer (2019)

This project is to inform the watershed management plans and conservation action plans in American Samoa, Guam, and The Commonwealth of the Northern Mariana Islands regions by developing GIS layers from available data, allowing for easier visualization and analysis of various data sets.

Assessment of contaminants and bioeffects in the East End Marine Park, USVI (2019)

The St. Croix East End Marine Park (STXEEMP) has a marine area of approximately 60 square miles, and contains a variety of habitats including coral reefs, seagrass beds, mangroves/salt ponds, colonized pavement, and beaches. The surrounding watersheds have an area of approximately 12 square miles, and include Southgate, Solitude, Teague Bay, Turner Hole, Madam Carty, and Great Pond Bay watersheds. Land use in the watersheds range from greater than 99% undeveloped (Madam Carty), to 31% residential (Solitude). The project deliverable is a bioeffects assessment for the STXEEMP that includes a characterization of the benthic infaunal community, two sediment toxicity tests, and an assessment of chemical contaminants in sediments. This information will be used by local resource managers to better manage the STXEEMP.

Develop coral reef sediment depths thresholds for essential fish habitat and Endangered Species Act consultations (2019)

This project addresses the need for a cost-effective monitoring program and reasonable, science-based thresholds in order to effectively execute adaptive management on projects that disperse sediments in the water column near corals reefs. Sediment depth measurements are a reliable, inexpensive, and rapid way to determine if a dredging project has impacted corals reefs.

Experimental evaluation of sedimentation effects on coral species (2019)

This project will analyze land-based sources of pollution, particularly nutrients, in coral mesocosm experiments to investigate the experimental effects of temperature, salinity, ocean acidification, and nutrients on coral ecosystems in a controlled environment. These

results will be examined in conjunction with field studies of nutrient effects on corals to determine if the laboratory and field results are complementary and how they can both be used to develop better targets for nutrients in a variety of coral ecosystems.

Integrating land-based sources of pollution into the investigation of resilient coral genotypes and ongoing coral programs, Florida (2019)

This project will determine how different water quality levels affect or, at least, are correlated with the coral reef condition. It will examine thresholds or non-linearities between water quality and coral reef condition variables. Developing these correlations and identifying any non-linearities allows for the identification of potential target levels for water quality in various reef ecosystems. Projects that will be augmented with water quality data include, but are not limited to Miami urban super-corals, Florida Keys resilient reefs, Cheeca Rocks, performance evaluation of nursery genets, and evaluation of mechanisms to increase reef resilience.

Investigation into environmental drivers impacting coral health in West Hawai'i's South Kohala District (2015-2017)

This project investigated the role of pollutants in the health, fitness, and disease susceptibility of corals along the South Kohala District nearshore reefs. The decline in coral cover and fish biomass over the past 40 years has been accompanied with increased fishing activities, mass sedimentation events, increased residential and resort development, and recreational use. Targeted management actions to pinpoint causal factors include biological and nutrient water quality monitoring in conjunction with coral disease surveys. This work contributed toxicity data from reef waters and sediment, and information on coral immunity and resilience to disease.

Comprehensive Watershed Management Plan for Achugao, CNMI (2019)

This project will result in a comprehensive watershed management plan for Achugao in the Commonwealth of the Northern Mariana Islands in collaboration with local partners and stakeholders. The watershed plan will propose a series of actions that can be taken to address known sources of land-based sources of pollution. The plan will include a watershed delineation and characterization, a field assessment, a prioritized list of recommended best management practices and their associated information, the various federal and state agencies, nonprofit organizations, and jurisdictional partners working on land-based sources of pollution issues to leverage support to implement key management projects, and the results of the stakeholder engagement processes.

Coral Reef Conservation Program Watershed Management Specialist (2017-2019)

The Watershed Management Specialist position helps the advance land-based sources of pollution goals and objectives by providing leadership on issues within the Coral Program, multi-year planning of simultaneous initiatives, individual project development and

implementation, and coordination with external partners. The Watershed Management Specialist works on projects and initiatives in both the Caribbean and Pacific coral reef jurisdictions.

Restore Viable Coral Populations



Saving coral reefs requires a multi-pronged approach. Direct and ecologically informed interventions at the local level are needed to keep coral reef ecosystems viable and functioning. Local stressors such as invasive species, chronic anchoring impacts, and vessel groundings need to be addressed locally, with simultaneous efforts to focus on repopulating key reefs. Active and targeted coral repopulation, using novel ecological interventions (e.g., stress hardening and assisted gene flow), will facilitate adaptation of coral reef ecosystems to evolving environmental conditions.

Restoration addresses building and maintaining resilience to threats and springboards recovery of the ecosystem. Restoration supports necessary research, implements on-the-ground actions to prevent additional losses of corals and their habitat, and applies innovations in restoration and intervention techniques to create resilient, genetically diverse, and reproductively viable populations of key coral species. Additionally, the Coral Program supports the use of regulatory mandates to prevent loss of coral and coral reef habitat through technical knowledge transfer to permitting agencies, encouraging consistent use of best management practices, and informing mitigation options with appropriate restoration techniques. The following projects support coral restoration efforts for fiscal years 2017 to 2019.

Coral Restoration Consortium and overall restoration cross-basin coordination (2019)

The project supports engagement with the Coral Restoration Consortium and continues to build domestic and foreign partnerships to foster restoration research and implementation knowledge exchange.

Collaboration and capacity building for coral restoration in the Pacific Islands (2019)

This project will develop options for building coral reef resilience, including interventions that enhance the process of reef recovery. Active coral reef restoration, including outplanting nursery-raised corals and seeding new reefs, is relatively new in the Pacific, where the focus of management has been on reducing local stressors to help coral reefs resist and recover from impacts. However, managers recognize that while reducing local stressors is necessary, it will not be sufficient, and they are ready to begin active restoration on their coral reefs. Restoration plans are needed to guide management, as is the development, testing and evaluation of strategic, science-based restoration projects.

Coral nursery pilot study in American Samoa (2019)

The purpose of this project is to test different coral nursery designs and coral species to determine the most successful approach for the Pacific. Phase one includes a pilot study to identify suitable location(s) to maximize coral growth, to determine the best nursery design, and identify the most suitable species for microfragmentation for maximum growth of different coral growth forms, branching, plating, massive, etc. Phase two is to upscale the coral nursery based on pilot study results. Phase three will be to outplant corals from nursery to degraded, low coral cover reef areas in Sanctuary management areas and elsewhere, and track survival rates of outplants. In addition, corals from the nursery can be used to restore corals damaged by hurricanes, large swells, or vessel groundings.

Downscaling reef resilience, Pacific (2019)

This project will explore the temporal data collected over a decade of monitoring in the Pacific. It will explore change in coral communities through time, as well as the environmental drivers of that variability and report on a downscaling approach. A quantitative examination at the sub-georegion scale will be conducted on reef fish, benthic, invertebrate, and environmental datasets to improve understanding of spatiotemporal trends.

Coral performance evaluation: assessing the strengths and weaknesses of coral genotypes used in reef restoration, Caribbean (2019)

Caribbean coral reefs are threatened by numerous global and local stressors, leading to a drop in live coral cover and a loss of essential reef habitat. Coral nurseries and outplanting provide a means to restore dwindling wild populations. The scale of the problem, however, presently dwarfs the capacities and capabilities of existing nursery operations. Technologies are needed to increase the efficiency and efficacy of these efforts. The purpose of this project is to provide nurseries with actionable information on the performance of their coral genotypes to make data-driven restoration decisions.

