Diver Impacts on coral reefs at Kealakekua Bay, Hawai'i



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Introduction

Coral reefs are diverse and productive biological communities and important natural resources in tropical areas. However, reefs in many parts of the world are currently being threatened with a wide variety of anthropogenic disturbances (Richmond, 1993). In the state of Hawai'i, coral reef resources are worth over $100 billion and are being degraded by overfishing, sediment runoff, nutrient pollution, and impacts from tourism (Clark and Gulko, 1999). On the island of Hawai'i, tourism along the west coast of the island is focused largely on nearshore activities, especially sunbathing, beachcombing, snorkeling and diving. In a typical year thousands of visitors swim, snorkel and dive over the reefs to observe corals, other invertebrates and colorful fishes. As the number of visitors has increased in recent years there has been an increasing concern about potential impacts to coral reef ecosystems. In particular, observations of swimmers, snorkelers and divers standing and sitting on the coral are common as are instances of divers fins' breaking coral. Increasing occurrences of both bleached and broken coral in areas frequently visited by divers raised concern by the Hawai'i Division of Aquatic Resources that prompted the initiation of this study.

The goal of this study was to estimate the extent of damage due to divers using the incidence of bleached and broken coral at a popular tourist site, Kealakekua Bay, in

west Hawai'i. The study compared the incidence of bleached and broken coral in an area of high diver activity to those in an adjacent low diver activity area. This study thus assumes that the two study areas were similar prior to the beginning of the study and had similar natural rates of bleaching and coral damage during the study period. These assumptions were tested during the course of the study.

Materials and Methods

The study was conducted in 1996-1997 at Kealakekua Bay. Four 50m transects were established at 3-6 m depths: two in areas of high diver activity, the impact site (directly in front of the Capt. Cook Monument and in the area where the diver boat moor) and two in areas of low to no diver activity, the control site located about 1km south of the impact site (Figures 1 & 2).

Figure 1. Location of impact transects.

Figure 2. Location of control transects.

Data were collected using photographs taken with a Nikonos V camera with a 15mm lens attached to a PVC quadrat covering an 0.50m2 area (Figure 3). On each transect 18 photographs were taken at randomly selected coordinators along the

transect lines at all study sites both at the beginning and end of the study (Figure 4). Percent cover estimates were made of all living and non-living substratum in each photograph by projecting the slide over a series of 50 random coordinates and recording the observed substratum under each point. In addition, the percent cover of bleached and broken coral was estimated for each slide. Bleached coral was noted as unusually pale portions of the coral colony, typically located at the tips or edges of coral colonies. Broken coral was identified as recently damaged coral fragments. A single observer was used to analyze all of the photographic data in order to minimize observer bias.

Figure 3. Diver using photoquadrat to. collect reef images.

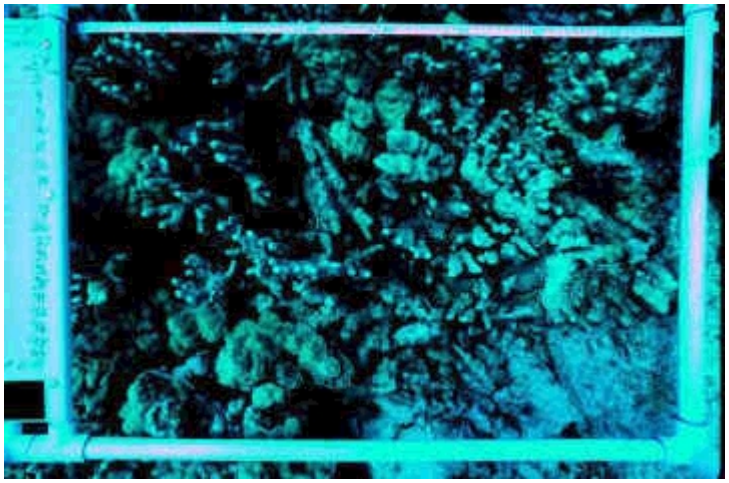

Figure 4. Example of photoquadrat image

Results

Test of assumptions

A comparison of overall substratum composition between the two sites can be used to test the assumption that control and impact sites are similar. In figure 5 the percent composition of both living coral (green) and non-living bottom types (blue) are shown for comparison at both sites. Both areas were characterized by a predominance of lobe coral (*Porites lobata*), and a mixture of coral rubble, coral boulders, and patches of coralline algae. At the impact site finger coral (*Porites compressa*), false brain coral (*Pavona varians*), and ridge coral (*Pavona duerdeni*) was more common than at the control site.

