Using Global Positioning Systems to Monitor Elkhorn Coral, *Acropora palmata*, at Buck Island Reef National Monument, U.S. Virgin Islands

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Introduction

Elkhorn coral, *Acropora palmata*, is a major reef-building species that is found mostly in water depths of less than 10 m. Up to the 1970s, elkhorn coral was the dominant coral in wave-exposed and high-surge reef zones throughout the Caribbean (Adey 1978; Gladfelter et al. 1977). In 1973, white band disease was recorded for the first time at Buck Island Reef National Monument (Robinson 1973). This disease affected Acroporids throughout the Caribbean, and within two decades killed over 80% of the elkhorn coral at the park. Hurricanes, such as Hurricane Hugo in 1989 and Marilyn in 1995, further damaged those reefs (Bythell et al. 2000; Hubbard et al. 1991; Rogers 1992). The wide-scale decline of elkhorn coral led to its being added in 1999 to the candidate species list of the Endangered Species Act.

Some areas in the park have experienced elkhorn coral recruitment and growth within the last decade. The growth rate of elkhorn coral can reach 10 cm/year, and the species is one of the fastest-growing among stony corals (Gladfelter et al. 1978). However, problems have occurred when applying conventional coral-monitoring methods to this species. The chain transect method may result in the accidental breakage of some of the fragile branches, especially in high-surge zones, while two-dimensional quadrant methods may poorly quantify its complex three-dimensional structure.

The objectives of this study were to (1) develop a non-invasive method to monitor distribution, abundance, and size of elkhorn coral within large areas of linear reef, and (2) collect baseline information for damage assessment after hurricanes, disease outbreaks, and ship groundings.

Methods

Buck Island Reef National Monument (N 17°47'/ W 64°37') encompasses a 176-acre island and 18,839 acres of submerged lands. Buck Island is located 1.5 miles to the northeast of St. Croix, U.S. Virgin Islands. The eastern part of the island is surrounded by a barrier reef system with a protected lagoon and a wave-exposed fore-reef. Our study area was an 18.4-acre section of this fore-reef, where large elkhorn thickets previously dominated.

We defined the elkhorn colony size as its maximal dimension and grouped the colonies into size classes: small, measuring 1–49 cm; medium, 50–99 cm; large, 100–199 cm; extra-large, 200–399 cm, and so forth. Two researchers using snorkels recorded the location of every colony using handheld global positioning system (GPS) units that were put into waterproof bags. One GPS was designated for each size class. We used 1-m PVC (polyvinylchloride plastic) poles demarcated at 0.5-m increments to verify colony sizes. A pilot study determined that, for small colonies, the surveyor error was greater than 25%; thus, we did not survey them. A section of the reef was surveyed repeatedly to calculate errors of the remaining size classes.

We downloaded the location of every colony and time of data collection to a computer and then differentially corrected the locations. The corrected locations were then plotted on a georectified aerial photo provided by the National Oceanic and Atmospheric Administration (NOAA) Biogeography Program using the GIS (geographic information system) software ArcView 3.2a. We used ArcView's spatial analyst extension to calculate elkhorn density. The density was defined as the number of elkhorn colonies within a 100-m^2 circle.

Results

Surveyor error for the medium, large, and extra-large classes were 3%, 2%, and <1%, respectively. Two researchers using snorkels surveyed, on average, 1 acre/hour. We recorded 1,808 elkhorn colonies greater than 50 cm. Of those, 57% were medium, 39% large, and 4% extra-large. Maximal density was 61–70 colonies per 100 m^2. Thirty-four percent of the study area had no colonies, 56% had a density of 1–10 colonies/100 m^2, 8% a density of 11–20 colonies/100 m^2, and 2% a density greater than 21 colonies/100 m^2.

Discussion

Elkhorn coral distribution, abundance, and size may change rapidly compared with other hard corals due to its fast growth rate and the ability to establish new colonies from broken fragments. However, conventional coral-monitoring protocols have proven difficult for this fragile, branching, shallow-water species. This new method provides a noninvasive and rapid way to monitor large areas of linear reef with relatively small surveyor error (<5%). It thus can detect a 5% change in the number of colonies within a study area or even within sections of a study area. Changes in the number of colonies will also be reflected in density changes. Furthermore, changes in the amount of area with no colonies are a sign of recruitment or mortality. A further benefit is the ability to detect shifts in the size class distribution that can occur if diseases or hurricanes are selective for certain size classes. This method is ideal for linear reefs, where the data collectors can orient themselves and avoid double-marking of colonies. However, this method can be modified; for example, by laying out reference lines prior to data collection. In the future, this method may even be possible using Scuba.

At the park, data collection by this method will be done on an annual basis. Additional surveys will be conducted after hurricanes, disease outbreaks, and ship groundings. Supplemented by data gathered from long-term monitoring sites, recruitment sites, and random survey plots on non-linear reefs, these data will provide the basis for future population trend-analysis.

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