



ECOSYSTEM SERVICES RESEARCH PROGRAM

INCORPORATING CORAL REEF ECOSYSTEM SERVICES INTO WATERSHED AND COASTAL ZONE DECISIONS

Issue:

Coral reef ecosystems provide valuable services to society -- food, shoreline protection, fishing, recreation, education, and water quality, as well as cultural and aesthetic enjoyment. Yet coral reefs are in serious decline, partly from global change factors such as high seawater temperatures, and partly from land-based activities that add pollutants to watershed runoff.

Human land use and human activities in the watershed are largely responsible for elevated levels of sediment, nutrients and contaminants, as well as changes in habitat and hydrology that can be harmful to coral reef communities. Continued population growth and economic development in coastal zones further threaten these valued ecosystems.

Effective protection of coral reefs will require recognition of the services they provide and consideration of these services in decision-making. It will be essential to establish links between ecological factors and social, economic and cultural values so that tradeoffs can be considered for different decision options.

Scientific Objective:

The coral reef project in EPA's Ecosystem Services Research Program is providing decision support tools for protection, enhancement, restoration and sustainability of coral reef ecosystems and the services they provide.

Areas of research are:

- Framing the human-coral reef dynamic, linking social and economic motives for human activities with their consequences

to reefs and delivery of reef services

- Quantifying reef ecosystem services
- Linking human activities to quantitative changes in delivery of ecosystem services
- Forecasting changes in ecosystem services for different decision and policy scenarios
- Determining reef tipping points for sustainable delivery of reef services
- Integrating decision-making processes, authorities and approaches with potential influences on delivery of services
- Producing decision support tools that can be effectively used by decision-makers

Four project areas are targeted to:

- Quantify coral reef ecosystem services for varying quality of coral reef conditions

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- Quantify changes in coral reef ecosystem services from changes in watershed land use
- Identify options to increase coral reef services through nutrient and sediment reduction
- Characterize the costs and benefits of climate change and ocean acidification on coral reefs

At least four ecosystem services will be examined: tourism, fish production, shoreline protection and future natural products (e.g., pharmaceuticals).

System modeling: Two types of models are being developed:

- Reef ecosystem model with ecosystem service endpoints to better establish conditions that will provide services into the future.
- Decision analysis model to examine various human decisions for biological outcomes and ecosystem services. Currently researchers are evaluating several existing models.

Human stressors: Effects of human stresses are being investigated through:

- Rate functions for effects of human stressors on coral growth and survival
- Correlations between reef indicators and human activity levels in the watershed and coastal zone
- Relationship of future services to different levels of human use

Application and Impact:

Coral reef research is:

- Engaging resource managers and stakeholders to identify the vision, challenges and opportunities for each project area
- Estimating the monetary and social value of coral reef services
- Assessing human activities that influence delivery of services from coral reefs
- Generating spatially-explicit models to forecast sustainability of coral reef services
- Providing models to evaluate trade-offs under different decision scenarios
- Generating decision tools useful to resource managers and stakeholders

EPA researchers have engaged hundreds of scientists and

managers in workshops and presentations to incorporate local knowledge into coral reef research planning.

Coral reef surveys have been completed in the U.S. Virgin Islands (USVI) to provide a regional characterization of coral reef extent and condition; and in Florida to develop a habitat assessment method that estimates habitat value of stony corals, octocorals and sponges. The stony coral portion of the procedure is being used in The Nature Conservancy's Florida Reef Resilience Program (www.nature.org).

Ultimately, research must lead to tools for decision-makers. Under development is an interactive web-based tool that will include annotations for relevant literature, legislation, management plans, rate functions, models and maps.

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