Elkhorn Coral: Science of Recovery

Florida Keys National Marine Sanctuary

Once Abundant Coral Listed as Threatened Species

Elkhorn coral, *Acropora palmata*, was once the most abundant stony coral on shallow reef crests and fore-reefs of the Caribbean and Florida reef tract. In the Florida Keys, this fast-growing coral with its thick antler-like branches formed extensive habitat for fish and marine invertebrates. By the early 1990s, elkhorn coral had experienced widespread losses throughout its range. A similar trend was seen in a close relative, staghorn coral, *Acropora cervicornis*. Multiple factors are thought to have contributed to coral declines, including impacts from hurricanes, coral disease, mass coral bleaching, climate change, coastal pollution, overfishing, and damage from boaters and divers.

In 2006, the two species were listed as threatened under the Endangered Species Act. The recovery strategy, developed by NOAA Fisheries, included designating critical habitats in Florida, Puerto Rico and the U.S. Virgin Islands and called for further investigations into the factors that prevent natural recovery of the species.

Coral-eating snails covered in algae feed on elkhorn coral tissue.
Photo: NOAA Fisheries

In response to population declines, the Center for Biological Diversity petitioned NOAA Fisheries to list elkhorn coral, along with its close relative, staghorn coral, under the Endangered Species Act (ESA). After a thorough review process that involved opportunities for public comment, NOAA Fisheries determined that these two corals met the criteria to be listed as threatened under the ESA. ESA protection is aimed at reducing threats and stressors to the focal species in order to encourage its natural recovery.

NOAA Scientists Investigate Causes of Coral Declines

In 2004, scientists from NOAA's Southeast Fisheries Science Center (Miami) began a long-term monitoring program in Florida Keys National Marine Sanctuary to determine the current population status of elkhorn coral and to better understand the primary threats and stressors affecting its recovery. Understanding basic population statistics (coral recruitment and mortality) and the nature of stressors is critical to the species recovery plan and management of elkhorn coral within the sanctuary.

The study area is focused in the Upper Keys and contains 25 permanent study plots located on eight different fore-reefs. All elkhorn coral colonies in each study plot are mapped and assessed annually. A randomly selected subset of colonies is assessed more comprehensively three times per year. During each of these more in-depth surveys, scientists record the sources and severity of coral tissue loss, which includes prevalence and impact of disease, physical damage, and predation by the coral-eating snail, *Coralliophila abbreviata*. From these surveys, a measure of live coral known as a "live area index" is calculated for each colony. This index is used to track the changes in the total live tissue for each coral over time and to determine the relative importance of each cause of tissue loss.

Several Factors Affect Coral Recovery

Overall, according to this study, the top three reasons for elkhorn tissue loss have been fragmentation or breakage of coral branches, "white" disease, and predation by the coral-eating snail (see graph on back). However, the proportion of loss due to fragmentation was skewed somewhat because of the large degree of physical damage done by hurricanes in 2005. Sixty-three percent of coral tissue loss that year was due to breakage. Since then, colonies within the study plots have only shown modest signs of recovery and most hurricane-generated fragments did not survive.

http://floridakeys.noaa.gov/

National Marine Sanctuaries

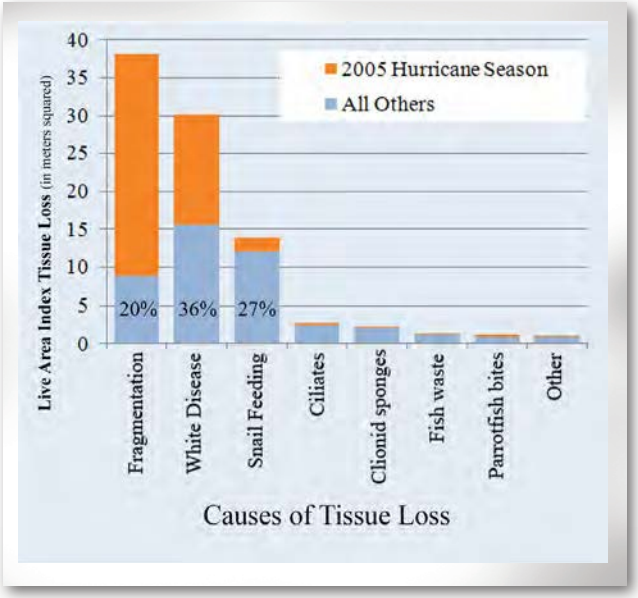
Low Population Density Reduces Spawning and Fragmentation Success

