

GOAL 9: RESTORE DAMAGED REEFS

KEY THREATS ADDRESSED:

Restoring damaged coral reef ecosystems is an important part of reducing key threats to coral reef ecosystems. The figure below is a general summary of the relative importance (H = high, M = medium, L = low) of this goal in addressing the impacts from these threats. A higher ranking suggests that activities under this goal are considered more important to addressing the threat. Lower rankings suggest that although activities under this goal may make significant contributions, they may currently be less important to addressing the threat. The rankings are a summary of input shown in Table 2. The actual importance of this goal to addressing threats to reefs will depend on location and other factors (see Tables 3 and 4 for regional comparisons).

THREATS	Global Warming/ Climate Change	Diseases	Hurricanes/ Typhoons	Extreme Biotic Events	Overfishing	Destructive Fishing Practices	Habitat Destruction	Invasive Species	Coastal Development	Coastal Pollution	Sedimentation & Runoff	Marine Debris	Overuse from Tourism	Vessel Groundings	Vessel Discharges
Restore Damaged Reefs	L	L	M	M	L	H	H	L	L	L	L	L	L	H	L

RATIONALE FOR ACTION:

A well-developed coral reef can represent thousands of years of slow incremental growth by resident stony corals, and consequently, many corals living today are centuries old. In spite of the longevity and apparent natural resilience of corals and the reefs they construct, both are extremely vulnerable to destruction by human activities – either gradually through degraded habitat quality, or suddenly through catastrophic damage from vessel groundings, toxic spills, or habitat destruction. Damaged coral reef communities recover slowly – if at all – particularly when the underlying habitat structure is destroyed, or when the prevailing environmental conditions have been chronically degraded over time. In such cases, full recovery of pre-existing ecological communities, and the full range of services they provide, may require tens to hundreds or thousands of years.

While it is clearly preferable to *prevent* the loss of coral reef habitat through the kinds of proactive conservation measures presented in other sections of this strategy, sometimes active restoration of coral reefs is needed to help prevent further degradation or possibly advance the natural restoration process in injured or damaged reef habitats. Executive Order 13058 charges federal agencies with ensuring, to the extent permitted by law, that any actions they authorize, fund, or carry out will not degrade the conditions of coral reef ecosystems (with limited exceptions such as in time of war, or when necessary for reasons of national security). Consequently, coral reef restoration is not usually considered a legitimate means to mitigate federal actions or projects that are expected to adversely impact reef habitats. The goal of restoration efforts are to help repair damage caused by human impacts and natural disturbances, and restore the normal function, structure and diversity of coral reef ecosystems.

To that end, this restoration strategy describes avenues to strengthen restoration science and methods ranging from eliminating anthropogenic stressors that impede recovery, to more direct restoration of damaged habitats or depleted populations.

RESTORATION STRATEGY

The goal of this strategy is to increase the capability of federal and non-federal managers to efficiently and effectively restore injured or degraded coral reefs where appropriate. The strategy is outlined in the U.S. National Action Plan to Conserve Coral Reefs and related documents of the Coastal Uses Working Group of the U.S. Coral Reef Task Force. For more detailed information see <http://coralreef.gov/>. The strategy includes research, monitoring, pilot studies and technology transfer outlined in six objectives to achieve this goal:

- Objective 1: Review and evaluate existing reef restoration projects to quantify the benefits gained by the effort and expenditure of the restoration, compared to scenarios in which no restoration efforts were undertaken, and make recommendations for improvements.
- Objective 2: Develop and test innovative methods and techniques to expedite reef restoration for all major categories of coral reef injury, using a hypothesis-driven approach that involves rigorous, quantitative evaluation.
- Objective 3: Develop regional restoration plans that identify significant restoration alternatives, and weigh the costs and benefits of natural recovery compared with restoration alternatives.
- Objective 4: Promote cost-effective restoration projects on selected degraded U.S. reefs, focusing on habitats of high ecological, economic, and social or conservation value.

Objective 5: Rehabilitate degraded fish habitat through the deployment of artificial structures and rapid inexpensive transplant methods, where appropriate.

Objective 6: Transfer proven restoration tools, techniques and lessons learned to domestic and international partners.

SUMMARY OF ACCOMPLISHMENTS (2001)

Some progress has been made in the science and implementation of coral reef restoration, but much remains unknown and coral reef restoration remains a difficult process in many respects. Progress has been made in the development and implementation of a range of new programs, in the support and training in effective response procedures following damage events, and in techniques for damage assessment and restoration activities to allow the reef system to recover. Restoration of reef systems can take tens to hundreds of years depending on the conditions. The following is a partial summary of recent accomplishments by members of the U.S. Coral Reef Task Force to achieve the goal and objectives. For more detailed information see <http://coralreef.gov/>.