Evaluation of mechanisms to increase resilience of outplanted coral fragments, Florida (2019)

To understand if the dichotomy in heat resistance between inshore and offshore reefs in the Florida Keys is due to acclimatization or adaptation, this project will measure gene expression associated with the different genotypes of *Orbicella faveolata* (which is listed as threatened under the Endangered Species Act). This will allow us to identify which genes are associated with adaptation and acclimatization to high temperatures in *O. faveolata*. The identification of heat-tolerant genotypes will be useful for coral nursery efforts to reseed degraded reefs and provide information on whether stress hardening of corals would make them more resistant to temperature and ocean acidification effects.

Laboratory-based experimental evaluation of novel disease abatement techniques (2019)

Recently, the widespread proliferation of coral disease has led to devastating mortality on reefs spanning the Florida Keys and Caribbean. As such, disease represents one of the most important factors influencing the persistence of U.S. coral reefs today. Despite the severity and ubiquitous nature of the problem, little is known concerning causative agents, processes influencing virulence and resilience, or mechanisms that can be utilized to enhance survivability. The purpose of this project is to understand, test, and influence the multifaceted processes of disease resilience and recovery.

Genetic relatedness: does it matter for successful coral sexual reproduction (2019)

This project would test whether genetic relatedness or kinship of coral is a critical feature in predicting reproductive success. This information will be useful for restoration practitioners in selecting brood stock for nursery operations and pairing genotypes to enhance sexual reproduction at outplanted sites.

Seeding reefs with *Diadema antillarum* to enhance coral recovery in Puerto Rico (2017-2019)

The mass mortality of *Diadema antillarum* throughout the Caribbean in the 1980s resulted in decreased herbivory and increased macroalgae on coral reefs in the region. This project increased population densities of *D. antillarum* on reefs in Puerto Rico by releasing lab-cultured urchins to enhance herbivory and coral recovery (recruitment rates, survival, and growth). This type of project has been identified as a high priority in the draft recovery plan for both *Acropora palmata* and *A. cervicornis* and builds off ongoing work with *D. antillarum* in Florida.

Acropora nurseries in Puerto Rico and the USVI (2017-2018)

This project supported *Acropora* nurseries in Puerto Rico and the U.S. Virgin Islands. Over the past several years, coral nursery operations have expanded exponentially. There are now nine different sites between the two regions, and the nurseries have reached a combined capacity to outplant over 16,000 colonies per year.

Restoration and monitoring of the East Flower Garden Bank localized mortality site, FGNMS (2019)

This project will monitor the natural response and recovery of the benthic community at East Flower Garden Bank following a localized mortality event in 2016. It will also establish permanent monitoring stations and monitor success of coral recruitment by employing coral transplanting techniques in a subset of stations.

Acropora monitoring, recovery, and disease resistance in the Florida Keys (2017-2019)

This project addresses high-priority recovery actions for Endangered Species Act-listed *Acropora* species in the Florida Keys as outlined in the *Acropora* Recovery Plan. Additionally, this project provides a baseline dataset for coral abundance, size structure, and condition.

Guiding restoration of Virgin Island reefs: are hybrids more resilient? (2019)

The purpose of this project is to gain a better understanding of the current status of the Caribbean acroporid hybrid, *Acropora prolifera*, including its distribution and abundance. The project will survey, map, and genotype colonies and compare their growth and survival to parental species in the coral nursery in St. Thomas, US Virgin Islands.

Advanced coral restoration techniques - testing strategies to increase thermal tolerance or restored corals in Florida (2018-2019)

Immense effort is already being invested in collecting, rearing, and outplanting corals, but relatively little effort is being made to ensure that these outplants will be able to survive continued warming. Even small gains in thermal tolerance have the potential to result in large increases in the number of survivors during warming episodes, ensuring that these reef restoration efforts deliver on their promise of continued coral reef recovery. This project addresses genetic differences among corals to identify more stress-hardened genotypes that may survive better during outplanting.

Genet age influence on individual fecundity in ESA-listed corals, Florida (2019)

This project will examine whether genotypic age influences fecundity and early life history traits of offspring of *Acropora palmata*. The results will provide guidance to maximize use of the most successful genotypes in restoration activities.

Disease and outplant monitoring, Florida (2019)

This project will assist the Florida Keys National Marine Sanctuary in obtaining critical information on the spread of Stony Coral Tissue Loss Disease, its impacts, and risks of coral restoration in light of the disease. The project will support field scientists to evaluate ongoing outplanting activities and research undertaken by partners and use this information to develop a strategy to address the disease and begin restoring the reefs.

Quantitative approaches to designing and scaling up coral restoration for coastal hazards risk reduction, Florida (2019)

This project will use Federal Emergency Management Agency-funded hurricane impacts assessment (Puerto Rico) data and hydrodynamic (wave) hindcasts to create a spatial predictive model of coral distributions and seascape-scale impacts from hurricanes in Puerto Rico. It will work in collaboration with the United States Geological Survey to quantitatively assess wave energy on degraded reefs (proposed for restoration) north of San Juan airport, and model potential hydrodynamic impacts from coral restoration scenarios. Additionally, it will support coral restoration monitoring through development and application of Structure For Motion photo-mosaics and support Florida Keys National Marine Sanctuary coral restoration planning through compilation of existing monitoring data into a relevant GIS.

Investigating how coral recruitment and juvenile survivorship varies along the Florida Reef Tract (2017)

This project characterized coral recruitment and juvenile survivorship across the Florida Reef Tract and compared settlement rates on tiles and natural reef substrate. The study examined species-specific patterns of recruitment and assessed temporal, spatial, and physical parameters that may facilitate various levels of recruitment. The study identified recruitment hotspots that will aid management efforts and will assist restoration efforts by prioritizing coral species or reef locations that indicate an inadequate ability to recover naturally.

Capacity building for coral grounding injuries in the Caribbean (2017-2019)

This project directly supports jurisdictions in implementing their grounding response plans, especially during bleaching, disease, grounding, and invasive species outbreak events. The project provided continued cost-share funding to a support contract, which provides regional capacity for injury response. A high percentage of groundings occur in Culebra and the Northeast Reserves, a NOAA Habitat Focus Area.

Coordination of ESA-listed coral population enhancement activities (2017-2019)

In the last five years, advances in restoration science, new funding, and more active partners have sparked increased attention and on-the-ground actions focused on threatened *Acropora* species active population enhancement (APE). While APE is a critical part of the species recovery plan, to be successful it must be done in a well-coordinated manner as evidenced by case studies from other depleted species. This project will provide coordination of *Acropora* APE efforts by developing a comprehensive APE plan and program, fostering collaboration and technology transfer, and integrating emerging science (i.e., resilience planning) into species recovery efforts.

Coral Disease and Health Consortium (CDHC): diagnostic metrics, epidemiology and capacity building (2017-2019)

The CDHC draws from public health and medicine to address coral conservation and management needs. This approach increases precision in identifying causal relationships between specific stressors and injury to coral, and the relative contribution among multiple stressors so management actions can focus on discrete stressors of highest risk. Cultured corals and new diagnostics provide a vehicle for assessing single and combined impacts of pollutants, climate change, and ocean acidification on coral health. This, in concert with training and technology transfer to the coral community, focuses and enhances science for early detection, identifying risk management options and proactive management.

Quantifying extinction risk for ESA-listed coral species in the Wider Caribbean (2017)

The purpose of this project was to help managers plan for the future of their coral reef communities by estimating the risk of and time to extinction for several reef-building coral species, predicting changes in coral population size under various climate and restoration scenarios, and providing Endangered Species Act (ESA)-mandated evaluations of population status and trends. Predictions were made by generating population models for Caribbean coral species listed under ESA.

