

Effects of Hurricane Hugo on a Coral Reef in St. John

By Caroline Rogers

In 1988, the National Park Service initiated a long-term coral reef assessment program for Virgin Islands NP. A primary objective was to establish permanent long-term sites on coral reefs around the island. In January 1989, we established five 20 m transects on the coral reef that fringes Yawzi Point, the point which separates Little and Great Lameshur Bays. This reef slopes to a depth of about 14 m where it ends in a well-defined sand channel which separates the base of the reef from a seagrass bed. We selected the Lameshur Bays for long-term study sites because they are in the core of the biosphere reserve and relatively undisturbed by human activities.

The permanent transects lie along the 12 m depth contour. Twenty-three hard coral species occur in the transects, with an additional 10 species observed elsewhere on the reef. We surveyed the transects in January, June/July, and November 1989 (following Hurricane Hugo); March, August, and November/December 1990; and in June 1991 (see Rogers et al. in press, for details).

Changes in Coral Reef Structure After Hugo

During Hurricane Hugo, powerful storm seas fragmented and overturned coral colonies. Waves hurled fragments or entire colonies of coral into other colonies leaving visible impact scars. Coral rubble collected in large piles in sand channels and other depressions in the reef. Damage was patchy, with some portions of the reef exhibiting more destruction than others. This patchiness, noted in other studies of storm damage, reflects differences in reef depth and structure, as well as the differing susceptibility of reef organisms to physical damage (Woodley et al. 1981).

At some sites around St. John, the storm surge transported loads of sediment and buried coral and gorgonian colonies. Off Yawzi Point, however, we did not observe smothering by sediments. Water quality was poor due to turbidity associated with rainfall during and after the storm and suspension of reef sediments. However, the turbid conditions probably did not last long enough to have serious deleterious effects on the reef organisms.

The following are some of our key findings at the Yawzi Point site since Hurricane Hugo:

- **Living coral cover:** In the November 1989 survey, the living coral cover showed a significant decrease, from about 20 percent to about 12 percent, a drop of about 40 percent (Fig. 1). Coral cover has not increased significantly in subsequent surveys, although there has been some healing of coral scars.

- **Diversity:** The dominant coral species, star coral (*Montastrea annularis*), has shown a statistically significant decline but remains the most abundant species. Neither the diversity (H') nor the evenness (J') of the survey transects increased as a result of the storm.

- **Substrate:** The amount of substrate available for colonization (pavement and dead coral) increased significantly following the storm.

- **Topographical relief:** Although one would expect a decrease in topographical complexity after a major storm, especially on reefs dominated by branching species such as *Acropora palmata*, we did not observe any decrease at the Yawzi Point site. Topographical relief could actually increase after a storm if coral fragments and colonies were transported into the

transects or if colonies in the transects split into several fragments.

- **Algal cover:** Macroscopic algal cover increased dramatically immediately after the storm and then fell to pre-storm levels by March 1990. Algal cover had risen again by the November 1990 survey and remained high in June 1991.

Changes in Algal Cover

The dramatic shifts in algal cover observed after Hurricane Hugo are probably the result of a combination of factors. Monitoring of fish populations indicates a decline in herbivorous fishes around Yawzi Point after the storm, reducing grazing pressure on reef algae (Beets and Friedlander 1990). By March 1990, when macroscopic algal cover had declined in the transects, parrotfishes and surgeonfishes had significantly increased (Beets and Friedlander 1990). Macroscopic algal cover may also have declined because algae were dislodged by strong currents or wave action.

We do not know if grazing pressure in the Lameshur Bays has been reduced because of overfishing, a decrease in fishes at the site as a result of Hugo, or a decrease in the number of the herbivorous black sea urchins *Diadema antillarum* during the Caribbean-wide epidemic (D. Levitan pers. comm.). These urchins are presently not abundant at the study site.

Coral Reef Recovery

Recovery of hard coral populations takes place through 1) settlement, survival, and growth of sexually produced coral recruits; 2) healing and regeneration of damaged colonies; and 3) growth of coral fragments (e.g., Connell 1973, 1976, 1978, Endean 1976, Loya 1976, Highsmith et al. 1980, Pearson 1981, Highsmith 1982). The rate of recovery will be affected by factors such as the morphological and life-history characteristics of the dominant species, the nature of the damage sustained by that species, changes in algal cover, and the occurrence of additional storms.

