

**HURRICANES AND ANCHORS: PRELIMINARY RESULTS FROM
THE NATIONAL PARK SERVICE REGIONAL
REEF ASSESSMENT PROGRAM**

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ABSTRACT

The U.S. National Park Service (NPS) began a Regional Assessment Program for coral reefs in the U.S. Virgin Islands and Florida in 1988. Scientists from NPS and six other institutions have now established long-term monitoring sites at Virgin Islands National Park (St. John, USVI), Buck Island Reef National Monument (St. Croix, USVI), Biscayne National Park (Florida) and Fort Jefferson National Monument (Florida). Hurricane Hugo passed through the USVI in 1989, causing severe destruction in some reef areas while leaving others untouched. Patchy damage to reefs in Florida was also noted after Hurricane Andrew; damage from this August 1992 storm is still being assessed. Fort Jefferson National Monument escaped the onslaught of Andrew. No significant recovery in live coral cover has been evident at the Buck Island or Virgin Islands National Park (VINP) study sites 3.5 years after Hurricane Hugo. Similarly, no recovery was evident at another site in St. John which was destroyed by a large anchor 4.5 years ago.

INTRODUCTION

In 1988, the U.S. National Park Service (NPS) began a Regional Assessment Program for coral reefs in the U.S. Virgin Islands and Florida. The goal of this ongoing program is to establish effective long-term research and monitoring programs at each of these four sites: Virgin Islands National Park (St. John, USVI), Buck Island Reef National Monument (St. Croix, USVI), Fort Jefferson National Monument (Florida, now Dry Tortugas National Park), and Biscayne National Park (Florida). The objectives of the program include: 1) development and evaluation of standardized methods for assessment of trends on coral reefs and preparation of a Coral Reef Monitoring Manual; 2) collection of environmental data; and 3) collection of baseline data and determination of rates of change in abundance of reef organisms. Scientists from NPS and six other institutions have participated in this program: the Principal Investigators are James Beets, James Bohnsack, John Bythell, Peter Edmunds, Virginia Garrison, Elizabeth Gladfelter, William Gladfelter, Dennis Hubbard, Walter Jaap, Joseph Kimmel, James Porter, Caroline Rogers, Jennifer Wheaton, and Jon Witman. Some of the research from this program was presented at the 7th International Coral Reef Symposium in June 1992, and several reports and publications are already available (e.g., Edmunds and Witman, 1991; Hubbard et al., 1991; Rogers et al., 1991; Porter and Meier, 1992; Rogers 1992).

During the course of this program, two major storms have affected the study reefs. Hurricane Hugo passed over the USVI sites in September 1989 causing severe destruction in some areas.

The effects of Hurricane Andrew (August 1992) on reefs in Florida are still being assessed.

This case history briefly highlights some of the overall findings of the Regional Assessment Program while focussing on work done by NPS scientists to quantify the effects of Hurricane Hugo on the long-term monitoring site established in Virgin Islands National Park. Recovery at this site since the storm is compared to recovery at another reef in the park which suffered severe damage from a large anchor. The emphasis is on the effects these stresses have had on hard coral cover with limited data on sponges and gorgonians.

RESULTS AND DISCUSSION

Anchor Damage: Virgin Islands National Park

Many of the approximately 1 million people who visit Virgin Islands National Park (VINP) each year arrive by boat. An increase in the number of boats visiting the park has resulted in increased damage from anchors. In October 1988, a 440' ship dropped its anchor on a coral reef within the park, creating a scar 122 m long and 3 m wide, and smashing about 283 square meters of the reef. This reef slopes gradually from a depth of 6 m (20') to 12 m (40') and then steeply drops off to 22 m (71') where it ends abruptly in a sand bottom. The shallower portion of this reef is a gorgonian-dominated pavement while in deeper water, especially on the steep slope, several species of hard corals occur. Damage was estimated in Nov./Dec. 1988 using 1 m square quadrats placed inside and outside the scar. The assumption was that areas adjacent to the scar were representative of the area destroyed by the anchor. Total live cover (excluding algae) was 25.8% outside the scar and 1.3% inside. The percent of live coral cover within quadrats outside the scar ranged from 0 to 79.5% (mean 21.9%, $n = 8$). Within the scar, percent live cover ranged from only 0.7 to 2.0% (mean 1.2 %, $n = 3$).