Determination of fertilization, larval survivorship, and competency period for Endangered Species Act-listed broadcasting corals, Florida (2017)

This project provided empirical data on ESA-listed corals' early life history and developed methods for successful larval culture and restocking. Specific activities include determining empirical survivorship and settlement competency curves for larvae of ESA-listed coral species, fertilization compatibility among extant parental genotypes, and settlement potential of different typologies of benthic turfs in the Florida Keys. Additionally, key interventions were evaluated to improve the survivorship of settled cultured larvae on the reefs for restoration.

Use of restoration genomics in recovering ESA-listed *Orbicella faveolata* (2017-2018)

This project evaluated the role of local adaptation in restoration and identified the genomic basis of local adaptation in *Orbicella faveolata*. Understanding the genomics of local adaptation provides information on pre-adapted colonies for use in repopulating and understanding the extent to which populations can be used interchangeably across habitats for restoration by applying recently developed genomic tools to address a critical conservation challenge.

Investigating reproductive failure in populations of ESA-listed *Acropora palmata*, USVI (2017-2018)

The purpose of this project was to conduct an environmental investigation into causes of reproductive failure in at-risk populations of ESA-listed *Acropora palmata*. Reproductive condition for *A. palmata* was assessed across 34 U.S. Caribbean reefs; reproductive effort ranged from 0%-100% (gonad presence) with a median of 40%. Florida and Salt River Bay (SRB), St. Croix were the most impacted populations, with SRB populations showing two of four sites with 0% reproductive effort with other sites 10% and 20%. The work focused the investigation of water quality and sediment contamination in SRB, using Buck Island populations as a reference.

Characterizing disease resistance to improve restoration and outplanting success, Florida (2017-2018)

This project conducted experiments in the Coral Restoration Foundation nursery to determine if certain genotypes of *A. palmata* and *A. cervicornis* displayed any signs of disease resistance. Results indicated a range of disease resistance and worked to determine whether the relative resistance observed in the nursery setting translates to resistance and improved performance in a natural reef setting.

Development of best management practices guidance for coral restoration monitoring, Caribbean (2018)

This project scaled up coral restoration actions across U.S. Caribbean jurisdictions that included Florida, Puerto Rico, and the Virgin Islands to address coral reef ecosystem degradation and physical impacts from Hurricanes Irma and Maria. The result was a best management practices guidance document for coral restoration monitoring.

Interaction among wave energy, reef complexity, and corals to inform restoration (2018)

The purpose of this project was to further an understanding of interactions among wave energy, reef complexity, and coral restorations and to make recommendations for coral restoration siting in the context of wave energy.

Characterizing the transcriptomic basis of disease resistance in two critically important Caribbean corals, Florida (2017-2018)

This work helped identify resistant genotypes from coral nurseries in Florida, and the genetic information will be used to better inform local managers about specific genotypes that exhibit a high disease resistance, and thus may be more successfully outplanted. It resulted in a further understanding of the functional aspect of disease resistance, which could point toward effective treatments or interventions.

ESA-listed species active population enhancement: targeted research to develop optimal methods, Florida (2017)

This project focused on scaling up the novel propagation of important reef-building species of corals, including ESA-listed species, for successful active population enhancement in Florida, U.S. Virgin Islands, and Puerto Rico. This study developed and tested techniques that hold the most promise for production scale growing of corals in nurseries. The results of this work will aid local managers to address the threats to corals from disease and other impacts while continuing on the ground work in expanding existing nurseries to include additional species.

Cross-cutting Highlights



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 the Coral Program ensures 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 the Coral Program assists 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 Program's Social Science Program includes: (1) strategic planning and coordination; (2) technical assistance; (3) socioeconomic research; and (4) capacity building.

The Coral 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 Coral 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 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, including funding a community-led coral bleaching network of citizen scientists in Florida and Guam, 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.

Socioeconomics and Jurisdictional Capacity

Coral Reef Conservation Program Social Science Program (2017-2019)

This project coordinates and executes the Coral Program's social science program and implementation of its Social Science Strategy. This project is critical to ensuring continued incorporation of social and economic factors into implementation of Coral Program projects supporting domestic and international efforts. Additionally, this program supports key activities that facilitate implementation of the socioeconomic components of the National Coral Reef Monitoring Plan.

Social-ecological vulnerability assessment of reef fisheries and communities to promote climate resiliency in American Samoa (2017)

This project developed a social-ecological climate change vulnerability assessment of coastal communities and coral reef fisheries in Tutuila, American Samoa, focusing on American Samoa's two priority watersheds (Vatia and Faga'alu). Information on vulnerability and resilience was presented to local agencies and communities to incorporate into existing management plans and processes and identify adaptation strategies at the community level.

Economic value of ecosystem services for recreation and tourism on the reefs of southeast Florida (2017)

This project estimated the regional economic impact and the non-market economic value of the coral reefs of the Southeast Florida Reef Tract. Economic values were estimated for recreation (including tourism) uses of the reefs and the change in value under varying reef conditions (e.g., improved species diversity, degraded reef condition, etc.) using a stated preference survey. Economic impacts were also estimated from existing survey data.

Global Socioeconomic Monitoring Initiative Coordination (2017-2019)

The Global Socioeconomic Monitoring Initiative, part of NOAA's Coral Program, is a global program to increase coral reef managers' capacity to understand and incorporate socioeconomic factors into management programs. This project supports the U.S. Agency for International Development efforts relevant to the Coral Triangle Initiative and continues to support region-level capacity building in socioeconomic and produce updates to training manuals.

Communicating about coral disease in the Florida Keys National Marine Sanctuary (2018)

The primary objective of this project was to develop a strategic communications campaign related to the on-going coral disease event that is impacting coral reefs along the Florida reef tract from Martin to Monroe Counties. This project directly supported work underway

focused on advancing our understanding of the scope, scale and potential source(s) of this unprecedented disease event.

Florida Keys National Marine Sanctuary Integrated Ecosystem Assessment (2018)

This project identified and quantified thresholds between ecosystem pressures and condition report indicators used to set management targets for the Florida Keys National Marine Sanctuary (FKNMS). Not only does identifying thresholds allow the ability to set indicator targets for use in FKNMS condition reports, it also completes the next step in the Integrated Ecosystem Assessment (IEA) process for FKNMS. The Office of National Marine Sanctuaries has been working to advance the science behind Sanctuary condition reports and management plans. These efforts have shown how IEAs can effectively inform sanctuary processes and result in better management and ecosystem outcomes.

Pacific Islands Managed and Protected Area Community and Micronesia region implementation activities (2017-2019)

The Pacific Islands Managed and Protected Area Community (PIMPAC) implements the sharing of information, expertise, practice, and experience to develop and strengthen site-based and ecosystem-based management capacity throughout the Pacific Islands region. This project will continue to support the PIMPAC Mentor Program to provide capacity-building opportunities to on-the-ground protected area managers in the Pacific Islands.

Coral Reef Conservation Program Management Liaisons (2017-2019)

The Coral Program supports coral reef management liaisons in each of our seven partner coral reef jurisdictions. The expected outcome is effective grants management and improved connections with the local management community. In each place the outcomes will be dependent upon the work plans of the liaisons who engage in local conservation efforts activities, grants management, planning, and policy development for the Coral Program. This project is designed to assist the management communities in each jurisdiction.