In 1980, Hurricane Allen devastated the Discovery Bay reef in Jamaica causing the greatest mortality

among the most abundant branching species, *Acropora palmata* and *Acropora cervicornis* (e.g., Porter et al. 1981, Woodley et al. 1981, Knowlton et al. 1990). Because *Montastrea annularis*, a slow-growing species with low rates of recruitment (Bak and Engel 1979) is the dominant coral at our study site off Yawzi Point, recovery will probably be comparatively slow. As a result of Hurricane Hugo, live cover by *M. annularis*, decreased by about 35 percent at Yawzi Point, and 34 percent at a nearby reef (Edmunds and Witman, in press). The new substrate created by the storm may provide additional settling surfaces for other hard coral species such as *Agaricia agaricites* and *Porites porites* which have relatively high rates of recruitment (Bak and Engel 1979). However, colonization, survival, and growth of coral recruits will only occur in the absence of intense competition from algae.

Human activities before and after storms can influence not only the speed but also the nature of recovery. For example, extreme overfishing in Jamaica has reduced the populations of herbivorous fishes, resulting in algal smothering of small corals and algal encroachment on the periphery of larger colonies (Woodley 1989). Algal biomass has also increased because of mortality of the sea urchin *Diadema antillarum* (Hughes et al. 1987). Hughes et al. (1987) observed dramatic declines in coral cover (up to 60%) because of competition with algae.

Recovery will be delayed by natural processes such as additional storms, intense predation, algal overgrowth, and coral diseases. Populations of the once-dominant reef-building coral *Acropora cervicornis* have failed to recover at the Discovery Bay reef after destruction by Hurricane Allen in 1980 in spite of this species's fast growth rate, because of a combination of factors, including predation and algal growth (Knowlton et al. 1990, Hughes et al. 1987). Hurricane Gilbert smashed the Discovery Bay coral reef 8 years after Hurricane Allen.

Even in the absence of major additional storms,

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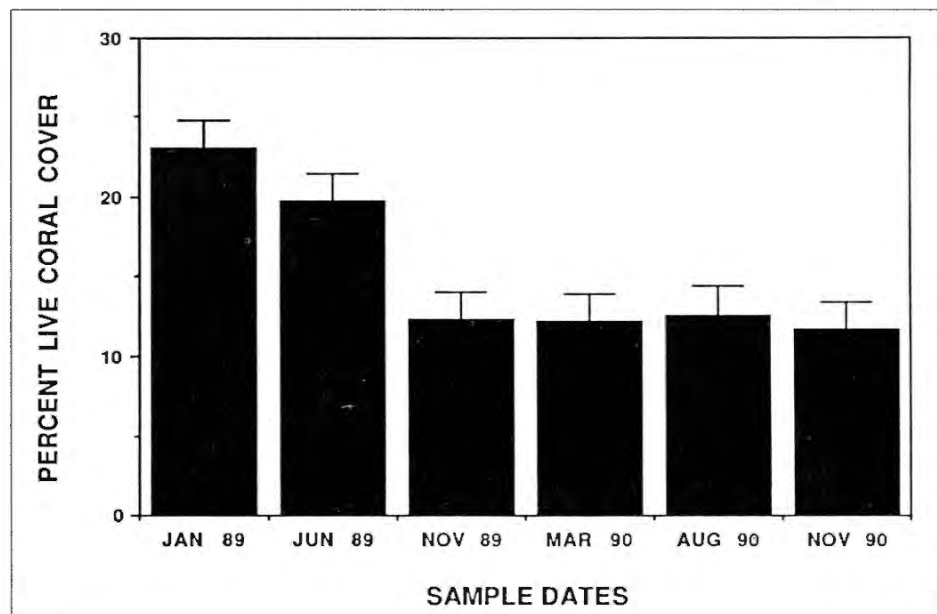


Figure 1.

recovery will be delayed and additional damage may occur if loose coral fragments, detached boulders, and rubble are tossed around in strong currents. In cases where the actual framework of the reef structure has been altered, re-establishment of the pre-disturbance topography may never occur.

Future Plans

We plan to continue monitoring of the Yawzi Point study site, and an additional site which we established at Newfound Bay, off the east shore of St. John. Here, one 100 m long transect was installed at a depth of about 10 m. This transect was surveyed in August 1990 and March 1991. In 1991, Dr. Bill Gladfelter conducted quantitative surveys of gorgonians and sponges along the Yawzi Point and Newfound Bay transects to augment the data we have obtained on hard corals.

Current programs establishing long-term monitoring of coral reefs should start to enable scientists to differentiate long-term fluctuations on the reefs from responses to anthropogenic and natural disturbances (Brown and Howard 1985). As Hatcher et al. (1989) point out, "the non-equilibrium nature of coral reef communities makes it difficult to determine "standard" reef conditions against which to evaluate impacts". Major progress in understanding recovery processes will require more information not only on hard coral populations but also on gorgonians, anemones, sponges, fishes and the other organisms which contribute to the spectacular diversity of coral reef systems.

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