Objective 1 Accomplishments:

- Evaluated coral recruitment onto different structures used in the FKNMS reef restoration projects to identify optimal surfaces to enhance natural recruitment. (NOAA and partners)
- Began a national scale compilation and assessment of restoration techniques and projects. (NOAA and partners).
- Completed a review of restoration experience in the Pacific. (NOAA & University of Hawaii)

Objective 2 Accomplishments:

- Deployed artificial structures with attached deepwater *Oculina* coral fragments in the Experimental *Oculina* Research Reserve off the east coast of Florida. (NOAA and partners)
- Conducted two pilot studies to re-introduce *Diadema antillarum* into fore-reef environments in the Florida Keys to enhance grazing and reduce macroalgal biomass. (DOI)
- Conducted initial experiments in culturing of spawned gametes of important reef-building corals to improve settlement and recruitment potential. (multiple partners)
- Employed new mapping technology and developed a spatial recovery model for seagrass damage assessment work in the FKNMS. (NOAA and partners)
- Developed a coral fragment holding and propagation facility at the Florida Aquarium and completed two experimental coral nursery/restoration research projects in the Florida Keys. (NOAA and partners)

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- Conducted coral transplants at various times throughout the year to study the role of genetics and physiology in survival of staghorn and elkhorn coral for possible use in reef restoration. (NOAA and partners)

Objective 3 Accomplishments:

- Drafted a Programmatic Environmental Impact Statement for coral and seagrass restoration in the FKNMS that will facilitate future restoration work. (NOAA and partners).
- Completed Environmental Sensitivity Index maps for the Caribbean, and main Hawaiian Islands. (NOAA and partners).

Objective 4 Accomplishments:

- Stabilized damaged reef habitat, recreated high relief topography, and transplanted corals in response to the *Columbus Iselin*, *Jacquelyn L*, *Bateau Duhe* and *Connected* groundings in the FKNMS. (NOAA and partners)
- Continued restoration of reefs damaged by grounding of nine long-liner ships in American Samoa; moved and transplanted corals during this restoration effort. (USCG, NOAA and partners)
- Restored over 1,000 acres of mangroves in the Los Machos and Red Mangrove Forests of Puerto Rico, through the Department of Defense Legacy project to support the recovery and protection of nearby coral reefs. (DOD)

Objective 6 Accomplishments:

- Produced technical information and resource guides for U.S. and international use to help respond to, and assess, damage from oil spill events in coral reef ecosystems (NOAA).
- Began developing database on current literature regarding assessment of the economic value of coral reef ecosystems for use in assessments following damage events
- Established “Reef Medics” volunteer restoration program in the FKNMS (NOAA and partners).
- Conducted artificial reef training workshops in Florida and Puerto Rico, planned for two workshops in the Pacific. (NOAA and partners).

IMPLEMENTATION PLAN 2002-2003

Successful implementation of the strategy is contingent on funding and other factors, including effort by a variety of federal and non-federal organizations. The Coastal Uses Working Group of the U.S. Coral Reef Task Force, working with many partners, provided the following partial summary of key actions needed from government and non-governmental entities in 2002-2003 to help fulfill the objectives. More

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detailed information is available from the working group or member organizations of the U.S. Coral Reef Task Force (<http://coralreef.gov/>).

To Address Objective 1:

- Complete the inventory of coral reef restoration projects and techniques for use by managers, scientists and others.
- Compile a manual on coral reef restoration/mitigation techniques recommended for various Pacific island marine habitats and environmental conditions.
- Evaluate recovery of coral and fish communities at the *Fortuna Reefer* ship grounding site, as well as the *Columbus Iselin*, *Houston*, *Wellwood*, *Elpis*, *Maitland*, *Bateau Duhe*, and *Connected* restoration sites.

To Address Objective 2:

- Develop an aquaculture facility at the Tampa Aquarium to grow coral colonies for use in reef restoration.
- Continue work on *Diadema* culture and re-introduction in the Florida Keys, applying lessons learned in 2001.

To Address Objective 3:

- Begin development of regional restoration plans in two regions to identify priorities and alternatives.

To Address Objective 4:

- Remove a high priority abandoned vessel from coral reefs in the Hawaiian Islands.
- Complete development of a programmatic Environmental Impact Statement (EIS) for coral reef and seagrass restoration projects in the FKNMS.

To Address Objective 5:

- Rehabilitate degraded fish habitat within impacted areas.
- Evaluate effects of artificial reefs and their role in fisheries management.

To Address Objective 6:

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- Produce technical information and resource guides for U.S. and international use to help prevent, respond to and restore damage events in coral reef ecosystems.
- Complete and make available database on current literature regarding assessment of the economic value of coral reef ecosystems for use in assessments following damage events.