Coral Reef Management Fellowship Program (2017-2019)

The Coral Reef Management Fellowship Program provides funding for two-year positions that strive to address current capacity gaps and to build longer-term capacity in the jurisdictions (Florida, Puerto Rico, U.S. Virgin Islands, Hawaii, Guam, The Commonwealth of the Northern Mariana Islands, and American Samoa) by placing highly qualified individuals whose education and work experience meet each jurisdiction's specific coral reef management needs. The vision for the program is to develop a thriving collaborative fellowship program that builds excellent next-generation leaders and capacity for effective local coral reef ecosystem management. The program is a partnership among the Coral Program, the U.S. Department of Interior Office of Insular Affairs, Nova Southeastern University's Halmos College of Natural Sciences and Oceanography, and U.S. Coral Reef All Islands Committee.

U.S. Coral Reef Task Force support (2017-2019)

This project supports NOAA's role, as co-chair of the U.S. Coral Reef Task Force (USCRTF) designated by E.O.13089, to lead and coordinate the USCRTF actions and semi-annual meetings. NOAA's leadership helps foster coordinated efforts by USCRTF members to build partnerships, strategies, and support for on-the-ground action to conserve coral reefs.

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. NOAA's Coral Program began to develop a National Coral Reef Monitoring Plan in 2010. The National Coral Reef Monitoring Plan built upon a decade of Coral 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. A NOAA working group was charged with developing an integrated plan focused on the monitoring of coral, benthos, and reef fish; climate change and ocean acidification; and human uses of, interactions with, and impacts to coral reefs. These measure long-term variables in a consistent and comparable manner across U.S. coral reef ecosystems, and integrate to assess status and trends in periodic reports.

The Coral Program's status and trends monitoring efforts included biological, physical, and socio-economic observations designed to provide consistent long-term data and information for multiple ecosystem components over very large areas. Observations include benthic and fish assemblages, ocean temperature, carbonate chemistry, ecological impacts of ocean acidification, and human dimensions information. Resulting data provide context for ongoing, intensive, smaller-scale survey programs in each jurisdiction, facilitate the detection and attribution of temporal and spatial changes to climate change, inform research efforts, and improve programs designed to protect coral reefs.

National Coral Reef Monitoring Program Coordination (2017-2019)

This project supports the National Coral Reef Monitoring Program for biological, physical, and socioeconomic monitoring of coral throughout the U.S. Pacific, Atlantic, and Caribbean coral reef areas. The overarching goal of this effort is to collect the information needed to gauge changing conditions of U.S. coral reef ecosystems, which are among the most biologically diverse and economically valuable ecosystems on earth, providing billions of dollars in food, jobs, recreational opportunities, coastal protection, and other important services.

Coral Reef Condition Status Reports (2018)

This project supported the development of status reports to communicate and evaluate the efficacy of place-based investments in coral reef conservation for status and trends of reefs in

U.S. coral reef jurisdictions. These reports provide summary and an overall look at the health of U.S. coral reefs across U.S. Pacific. Reports for the Atlantic and Caribbean will be available in early 2020.

National Coral Reef Monitoring Program report support (2018)

This project addresses data needs for Caribbean benthos for National Coral Reef Monitoring Program to support status reports development for Caribbean jurisdictions. The project resulted in an open-source, publicly available R package for data analyses and an accompanying methods document for the metrics used for the report.

Southeast Fisheries Science Center Coral Reef Conservation Program coordination and communication (2017-2019)

This project ensures effective management of NOAA's Southeast Fisheries Science Center's coral reef related projects by supporting creation and dissemination of coral reef data, documents, proposals, accomplishments, and budget; ensuring participation in meetings, working groups, conference calls, and outreach and education; and promoting communications with coral reef managers and other NOAA programs.

Pacific Islands Coral Reef Ecosystem Division coordination (2017-2019)

NOAA's Pacific Islands Coral Reef Ecosystem Division conducts habitat mapping, integrated ecosystem assessment/monitoring, and management-relevant research. These efforts require extensive coordination and visioning with the Coral Program, external partners, and internal staff due to the areas serviced and complex logistics required for interdisciplinary data collection and analyses in remote areas. The coordination/management team ensures that the division operates efficiently, is responsive to external requests, and provides administrative support that allows effective function.

Pacific Reef Assessment and Monitoring Program data, reports, and information products for management (2017-2019)

This project focuses efforts toward analyzing National Coral Reef Monitoring Program data and producing a suite of reports, information products, and services to support ecosystem-based management and conservation of coral reefs across the Pacific Islands Region, as requested by federal, state, and jurisdictional resources managers. Many of these information products, services, and analyses are aimed at responding to specific requests received during on-going collaborative discussions with local and jurisdictional partners in Hawaii, American Samoa, Guam, and The Commonwealth of the Northern Mariana Islands, as well as our NOAA and other Federal partners.

Global Coral Reef Monitoring Network Coordination (2018-2019)

The Global Coral Reef Monitoring Network (GCRMN)-Caribbean is an open and growing network of coral reef scientists and managers involved with coral reef monitoring in the

region. Following on the publication of the "Status and Trends of Caribbean Coral Reefs: 1970-2012" report, it has taken the initiative to strengthen or revitalize coral reef monitoring in the region to ensure collection of useful and accessible data that can effectively reveal the status and trends of the coral reefs in the region. The GCRMN-Caribbean seeks to be instrumental as an information and exchange platform center for monitoring groups and relevant actors of the whole region. The GCRMN-Caribbean also specifically addresses building local capacity through organizing training programs and expert support.

Coral Mapping

NOAA's Coral 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 marine protected areas, assessing 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 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 Coral Program's mapping efforts authored a report, Coral Reef Conservation Program Mapping Achievements and Unmet Needs, to compile and summarize these statistics and to advise Coral 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 Program allocates funding towards activities for initiatives from mapping programs in the Pacific, Caribbean, and Atlantic to include:

Mapping and EcoSpatial Information Products to support coral reef ecosystem management in the Pacific Islands Region (2017-2018)

The purpose of the Mapping and EcoSpatial Information Products project was to provide accurate and complete bathymetry, geomorphology, benthic characterization and other spatial, ecological and socioeconomic data for all jurisdictions across the Pacific Islands Region. The project used these data layers to derive higher-order analytical information products to support efforts to address specific coral reef threats and management needs, including information to support management of ESA-listed corals, reef fish stock assessments, climate change vulnerability assessments, and broader ecosystem-based management decision-making and policy implementation to conserve coral reef ecosystems and their associated services.

Mapping essential fish habitat in the U.S. Caribbean to inform marine protected area management (2017-2019)

The purpose of this project is to fill critical informational gaps that support improved management measures in U.S. Virgin Islands high priority sites identified by jurisdictional managers. This project utilizes NOAA ship-based efforts to identify the distribution, health, extent, and type of coral reefs ecosystems and the abundance of reef fishes in coastal waters (approximately 10-150 meters water depth) using multibeam sonars and remotely operated vehicle deployments. Efforts focus on southwest coast of St Croix and along the insular shelf south of St. Thomas.

Habitat mapping in the Florida Keys National Marine Sanctuary (2017-2018)

The primary objective of this project was to advance habitat map coverage of priority areas in Florida Keys National Marine Sanctuary. This project specifically focused on prioritizing areas to conduct targeted mapping efforts to detect changes from Hurricane Irma.

Developing a benthic habitat map for the Southeastern Puerto Rican Shelf (2017)

The purpose of this project was to develop a benthic habitat map for uncharacterized areas between 30-100 meters in depth on the Southeastern Puerto Rican Shelf. The new habitat map provides baseline information to help guide the monitoring and management of important coral reef habitats, fisheries species spawning aggregation sites, and marine protected areas in the region.

