Assessing Coral Reef Health and Herbivore Biomass on Patch Reefs in South Eleuthera as a Function of Mangrove Proximity

Ben VanderWeide, Brad Driscoll, Caroline Muggia, Cole Vanacore, Michael Banks, and Sarah Haselton

Advisors: Kristal Ambrose and Maria White

Introduction

Scientists once viewed coral reefs as indestructible ecosystems. However, since the late 1970's reefs in the Caribbean have seen an 80% decline in coral cover (Hance 2009). This phase shift from coral covered reefs to algal covered reefs (Figure 1) occurred when the long-spined sea urchin (Figure 2) a dominant grazer on patch reefs, suffered a mass mortality in 1983 (Mumby and Steneck 2008). Herbivores, or grazers, are vital to coral reef health because they feed on macroalgae that would otherwise compete with coral for sunlight and space. Parrotfish (Figure 3) are now the dominant grazers on reefs in the Caribbean (Mumby et al 2004).

Figure 1: Phase shift from a healthy, coral covered reef to an unhealthy, algal covered reef

Figure 2: Long-spined sea urchin (*Diadema antillarum*)

Figure 3: Queen Parrotfish

Patch reefs (Figure 4) are small, isolated coral reef outcrops, that are usually found 3-6 meters deep and contain a high diversity of marine organisms. These reefs act as transitional habitats for juvenile fish (Figure 5).

Figure 4: A patch reef

Mangroves are an important ecosystem as they serve as a nursery habitat, providing food and protection for juvenile fish. (Figure 5) Mangroves have been proven to enhance fish biomass on nearby patch reefs (Mumby *et al* 2004).

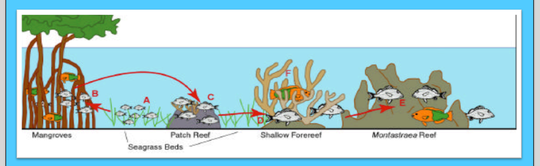

Figure 5: Diagram showing juvenile fish species transitioning from seagrass beds to mangrove ecosystems, and then to patch reefs.

Purpose

To determine if the distance from mangrove ecosystems to patch reefs play a pivotal role in coral reef health and herbivore biomass.

Hypotheses

- Reefs closer to mangroves will have a larger herbivore biomass, an increase in coral cover, and a decrease in algal cover.
- Reefs further from mangroves will have a larger predator biomass, a lower herbivore biomass, a decrease in coral cover, and an increase in algal cover.

Study Area

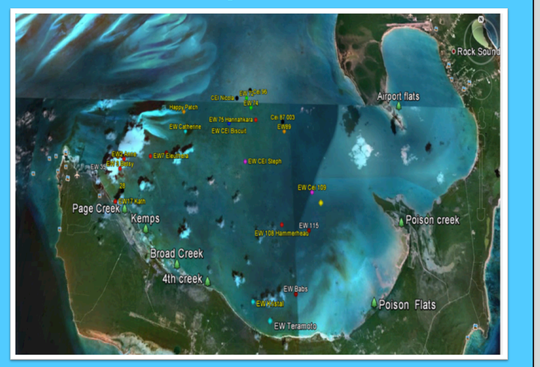

Figure 6: The tree symbols represent mangrove creeks, while colored dots represent the 25 patch reef sites selected for study.

Methods

Fish Surveys

Fish surveys were conducted by recording the size and abundance of all species.

Figure 7

Substrate Survey

A 5-meter long tape was laid on the reef. The substrate under each ½ meter was recorded.

Figure 8

Rugosity

To assess structural complexity, a meter long metal chain was laid across any section of the reef, and then measured for change in length.

Figure 9

Reef Measurements

These were recorded by measuring the length, perpendicular width, height and depth of each reef with .

Figure 10

Data Analysis

In the study area, there were seven mangrove creeks relatively close to the patch reefs surveyed. A specific calculation was used to determine absolute mangrove proximity. For each patch reef, the distance from the furthest mangrove creek was calculated. This number was then subtracted by the distance from the remaining six mangrove creeks, resulting in absolute mangrove proximity. The lower the absolute mangrove proximity, the further away from mangrove creeks the patch reefs were.

Biomass was calculated using a biomass calculator on Fishbase.org. Biomass was calculated by dividing the total weight of the fish on a patch reef by the area of that reef. The square area of any given patch reef was calculated using the physical measurements of the length and width of that reef. Biomass was measured in grams per meter squared. To determine the relationship or correlation in the data, a linear regression analysis was performed.

Results

From March 1st to May 30th 2013, 13 patch reefs were surveyed. On each graph, the x-axis represents absolute mangrove proximity. Each data point represents a patch reef, with the higher numbers representing patch reefs that are close to mangrove creeks and lower numbers further away from mangrove creeks (Figure 11-14).