Overall the percent similarity between sites is 89%, indicating high similarity in the substratum composition at both sites. These results verify that sites are very similar and thus the major differences between them can likely be attributed to the human use differences (more divers at the impact site).

Changes in coral abundance

Both sites had similar mean percent live coral cover with the impact site at 54% and the control at 52% (figure 6). Between the one year survey period, the percent cover declined at both sites. Although the decline was greater at the impact site (5.3%) relative to the control site (1.9%), neither of these declines were statistical significant ($P < 0.05$).

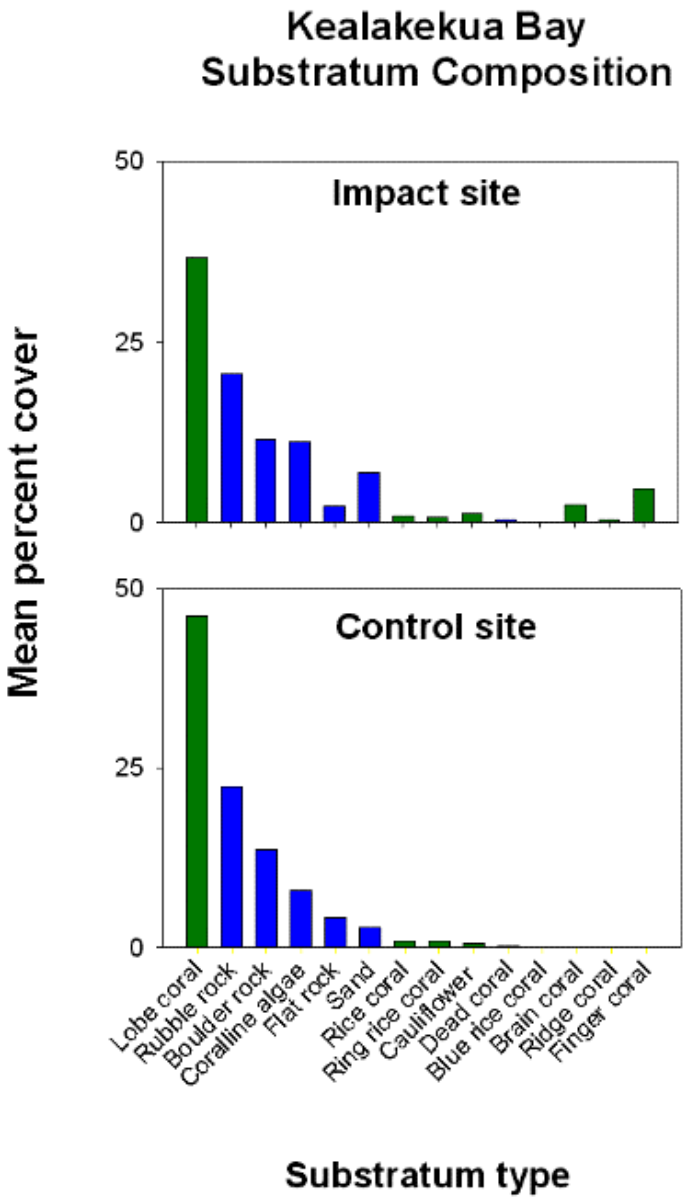

Figure 5. Comparison of substratum types at control and impact sites.

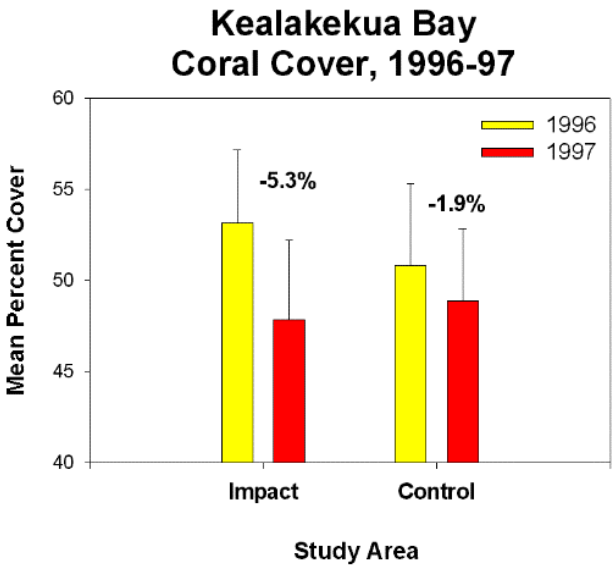

Figure 6. Change in live coral cover after a one year interval at control and impact sites.