In April 1991, 2.5 years after the anchor destruction occurred, nine permanent quadrats were established inside the scar at depths from 9 m (30') to 12 m (40') deep. These quadrats were surveyed in April 1991, June 1992, and December 1992. No substantial recovery in terms of total live cover (excluding algae) or cover by hard corals, sponges and gorgonians is evident (ANOVA, $p < 0.05$). Mean hard coral cover is only about 2% (Table 1). Note that some of the live cover within these permanent quadrats is from organisms which escaped damage by the anchor, not newly settled recruits.

Assessment of changes at NPS sites in the USVI and Florida

Permanent long-term monitoring sites have now been established at each of the four NPS sites in the U.S.V.I. and Florida. A brief description of the results of research conducted at these sites follows (see also Rogers et al., 1991, Bythell et al., 1992; Bythell et al., 1992).

Table 1. Percent cover of hard corals, sponges, and gorgonians and total live cover at anchor damage site (mean +/- SD)

	APRIL 1991	JUNE 1992	DECEMBER 1992
HARD CORALS	0.95 +/- 0.93	1.71 +/- 1.30	2.07 +/- 1.56
SPONGES	0.67 +/- 0.48	2.84 +/- 1.38	1.30 +/- 0.94
GORGONIANS	2.34 +/- 2.32	5.43 +/- 5.80	2.75 +/- 4.65
TOTAL LIVE COVER	4.00 +/- 3.20	10.08 +/- 6.6	6.27 +/- 6.49

Virgin Islands National Park.- In January 1989, five 20 m long transects were installed at a depth of about 12 m off Yawzi Point in Lameshur Bay, St. John. Hurricane Hugo passed over the Virgin Islands eight months later, in September 1989. Total live coral cover along study transects decreased significantly as a result of this major storm, dropping from about 21% to 12% (a change of 40%) (Rogers et al., 1991). Cover by the dominant species Montastrea annularis decreased as a result of Hurricane Hugo (Sept. 1989) from about 8% to about 5% (a 35% change), but it remained the most abundant coral at the study site, and neither diversity (H') nor evenness increased. The permanent transects have been surveyed eight times since Hurricane Hugo, most recently in March 1993, and no detectable increase in total live coral cover or cover by Montastrea annularis is evident (Figure 1).

Cover by sponges along permanent transects averaged 2.3% (range 0.5 to 5.9%) before Hugo, decreasing to 0.7% after the storm (range 0 to 2.7). Cover by sponges has consistently increased reaching maximum average values of about 5% in November 1992 (higher than before the storm).

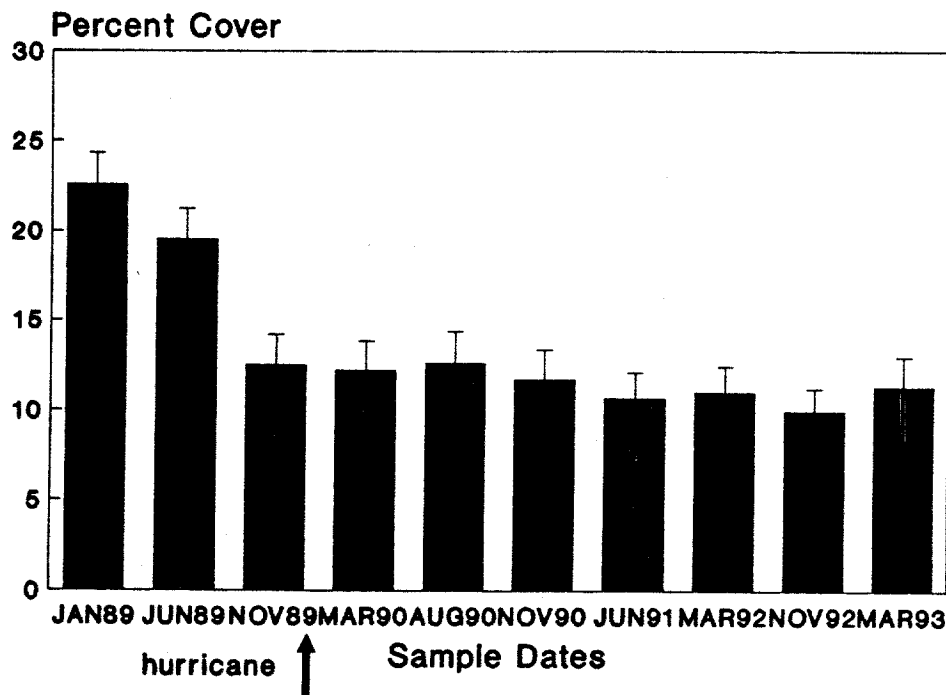
Gladfelter (1993) examined sponges and gorgonians in quadrats along the permanent transects at Yawzi in July 1991 and July 1992. He suggests that sponges are recovering somewhat faster than gorgonians, but points out that his data are not from permanent quadrats and should be interpreted cautiously. He found more gorgonian and sponge species, and more gorgonian colonies in 1992 than in 1991.