Coral and Algal Abundance

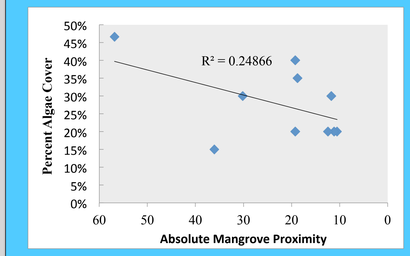

Figure 11: Percent algal cover in relation to absolute mangrove proximity

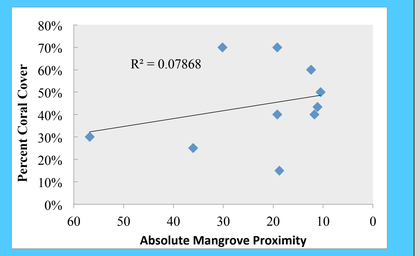

Figure 12: Percent coral cover in relation to absolute mangrove proximity

Figure 11 shows a negative relationship between algal cover and mangrove proximity (R^2=0.24866). The trend suggests that the further away from mangrove creeks that patch reef is, the less algae there was on the patch reef. Figure 12 shows a positive correlation in the data between coral cover and mangrove proximity (R^2=0.07868). The general trend in Figure 12 shows patch reefs closer to mangroves had less coral cover than the patch reefs that were further away from mangrove creeks.

Herbivore and Predator Biomass

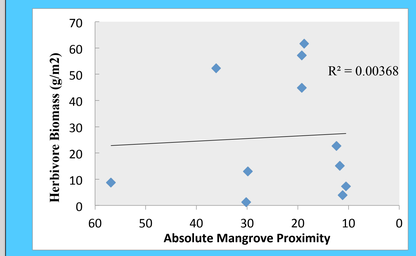

Figure 13: Herbivore biomass in relation to absolute mangrove proximity

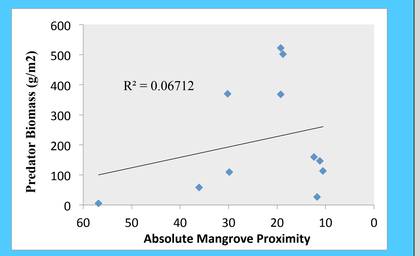

Figure 14: Predator biomass in relation to absolute mangrove proximity

Figure 13 shows no correlation in the data (R^2=0.00368). The trend shown is that mangrove proximity has no effect on herbivore biomass. Figure 14 shows a positive correlation in the data between predator biomass and absolute mangrove proximity (R^2=.06712). The trend displayed is that the patch reefs closer to the mangroves had a relatively smaller predator biomass than the patch reefs further away from the mangroves.

Discussion

Algae and Coral Abundance

From this brief study it was established that there was a negative relationship between algae and mangrove proximity, as on reefs further from mangrove creeks algae was less abundant. There was a positive relationship between coral and mangrove proximity, as reefs further from mangrove creeks showed an increase in coral cover. This result rejected the first hypothesis. These results could be attributed to nutrient flow from mangrove creeks, more data must be collected to test this hypothesis further.

Herbivore Biomass and Predator Biomass

The results showed that there was no correlation between herbivore biomass and mangrove proximity, while there proved to be a positive relationship between predator biomass and absolute mangrove proximity, as reefs further from mangrove creeks had an increase in predator biomass.

Conclusion

Patch reefs are an economical and ecological resource that many organisms heavily depend on. They provide food for humans, shelter for fish, and boost the local tourism economy (Danylchuk 2003). It is important to continue to monitor the health of these fragile ecosystems to ensure that the biodiversity on such reefs continues to thrive.

Future Research

Future research on the relationship between patch reefs and mangroves could include studying the effects of nutrient flow from mangrove creeks onto reefs , systematic study of reefs from individual creeks, and ecological assessments of mangrove creeks.

Acknowledgements

Thank you to the patch research advisors Kristal Ambrose and Maria White, Dr. Alastair Harborne and the Earthwatch Institute, Charlie Sandor, CJ Pelecanos, Jason Kincaid, Ron Knight, The Island School and Cape Eleuthera Institute for supporting the group's research.

Literature Cited

Danylchuk, J. A. 2003. Fisheries Management in South Eleuthera, Bahamas: Can a Marine Reserve Help Save the 'Holy Trinity'?. *Proceedings of the Gulf and Caribbean Fisheries Institute,* 56: 1-10.

Mumby, P. J., Dahlgren, C. P., Harborne, A. R., Kappel, C. V., Micheli, F., Brumbaugh, D. R., Holmes, K. E., Mendes, J. M., Broad, K., Sanchirico, J. N., Buch, K., Box, S., Stoffle, R. W., Gill, A. B. 2006. Fishing, trophic cascades, and the process of grazing on coral reefs. *Science,* 311: 98-101.

Mumby, P.J., Edwards, A.J., Arlas-Gonzalez, E.J., Lindeman, K.C., Blackwell, P.G., Gall, A., Gorczynska, M.I., Harborne, A.R., Pescod, C.L., Renken, H., Wabnitz Colette, C. C., Llewellyn, G. 2004. Mangroves enhance the biomass of coral reef fish communities in the Caribbean. *Nature,* 427: 533-536.

Mumby P. J., Steneck, R. S. 2008. Coral reef management and conservation in light of rapidly evolving ecological paradigms. *Trends in Ecology and Evolution,* 23: 555-563.