Elkhorn populations depend upon both fragmentation and spawning as methods of reproduction for long-term viability. Spawning results in a new, genetically unique coral, while fragmentation produces genetic copies of the parent coral. Fragmented corals have the potential to grow into new colonies under the right conditions, but scientists have noted that relatively few fragments are managing to do so. At the reef crest, elkhorn coral colony density is so low that when fragments break off, they tend to land in nearby sandy areas where they usually die, as opposed to being trapped by dense elkhorn thickets where they are held in place, allowing them to flourish and grow.

Low population density can also reduce the chances for successful spawning. During spawning, coral gametes (egg and sperm) do not survive long, and if individual colonies are located too far apart on the reef, the chance of successful reproduction decreases.

Predation Revealed as Factor Affecting Tissue Loss

To reveal the threats facing elkhorn coral when hurricanes are not a factor, the live area index data were re-analyzed excluding the 2005 data. Analysis of the remaining survey years showed that the proportion of tissue loss attributed to fragmentation (20%) was less important than the proportion attributed to either disease (36%) or predation from snails (27%). These results indicate that white disease and coral-eating snails represent more chronic threats to elkhorn corals than breakage from hurricanes.



Without 2005 data, fragmentation accounts for 20% of tissue loss.
Figure: NOAA Fisheries

About one-third of the elkhorn colonies surveyed had snails feeding on them, with an average of four snails per affected colony. Yet, coral-eating snails accounted for about 25% of all tissue loss recorded in the survey. Thus, a relatively small number of snails were capable of causing substantial tissue loss. Scientists observed that snails often feed on a colony until it is dead or nearly dead. Studies have also shown that as coral colonies die, snails will move to nearby "healthier" colonies to find food. In turn, the remaining corals succumb to the higher densities of snails feeding on them. Physically removing snails from corals might reduce live tissue loss, which could promote colony survival. Because snails are also a known carrier of coral disease, their removal might indirectly reduce the rate of live tissue loss to "white" disease. Continued research into the factors that compromise recovery in elkhorn corals is underway. More information about the impact of snail removal is needed before this is deemed an effective and appropriate management response.

Restoration Efforts Using Coral Fragments are Underway

While the issues facing elkhorn and staghorn coral recovery are complex, the capacity for these species to asexually reproduce through fragmentation and their fast growth rates make them good candidates for coral restoration. Coral restoration has been underway in the Florida Keys since local marine life expert Ken Nedimyer started the first offshore coral nursery in 2000. Nedimyer is a long-time sanctuary advisory council member who has worked closely with sanctuary staff and volunteers on this project. Since 2003, more than 1700 staghorn coral fragments grown at the Coral Restoration Foundation nursery have been transplanted to 20 restoration sites where they have shown high survival and growth rates. The foundation has also been growing elkhorn coral for future restoration projects.

In 2009, the Coral Restoration Foundation became one of several nursery partners participating in a regional restoration project coordinated by The Nature Conservancy and supported by NOAA using American Reinvestment and Recovery Act (ARRA) funds. The project seeks to restore reef areas that once supported large thickets of acroporid corals by out-planting 5,000 nursery-reared staghorn corals throughout south Florida and the U.S. Virgin Islands. Out-planted corals are being grown from at least 144 genetically distinct colonies. The seeding of different genotypes helps ensure genetic diversity and sustainability in the growing population. Increased coral density can improve the chances for successful fertilization during spawning, as well as improve retention and growth of fragmented corals.

Scientists from NOAA and partner agencies are continuing to evaluate potential actions to enhance coral recovery, carefully monitor coral population dynamics and investigate the causes of coral disease. For more information on the status of elkhorn and staghorn corals, visit http://www.sefsc.noaa.gov/species/corals/acropora.htm.

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