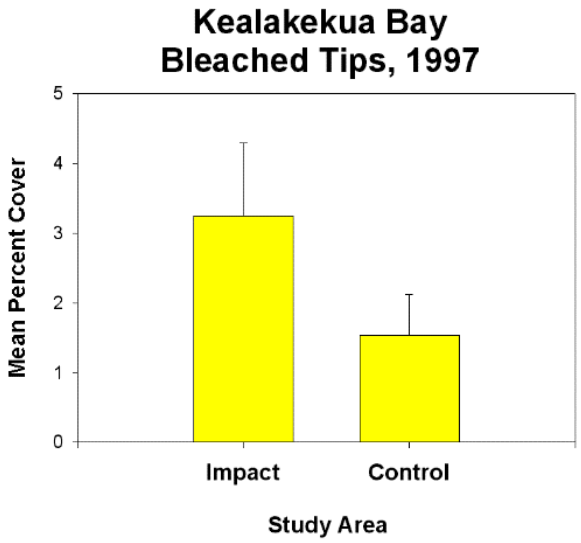

Figure 7. Percent bleached coral tips at control and impact sites in 1997.

Bleached coral

The percent cover of bleached coral tips at sites in 1997 was higher at the impact (3.1%) site relative to the control (1.8%). However, these differences were not statistically significant (two-sample t-test, P< 0.05).

Broken coral

The percent cover of freshly broken coral at sites in 1997 was higher at the impact (7%) site relative to the control (3%). However, these differences were not statistically significant (two-sample t-test, P< 0.05).

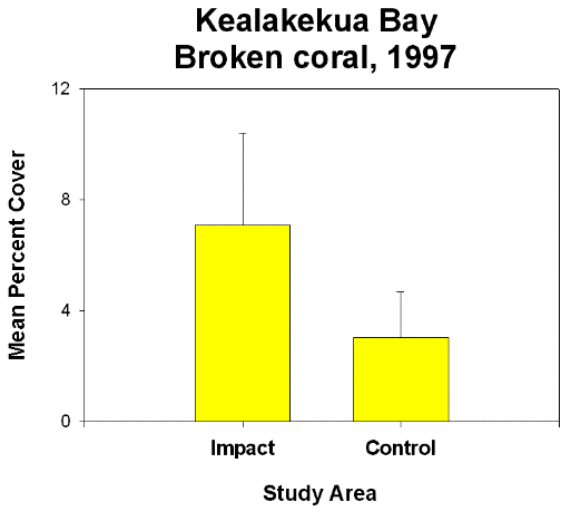

Figure 8. Percent broken coral at control and impact sites in 1997.

Discussion

Both control and impact sites had similar substratum composition and hence met the assumption of the method that they were similar prior to the study. Therefore, assuming that natural processes which cause bleached and broken coral occurred at similar frequencies at both sites, any differences in these parameters is likely to be associated with the major difference between these sites: the frequency of human use by swimmers, snorkelers and divers. Kealakekua Bay, being one of the most popular dive tour destinations in Kona, receives at least 50-200 visitors a day (personal observations). Additional visitors may hike or drive down the trail to the Cook Monument or swim, sail or kayak over from Napo'opo'o across the bay. In contrast, swimmers are rarely seen at the control site.

The results of this study found no significant differences between impact and control sites in changes in coral cover, or the incidence of bleached and broken coral. Therefore, there is no statistical support for the premise that divers at Kealakekua Bay are causing damage to the reef. However, in all cases the decline in coral cover and the incidence of bleached and broken coral was higher at the impact relative to the control site. Thus, these data suggest that divers may be having an impact to the reef but over a one year period these changes are too small to distinguish from natural changes in coral abundance, bleaching and breakage. Thus, the principle results of this study strongly support the conclusion that a longer study be initiated to further investigate this possibility. Given the importance of reefs in Hawai'i and the increasing pressures being applied by swimmers, snorkelers and divers, further study is warranted.

Acknowledgements

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References

Clark, A. M. and D. Gulko. 1999. Hawai'i's State of the Reefs Report, 1998. Department of Land and Natural Resources, Honolulu, HI. 41pp.

Grigg, R. W. 1997. Hawaii's coral reefs: status and health in 1997, the International Year of the Reef. In: Status of Coral reefs in the Pacific. R. W. Grigg and C. Birkeland, eds. University of Hawaii Sea Grant College Program. Honolulu, HI. Pp. 59-72.

Richmond, R. H. 1993. Coral reefs: present problems and future concerns resulting from anthropogenic disturbance. Amer. Zool. 33: 524-536.