Grants and other Financial Assistance



Each year, the Coral Program publishes notices of funding opportunities to solicit proposals for coral reef conservation activities. These funds support conservation projects and scientific studies that benefit coral reef management across seven U.S. states and territories with coral reef ecosystems. All projects focus on the implementation of the coral reef conservation program strategic plan to address climate, fisheries, land-based sources of pollution, and restoration activities (Appendix II).

Awards fall into six broad categories:

- (1) *Domestic Grants (2017-2019)* address the three primary threats to coral reefs (climate change, land-based sources of pollution, and unsustainable fishing practices) as well as emerging coral reef issues identified by local management agencies and partners.
- (2) *Fishery Management Councils Cooperative Agreements (2017-2019)* support sustainable coral fisheries management in cooperation with regional fishery management councils.
- (3) *The Coral Reef Conservation Fund (2017-2019)* is a competitive grant program administered on behalf of the Coral Program by the National Fish and Wildlife Foundation, and it implements a long-standing public-private partnership created to support coral reef conservation projects both domestically and internationally.

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- (4) *State and Territory Cooperative Agreements (2017-2019)* sustain coral reef management and monitoring in the states and territories of American Samoa, The Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawaii, Puerto Rico, and U.S. Virgin Islands.
 - (5) *Non-Government Organization (NGO) Partnership Cooperative Agreements (2017-2019)* provide funding to NGOs with specialized experience in supporting the ongoing coral reef conservation efforts of our state and territorial partners.
 - (6) *International Cooperative Agreements (2017-2019)* build local coral reef management capacity and support coral reef monitoring in priority international geographies.

Appendix I: Budget Table



Coral Program-Supported Initiatives

Category	FY17	FY18	FY19
Administration, operations, rent, & rescissions	\$ 1,031,902	\$ 1,527,142	\$ 1,807,384
Climate	\$ 1,872,085	\$ 1,748,632	\$ 2,216,923
Fisheries	\$ 2,826,352	\$ 2,601,598	\$ 3,343,747
Land-Based Sources of Pollution	\$ 1,423,207	\$ 1,264,284	\$ 1,380,362
Restoration	\$ 1,627,334	\$ 1,650,569	\$ 2,303,987
Monitoring	\$ 6,271,908	\$ 6,599,173	\$ 5,298,360
Mapping	\$ 899,965	\$ 810,005	\$ 445,475
Socioeconomics	\$ 710,527	\$ 646,470	\$ 350,213
Jurisdictional Capacity (liaisons and fellows)	\$ 1,255,722	\$ 1,375,126	\$ 1,149,548
Grants	\$ 8,181,000	\$ 8,381,000	\$ 9,304,000
Total	\$ 26,100,000	\$ 26,604,000	\$ 27,600,000

Appendix II: Grants and Other Financial Assistance 2017-2019



NOAA Coral Reef Conservation Program, Financial Assistance Awards for Fiscal Year 2019

Award Number	Project Title	Applicant	Applicant Type	Region	Location	Federal Funding	Matching Funds
State and Territorial Coral Reef Conservation Cooperative Agreements							
NA19NOS4820055	USVI Coral Reef Management Initiative	USVI DPNR, Division of Coastal Zone Management*	Territorial Government	Atlantic/Caribbean	U.S. Virgin Islands	\$533,629	\$285,778
NA19NOS4820054	Puerto Rico Coral Reef Conservation 2019-2020	Puerto Rico Department of Natural and Environmental Resources*	Commonwealth Government	Atlantic/Caribbean	Puerto Rico	\$450,000	\$205,617
NA19NOS4820053	Coral Reef Conservation Cooperative Agreement	Florida Department of Environmental Protection*	State Government	Atlantic/Caribbean	Florida	\$710,000	\$710,000
NA19NOS4820051	Hawaii FY19-20 Coral Reef Management Grant	Hawaii DLNR, Division of Aquatic Resources*	State Government	Pacific	Hawaii	\$743,000	\$743,000
NA19NOS4820052	CNMI's FY19-20 Coral Reef Conservation Cooperative Agreement	CNMI Division of Coastal Resources Management*	Commonwealth Government	Pacific	CNMI	\$522,000	\$6,400
NA19NOS4820057	Guam's FY 19-20 Coral Reef Conservation Program Cooperative Agreement Application	Guam Bureau of Statistics and Plans, Coastal Management Program*	Territorial Government	Pacific	Guam	\$510,000	\$88,276
NA19NOS4820056	Coral Reef Conservation Cooperative Agreement	American Samoa Department of Marine and Wildlife Resources*	Territorial Government	Pacific	American Samoa	\$536,964	\$49,588
<i>* At the recipient's request, a portion of the funds were held back for the All Islands Committee Secretariat and other specific tasks.</i>							
Fishery Management Council Coral Reef Conservation Cooperative Agreements							
NA17NMF4410270	FY18 Monitoring Surveys of Mesophotic Habitats	Caribbean Fishery Management Council	FMC	Atlantic/Caribbean	Puerto Rico, USVI	\$185,484	\$0
NA17NMF4410272	Coral Reef Conservation Program Fishery Management Council Coral Reef Conservation Agreements	Gulf of Mexico Fishery Management Council	FMC	Atlantic/Caribbean	Florida, Gulf of Mexico	\$190,090	\$0
NA17NMF4410271	South Atlantic Fishery Management Council Coral Reef Conservation Activities to Conserve and Manage Fishery Resources and Essential Fish Habitat	South Atlantic Fishery Management Council*	FMC	Atlantic/Caribbean	Florida	\$360,476	\$0
NA17NMF4410251	Western Pacific Coral Reef Ecosystem Fishery Resource Assessment and Management, FY 17-19	Western Pacific Regional Fishery Management Council	FMC	Pacific	AS, HI, GU, CNMI	\$445,972	\$0
<i>* At the recipient's request, a portion of the funds were held back for specific work conducted by NOAA Principal Investigators.</i>							
Domestic Coral Reef Conservation Grants							
NA19NOS4820116	Improve Coral Reef Health by Expanding and Leveraging Stream Gulch Restoration Actions in Waikeolu, West Maui	The Coral Reef Alliance	NGO	Pacific	Hawaii	\$77,066	\$77,359
NA19NOS4820128	Mapping coral reef vulnerability to climate change in Leeward Maui to aid in designing a resilient managed area network	Marine Applied Research Center	Small Business	Pacific	Hawaii	\$79,986	\$80,067
NA19NOS4820130	Enhancing the Effectiveness of Restoration Efforts in Honokwai and Kapunakea Preserve	Ridge to Reefs, Inc	NGO	Pacific	Hawaii	\$77,870	\$78,436
NA19NOS4820127	SE FL Reef-building-coral Response to Broader-scale Coral Disease Intervention to Aid in the Identification of Disease Resilient/Resistant Coral Sites	Nova Southeastern University	Academic	Atlantic/Caribbean	Florida	\$79,004	\$32,320
NA19NOS4820117	Identifying key reef sites for the management and conservation of coral genetic diversity and resilience	University of Guam	Academic	Pacific	Guam	\$69,769	\$75,073
NA19NOS4820126	Impact of the invasive sea vine Halophila stipulacea on native seagrasses, invertebrates and fish assemblages	Sociedad Ambiente Marino	NGO	Atlantic/Caribbean	Puerto Rico	\$66,482	\$88,181
NA19NOS4820115	Building resiliency and development of a Management Action Plan for the Marine Extension of the Guanica State Forest	Protectores de Cuencas	NGO	Atlantic/Caribbean	Puerto Rico	\$76,755	\$88,602
NA19NOS4820114	Developing Probiotic Treatments to Treat Disease and Protect Captive Coral for Conservation Efforts	Smithsonian Institution	NGO	Atlantic/Caribbean	Florida	\$51,279	\$51,279
NA19NOS4820129	Satellite and field observations water quality parameters associated to coral reef high priority areas in Puerto Rico	Environmental Mapping Consultants	Small Business	Atlantic/Caribbean	Puerto Rico	\$73,619	\$74,286
NA19NOS4820120	Mapping climate resilience and vulnerability for the coral reefs of Guam to aid in prioritizing restoration sites	SymbioSeas	NGO	Pacific	Guam	\$79,818	\$80,731
NA19NOS4820118	Evaluating the impact of invasive seagrass, Halophila stipulacea, on growth and survival of commercially important juvenile fishes in the US Virgin Islands	University of the Virgin Islands	Academic	Atlantic/Caribbean	U.S. Virgin Islands	\$80,000	\$0
NA19NOS4820125	Testing approaches for the mitigation and prevention of coral disease outbreaks in the U.S. Virgin Islands	University of the Virgin Islands	Academic	Atlantic/Caribbean	U.S. Virgin Islands	\$79,938	\$0
NA19NOS4820132	Metabolomics of SCTL: identifying toxic compounds for disease mitigation	Pennsylvania State University-University Park	Academic	Atlantic/Caribbean	Florida	\$80,000	\$80,000
NA19NOS4820124	Investigating the role of groundwater in pollutant transport to Nu'uuli Pala Lagoon, American Samoa	American University	Academic	Pacific	American Samoa	\$78,430	\$83,129
NA19NOS4820119	Resident Perceptions of and Satisfaction with Ecological and Social Conditions at Selected Nearshore Sites in the Commonwealth of the Northern Marianas	Lynker Technologies, LLC	Small Business	Pacific	CNMI	\$38,500	\$38,707

