

Applying Science to Manage and Protect Coral Reef Ecosystems

Coral reef ecosystems are highly valued for their biological, ecological, cultural, and economic resources. They cover less than one percent of the earth's surface (approximately 23,000 square miles), yet provide over \$30 billion in annual goods and services worldwide by enhancing biological diversity, fisheries production, tourism, maritime and cultural heritage, and shoreline protection. However, competing demands on coral reef ecosystems and increasing threats from fishing, pollution, coastal uses, invasive species, climate change, and extreme events (e.g., disease and harmful algal blooms) threaten 60 percent of the world's reefs and the resources they support. The National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science (NCCOS) works with resource managers to understand these problems and evaluate possible solutions.

Approach

Sound management of coral reef ecosystems requires scientifically-based information on their condition, the causes and consequences of that condition, forecasts of their future condition, and the costs and benefits of possible management actions to maintain or improve it. Even more fundamental to effective



management is knowing the spatial extent, boundaries, and physical characteristics of U.S. coral reef ecosystems. Because these ecosystems are dynamic, continuous research and monitoring is required to document changes and understand the processes by and rates at which these changes are occurring.

NCCOS mapping and monitoring programs record changes in ecosystem conditions, while NCCOS research examines the causes and predicts the impacts of those changes.

Understanding Status and Trends

Mapping and monitoring are the cornerstones to ecosystem-based management and provide information necessary to understand the history, current state, and future condition of coral reef ecosystems. NCCOS develops computer and remote sensing technologies to map coral reef ecosystems inexpensively and with increased speed and



accuracy. Using these technologies, NCCOS leads federal efforts to map all U.S. coral reefs by 2010. The maps provide the spatial framework to design and implement research programs and the capability to effectively communicate information to ecosystem managers. NCCOS maps have been used to delineate water depths derived from satellite technology, and to define biologically relevant boundaries of marine protected areas by conducting species habitat use studies.



The condition of coral reef ecosystems is determined by the interaction of climate change, pollution, invasive species, land and resource use, and extreme events.

NCCOS is building a nationally coordinated, long-term program to inventory species, assess conditions, monitor trends, and predict changes in U.S. coral reef ecosystems. Projects build on and link to existing federal, state, and territorial monitoring efforts. When monitoring gaps are identified, NCCOS initiates new monitoring projects. These programs provide decision-makers with key information to respond to changing environmental conditions, assess the effectiveness of existing management strategies, and identify the need for additional protective measures. NCCOS' biennial *State of the Reefs* reports are available at www.nccos.noaa.gov/publications/notables.html.

Understanding Land-Water Interactions

NCCOS supports two long-term regional Coral Reef Ecosystem Studies (CRES) in the Caribbean and Micronesia. The Caribbean CRES examines sedimentation impacts on water quality, reef demographics, and the effectiveness of marine protected areas. The Micronesia CRES, focused in Guam, is determining which land-based inputs are the greatest threat to coral reef health, and developing integrated management strategies to reduce pollution. Information from these studies helps local agencies develop and update management efforts.

The Hawaii Coral Reef Initiative and National Coral Reef Institute are administered by NCCOS to examine threats to coral reefs. The Hawaii Coral Reef Initiative started a statewide assessment and monitoring program, completed the first assessments of non-native algae, trained managers to identify problem species, and examined how water quality impacts reef health. The National Coral Reef Institute produced maps of Florida reefs, evaluated coral reef restoration projects, and studied the role of artificial reefs.

Understanding Coral Reef Ecosystem Health



NCCOS is coordinating the scientific resources of the U.S. and its territories through the U.S. Coral Reef Task Force's Coral Disease and Health Consortium. Research programs examine synergistic effects of disease and environmental stressors, and how they impact the health of coral reef ecosystems. NCCOS scientists are developing better measures of coral health that will allow managers to detect problems before it is too late to intervene. Some of these indicators will link the decline to its cause, helping managers target their efforts. Research on the biomolecular mechanisms of coral bleaching will allow managers to forecast bleaching events and mitigate conditions threatening coral health.

Partnerships

NCCOS leads and coordinates these coral reef activities, but the research and products would not be possible without the strong partnerships forged within NOAA and with other federal agencies, states, territories, commonwealths, universities, industry, and non-profit organizations.

Linking Science to Management

The tools developed by NCCOS scientists are used by NCCOS and natural resource managers to assess the status and trends of coral reefs, and relate that information to the causes and consequences of coral reef stressors. This information provides managers with a better understanding of how reefs function and how they may be better managed. NCCOS data and models help predict the impacts of alternative management decisions regarding marine protected areas, fishing regulations, recreational uses, pollution control, and coastal development.



Maintaining healthy coral reef ecosystems requires a balance not only between ecological functions and human uses, but also among the many human uses of those ecosystems. Protection of coral reef ecosystems necessitates a strong legal framework providing managers with a variety of tools (e.g., zoning ordinances, regulations, and enforceable management plans) that operate across multiple jurisdictions. Thus, policy makers and the public are integrally linked to management and protection efforts.

For more information about NCCOS' efforts to protect coral reef ecosystems, contact:

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