Buck Island Reef National Monument.- Hurricane Hugo devastated portions of the reef at Buck Island Reef National Monument but left other areas intact. The storm caused statistically significant decreases in percent total live coral cover at some permanent study sites but no significant changes in cover by the dominant species (Montastrea annularis, Porites porites). (Percent cover by P.

porites did drop substantially in 3 out of 4 transects at one site.) No significant recovery in the amount of hard coral cover along transects had taken place two years after Hugo (Bythell and Bythell, 1992). Populations of Acropora palmata which appeared to be recovering slowly from white band disease were decimated by the storm, and cover fell from 5% to 0.8% (Gladfelter 1992). Resurveys of permanent transects indicate that total live coral cover has not increased substantially as of February 1993 but that significant recruitment of Diploria strigosa, Porites spp., and Agaricia spp. has occurred in some very shallow areas (pers. comm., J. Bythell, E. Gladfelter).

Biscayne National Park.- Porter and Meier (1991) reported on changes from 1989 - 1991 at two shallow "photostations" within Biscayne National Park. Ball Buoy Reef exhibited an increase in projected surface area (primarily Acropora palmata) of 30.2%. However, transects through this same area indicated no net loss or gain of this species because of loss of living tissue on understory branches. At Triumph Reef, a decrease of 7.5% in projected surface area of live coral was observed. Hurricane Andrew caused damage within the photostation at Triumph Reef but not the one at Ball Buoy Reef (pers. comm., J. Porter).

Figure 1. Percent live coral cover at Yawzi Point, St. John.



Fort Jefferson National Monument.— Extensive research at Fort Jefferson National Monument has indicated an overall stability in abundance of octocorals and hard corals at this site as estimated from several methods (Jaap et al., 1992). For example, k-dominance curves indicate no shifts in coral species diversity. This site escaped the onslaught of Hurricane Andrew and is relatively free from many of the stresses which affect Biscayne National Park. It is a critical comparative site for long-term monitoring.

CONCLUSIONS

Even extremely powerful storms such as Hurricane Hugo and Hurricane Andrew can leave some reef areas intact. Where significant losses of coral occur, recovery may be slow. Within Virgin Islands National Park, no significant recovery is apparent at the long-term study site in Lameshur Bay 3.5 years after Hurricane Hugo or at a reef damaged by a large anchor 4.5 years ago. The reefs within this park are protected from many of the stresses causing degradation of other reefs in the Caribbean, and the recovery rates reported here probably reflect natural rates following physical disturbances. None of the scientists in the Reef Assessment Program have reported significant recruitment of hard coral colonies at any of the long-term study sites. Values for mean percent coral cover at these sites in Florida and the USVI in the beginning of the program were comparable to those for many other reefs in the Caribbean and ranged from < 5% at one site in Biscayne National Park to a maximum of 40% at one zone in Buck Island. Live coral cover is now lower at three of the four long-term study sites because of damage from Hurricane Hugo and Hurricane Andrew.

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