NOAA Coral Reef Conservation Program, Financial Assistance Awards for Fiscal Year 2019

International Coral Reef Conservation Cooperative Agreements								
NA18NOS4820015	Building MPA management capacity in the wider Caribbean region with special emphasis on MPA implementation in the eastern Caribbean	Gulf and Caribbean Fisheries Institute	NGO	Wider Caribbean	Caribbean MPAs	\$291,420	\$291,445	
NA18NOS4820017	Advancing science-to-management feedback loops to prioritize stressors on coral reef ecosystems in support of the Micronesia Challenge	Micronesia Conservation Trust	NGO	Micronesia	Palau, FSM, Marshall Isl.	\$300,000	\$300,000	
NA18NOS4820014	Expanding Community Marine Managed Area Networks and Institutional Capacity to Support Coral Reef Conservation in Papua New Guinea and the Solomon Islands	Conservation International Foundation	NGO	South Pacific	Papau New Guinea, Solomon Isl.	\$131,032	\$131,032	
NA18NOS4820016	Increased Resilience to Climate Change through Socio-ecological Resilience Analysis of prioritized Marine Protected Areas of the Mesoamerican Reef	World Wildlife Fund, Inc.	NGO	Mesoamerica and Wider Caribbean	Belize, Honduras, Mexico	\$70,000	\$70,000	
Other: Competitive Awards								
NA16NOS4820106	Promoting Local Action for Global Coral Reef Conservation: Supporting Effective Management of Coral Reefs through partnerships in priority U.S. Geographies	The Nature Conservancy, Regional	NGO	Domestic	Domestic	\$590,000	\$575,045	
NA16NOS4820105	A Cooperative Agreement to Reduce Fishing Impacts and Effectively Conserve Coral Reefs in the Hawaiian Islands	Conservation International Foundation	NGO	Domestic	Domestic	\$59,713	\$58,019	
NA18NOS4820181	National Fish and Wildlife Foundation--Coral Fund Competitive Grants	National Fish and Wildlife Foundation, Competitive Programs	Public-Private Partnership	Domestic & International	Domestic & International	\$572,204	\$572,204	
NA19NMF4630259	Implementing the Florida Keys Coral Disease Response and Restoration Initiative	Mote Marine Laboratory, Inc.	NGO	Caribbean	Florida	\$500,000	\$0	
NA19NMF4630260	Large-scale Restoration of ESA Threatened Coral Species in the Florida Keys National Marine Sanctuary. Focusing on Five Reefs to be Restored to Criteria Outlined in the Acropora Recovery Plan	Coral Restoration Foundation, Inc.	NGO	Caribbean	Florida	\$420,000	\$405,959	
Other: Non-Competitive Awards								
NA19NOS4820059	Support for the 14th International Coral Reef Symposium (ICRS 2020) to be held at the Bremen Exhibition & Conference Center, Bremen, Germany, 5-10 July 2020	International Society for Reef Studies Corporation	NGO	Europe	Germany	\$50,000	\$50,000	
NA19NOS4820150	42nd U.S. Coral Reef Task Force	Palau International Coral Reef Center	NGO	Micronesia	Palau	\$44,308	\$0	
Total						\$9,304,808	\$5,470,533	

NOAA Coral Reef Conservation Program, Financial Assistance Awards for Fiscal Year 2018

Award Number	Project Title	Applicant	Applicant Type	Region	Location	Federal Funding	Matching Funds
State and Territorial Coral Reef Conservation Cooperative Agreements							
NA17NOS4820033	USVI Coral Reef Management Initiative	USVI DPNR, Division of Coastal Zone Management*	Territorial Government	Atlantic/Caribbean	U.S. Virgin Islands	\$495,000	\$248,989
NA17NOS4820037	Puerto Rico Coral Reef Conservation 2017-2018	Puerto Rico Department of Natural and Environmental Resources*	Commonwealth Government	Atlantic/Caribbean	Puerto Rico	\$480,000	\$234,259
NA17NOS4820032	Coral Reef Conservation Cooperative Agreement	Florida Department of Environmental Protection*	State Government	Atlantic/Caribbean	Florida	\$770,000	\$671,381
NA17NOS4820039	Hawaii FY17-18 Coral Reef Management Grant	Hawaii DLNR, Division of Aquatic Resources*	State Government	Pacific	Hawaii	\$760,000	\$810,086
NA17NOS4820034	CNMI's FY17-18 Coral Reef Conservation Cooperative Agreement	CNMI Division of Coastal Resources Management*	Commonwealth Government	Pacific	CNMI	\$475,000	\$0
NA17NOS4820038	Guam's FY 17-18 Coral Reef Conservation Program Cooperative Agreement Application	Guam Bureau of Statistics and Plans, Coastal Management Program*	Territorial Government	Pacific	Guam	\$400,000	\$51,454
NA17NOS4820036	Coral Reef Conservation Cooperative Agreement	American Samoa Department of Marine and Wildlife Resources*	Territorial Government	Pacific	American Samoa	\$560,000	\$16,340
<i>* At the recipient's request, a portion of the funds were held back for the All Islands Committee Secretariat and other specific tasks.</i>							
Fishery Management Council Coral Reef Conservation Cooperative Agreements							
NA17NMF4410270	FY18 Monitoring Surveys of Mesophotic Habitats	Caribbean Fishery Management Council	FMC	Atlantic/Caribbean	Puerto Rico, USVI	\$365,546	\$0
NA17NMF4410272	Coral Reef Conservation Program Fishery Management Council Coral Reef Conservation Agreements	Gulf of Mexico Fishery Management Council	FMC	Atlantic/Caribbean	Florida, Gulf of Mexico	\$190,247	\$0
NA17NMF4410271	South Atlantic Fishery Management Council Coral Reef Conservation Activities to Conserve and Manage Fishery Resources and Essential Fish Habitat	South Atlantic Fishery Management Council*	FMC	Atlantic/Caribbean	Florida	\$358,646	\$0
NA17NMF4410251	Western Pacific Coral Reef Ecosystem Fishery Resource Assessment and Management, FY 17-19	Western Pacific Regional Fishery Management Council	FMC	Pacific	AS, HI, GU, CNMI	\$335,000	\$0
<i>* At the recipient's request, a portion of the funds were held back for specific work conducted by NOAA Principal Investigators.</i>							
Domestic Coral Reef Conservation Grants							
NA18NOS4820108	HIMARC Phase II: Estimating indicators and reference points in support of effectively managing Hawaii's nearshore marine resources	University of Hawaii	Academic	Pacific	Hawaii	\$56,549	\$56,552
NA18NOS4820111	Village-based planning in American Samoa to address threats posed to coral reefs by climate change.	Marine Applied Research Center	Small Business	Pacific	American Samoa	\$79,939	\$80,067
NA18NOS4820113	Integrating Visual Ecological Surveys, Passive Acoustics and Habitat Photogrammetry to Characterize Reef Fish Assemblages, Spawning Activity & Resilience across Coral Reef Management Zones Post-Hurricane Irma	North Carolina State University	Academic	Atlantic/Caribbean	Florida	\$65,053	\$72,301
NA18NOS4820106	Human and natural drivers of coral reef resilience to climate-induced coral bleaching in Guam; Identifying potential climate refugia	SymbioSeas	NGO	Pacific	Guam	\$79,975	\$80,532
NA18NOS4820115	Addressing land-based sources of pollution affecting listed coral species in Guanica, Puerto Rico	Protecores de Cuencas, Inc.	NGO	Atlantic/Caribbean	Puerto Rico	\$79,581	\$84,933
NA18NOS4820112	Delineate, Designate, and Demonstrate Stream Riparian Buffers in Waihihiki, West Maui	The Coral Reef Alliance	NGO	Pacific	Hawaii	\$70,223	\$70,223
NA18NOS4820110	Scaling up production capacity for Hawaiian coral reef restoration: few large or many small?	University of Hawaii	Academic	Pacific	Hawaii	\$69,454	\$69,483
NA18NOS4820107	Assessing the impacts of the invasive seagrass, Halophila stipulacea, and two major hurricanes on the distribution of native seagrass communities of Culebra Island, Puerto Rico	Coastal Survey Solutions LLC	Small Business	Atlantic/Caribbean	Puerto Rico	\$63,386	\$64,087
NA18NOS4820114	Establishing the catchment to sea connection: spatial and temporal patterns of terrestrial pollution sources and impacts to herbivorous fish assemblages	James Cook University	Academic	Pacific	American Samoa	\$40,364	\$43,545
NA18NOS4820116	A scientific analysis and decision framework for the standardization of citizen science ecological monitoring methods for community based fishing areas (CBFA)	Conservation International Foundation	NGO	Pacific	Hawaii	\$40,971	\$41,023
NA18NOS4820104	Equipping U.S. Virgin Island managers with high and low-tech options for native reef fish and seagrass conservation: mitigating impacts of the invasive seagrass, Halophila stipulacea	William Marsh Rice University	Academic	Atlantic/Caribbean	Virgin Islands	\$69,167	\$69,170
NA18NOS4820105	Effect of Hurricane Maria on resilience of Puerto Rico's Coral Reef	University of Puerto Rico Mayaguez	Academic	Atlantic/Caribbean	Puerto Rico	\$70,926	\$70,926
NA18NOS4820206	Assessment and Restoration of the Pillar Coral Dendrogyra cylindrus on the Florida Reef Tract	Nova Southeastern University, Inc.*	Academic	Atlantic/Caribbean	Florida	\$69,000	\$69,498
<i>*This project was awarded in FY 2017 and transferred at the original recipient's request.</i>							
International Coral Reef Conservation Cooperative Agreements							
NA18NOS4820015	Building MPA management capacity in the wider Caribbean region with special emphasis on MPA implementation in the eastern Caribbean	Gulf and Caribbean Fisheries Institute	NGO	Wider Caribbean	Caribbean MPAs	\$290,126	\$290,290

NOAA Coral Reef Conservation Program, Financial Assistance Awards for Fiscal Year 2018

NA18NOS4820017	Advancing science-to-management feedback loops to prioritize stressors on coral reef ecosystems in support of the Micronesia Challenge	Micronesia Conservation Trust	NGO	Micronesia	Palau, FSM, Marshall Isl.	\$300,000	\$300,000
NA18NOS4820014	Expanding Community Marine Managed Area Networks and Institutional Capacity to Support Coral Reef Conservation in Papua New Guinea and the Solomon Islands	Conservation International Foundation	NGO	South Pacific	Papau New Guinea, Solomon Isl.	\$132,060	\$132,060
NA18NOS4820016	Increased Resilience to Climate Change through Socio-ecological Resilience Analysis of prioritized Marine Protected Areas of the Mesoamerican Reef	World Wildlife Fund, Inc.	NGO	Mesoamerica and Wider Caribbean	Belize, Honduras, Mexico	\$70,000	\$70,000
Other Competitive Awards							
NA16NOS4820106	Promoting Local Action for Global Coral Reef Conservation: Supporting Effective Management of Coral Reefs through partnerships in priority U.S. Geographies	The Nature Conservancy, Regional	NGO	Domestic	Domestic	\$805,000	\$787,202
NA16NOS4820105	A Cooperative Agreement to Reduce Fishing Impacts and Effectively Conserve Coral Reefs in the Hawaiian Islands	Conservation International Foundation	NGO	Domestic	Domestic	\$59,903	\$57,811
NA18NOS4820181	National Fish and Wildlife Foundation--Coral Fund Competitive Grants	National Fish and Wildlife Foundation, Competitive Programs	Public-Private Partnership	Domestic & International	Domestic & International	\$680,000	\$680,000
						\$8,381,116	\$5,222,212

NOAA Coral Reef Conservation Program, Financial Assistance Awards for Fiscal Year 2017

Award Number	Project Title	Applicant	Applicant Type	Region	Location	Federal Funding	Matching Funds
State and Territorial Coral Reef Conservation Cooperative Agreements							
NA17NOS4820033	USVI Coral Reef Management Initiative	USVI DPNR, Division of Coastal Zone Management*	Territorial Government	Atlantic/Caribbean	U.S. Virgin Islands	\$540,000	\$222,602
NA17NOS4820037	Puerto Rico Coral Reef Conservation 2017-2018	Puerto Rico Department of Natural and Environmental Resources*	Commonwealth Government	Atlantic/Caribbean	Puerto Rico	\$490,000	\$237,447
NA17NOS4820036	Coral Reef Conservation Cooperative Agreement	Florida Department of Environmental Protection*	State Government	Atlantic/Caribbean	Florida	\$790,000	\$671,381
NA17NOS4820039	Hawaii FY17-18 Coral Reef Management Grant	Hawaii DLNR, Division of Aquatic Resources*	State Government	Pacific	Hawaii	\$750,000	\$629,914
NA17NOS4820034	CNMI's FY17-18 Coral Reef Conservation Cooperative Agreement	CNMI Division of Coastal Resources Management* **	Commonwealth Government	Pacific	CNMI	\$480,000	\$0
NA17NOS4820038	Guam's FY 17-18 Coral Reef Conservation Program Cooperative Agreement Application	Guam Bureau of Statistics and Plans, Coastal Management Program*	Territorial Government	Pacific	Guam	\$460,214	\$49,811
NA17NOS4820036	Coral Reef Conservation Cooperative Agreement	American Samoa Department of Marine and Wildlife Resources*	Territorial Government	Pacific	American Samoa	\$572,607	\$7,520
<i>* At the recipient's request, a portion of the funds were held back for the All Islands Committee Secretariat and other specific tasks.</i>							
Fishery Management Council Coral Reef Conservation Cooperative Agreements							
NA17NMF4410270	FY17 Oceanographic Pathways and Hydrodynamic Connectivity	Caribbean Fishery Management Council	FMC	Atlantic/Caribbean	Puerto Rico, USVI	\$301,282	\$0
NA17NMF4410272	Coral Reef Conservation Program Fishery Management Council Coral Reef Conservation Agreements	Gulf of Mexico Fishery Management Council	FMC	Atlantic/Caribbean	Florida, Gulf of Mexico	\$158,469	\$0
NA17NMF4410271	South Atlantic Fishery Management Council Coral Reef Conservation Activities to Conserve and Manage Fishery Resources and Essential Fish Habitat	South Atlantic Fishery Management Council*	FMC	Atlantic/Caribbean	Florida	\$367,168	\$0
NA17NMF4410251	Western Pacific Coral Reef Ecosystem Fishery Resource Assessment and Management, FY 17-19	Western Pacific Regional Fishery Management Council	FMC	Pacific	AS, HI, GU, CNMI	\$430,000	\$0
<i>* At the recipient's request, a portion of the funds were held back for specific work conducted by NOAA Principal Investigators.</i>							
Domestic Coral Reef Conservation Grants							
NA17NOS4820075	Coral community structure, health and calcification at nearshore reefs adjacent to the Guanica Bay watershed, southwest Puerto Rico	University of Puerto Rico Mayaguez	Academic	Atlantic	Puerto Rico	\$70,986	\$70,986
NA17NOS4820124	Assessment and Restoration of the Pillar Coral <i>Dendrogyra cylindrus</i> on the Florida Reef Tract	Florida Department of Education-Florida Keys Community College	Academic	Atlantic	Florida	\$69,000	\$75,095
NA17NOS4820083	Building a genetic and bioinformatic analysis pipeline for genotyping of Caribbean corals	Pennsylvania State University - University Park	Academic	Atlantic	Florida	\$70,392	\$50,663
NA17NOS4820084	Predicting the unpredictable: identifying environmental and genomic correlates of <i>Acropora cervicornis</i> out-plant success in the Florida Keys	University of Southern California	Academic	Atlantic	Florida	\$76,420	\$103,947
NA17NOS4820079	Benthic community structure characterization and assessment of turbidity impacts of the north (Manata and Vega Baja) and south (Guanica) coasts, Puerto Rico	Protectores de Cuenca, Inc.	NGO	Atlantic	Puerto Rico	\$69,331	\$69,858
NA17NOS4820086	Testing the efficacy of MPAs and the impact of invasive lionfish on mesophotic reefs in the US Virgin Islands	University of the Virgin Islands	Academic	Atlantic	Virgin Islands	\$80,000	\$31,800
NA17NOS4820081	Optimal placement of coral restoration projects to enhance reef resilience: a management tool	Nova Southeastern University	Academic	Atlantic	Florida	\$79,992	\$81,086
NA17NOS4820080	Understanding & Preventing Land-Based Sources of Pollution in the U.S. Virgin Islands	University of the Virgin Islands	Academic	Atlantic	Virgin Islands	\$80,000	\$1,200
NA17NOS4820087	Southeast Florida large (>2 m) ESA threatened coral colony disease impact assessment	Nova Southeastern University	Academic	Atlantic	Florida	\$79,891	\$38,245
NA17NOS4820088	Assessing resistance and recovery in CNMI during and following a bleaching and typhoon event to identify and prioritize resilience drivers and action options	Marine Applied Research Center, LLC	Small Business	Pacific	CNMI	\$79,750	\$81,317
NA17NOS4820085	Clean Water for Reefs: Halting Sediment Runoff from Dirt Roads by Restoring Natural Filtration Processes in the Honokowai Priority Watershed, West Maui	CORAL	NGO	Pacific	Hawaii	\$70,806	\$92,242
NA17NOS4820078	Integrating climate resiliency into planning processes, action plans and school curriculum in American Samoa.	Marine Applied Research Center, LLC	Small Business	Pacific	American Samoa	\$74,910	\$74,950
NA17NOS4820074	Predicting extreme tide events to inform shallow reef community restoration and management in Guam, Micronesia	University of Guam	Academic	Pacific	Guam	\$78,538	\$34,300
NA17NOS4820076	Assessing nearshore management strategies for coral resilience	University of Hawaii Manoa	Academic	Pacific	Hawaii	\$79,739	\$81,317
NA17NOS4820082	Identifying Hotspots of Nitrogen Pollution in Saipan	American University	Academic	Pacific	CNMI	\$62,736	\$66,419
NA17NOS4820077	Assessing the Resilience of Leeward Maui Reefs to Help Design a Resilient Managed Area Network	The Nature Conservancy, Hawai'i Program	NGO	Pacific	Hawaii	\$77,631	\$77,631
NA17NOS4820073	Collaborative design of a network of marine managed areas to ensure sustainable and resilient coral reef ecosystems on Maui.	The Nature Conservancy	NGO	Pacific	Hawaii	\$79,405	\$79,405

NOAA Coral Reef Conservation Program, Financial Assistance Awards for Fiscal Year 2017

International Coral Reef Conservation Cooperative Agreements							
NA16NOS4820070	Consolidating MPA Management Capacity Building in the Wider Caribbean Region	Gulf and Caribbean Fisheries Institute	NGO	Wider Caribbean	Caribbean MPAs	\$173,622	\$174,615
NA16NOS4820071	Understanding the ecology and social perceptions of fisheries for the development of long-term education and enforcement strategies to support sustainable fisheries in Bahamas and Dominican Republic	Institute for Socio-ecological Research, Inc.	NGO	Wider Caribbean	Bahamas, Dominican Republic	\$65,342	\$65,344
NA16NOS4820069	Expanding science-to-management frameworks for coral reef ecosystems across Micronesia	Micronesia Conservation Trust	NGO	Micronesia	Palau, FSM, Marshall Isl.	\$300,000	\$300,000
Other Competitive Awards							
NA16NOS4820106	Promoting Local Action for Global Coral Reef Conservation: Supporting Effective Management of Coral Reefs through partnerships in priority U.S. Geographies	The Nature Conservancy, Regional	NGO	Domestic	Domestic	\$640,000	\$660,549
NA16NOS4820105	A Cooperative Agreement to Reduce Fishing Impacts and Effectively Conserve Coral Reefs in the Hawaiian Islands	Conservation International Foundation	NGO	Domestic	Domestic	\$59,985	\$59,554
NA14NOS4820143	National Fish and Wildlife Foundation--Coral Fund Competitive Grants	National Fish and Wildlife Foundation, Competitive Programs	Public-Private Partnership	Domestic & International	Domestic & International	\$323,525	\$323,525
						\$8,181,741	\$4,512,723