Our World Underwater Scholarship Society®
Darling Marine Center Coral Reef Ecology Internship
Summer 2005

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Abstract

Our World Underwater Scholarship Society® is an independent, nonprofit, tax-exempt organization that promotes "hands-on" educational scholarships and internships for talented, deserving young people. OWUSS® provides rewarding marine and fresh water educational opportunities for these individuals, to encourage positive, successful underwater career choices. OWUSS® organized the Darling Marine Coral Reef Ecology Internship for the summer of 2005. This internship included funding for the intern to travel to DMC in Maine, as well as Bonaire, the research study sight.

Introduction

The Darling Marine Center is studying coral settlement to learn more about which species settle first, where they settle, and which species have a higher percentage of long term survival. Through discovering more information about coral settlement, marine biologists hope to endorse increased coral growth and overall reef health.

In 1989, a significant coral bleaching event occurred in the Caribbean, meaning coral expelled their symbiotic zooxanthellae and therefore died. This ecological disruption occurred due to a massive fish kill in 1980, a 95% die-off of the sea urchin *Diadema* 1983-1984, increase in coral diseases, and pollution (Garrison, 2002). There may be other factors as well that have caused an extreme loss in percentage of live coral within the Caribbean. Where live coral once was, algae have quickly taken over the space, which is the basis of my internship with the Darling Marine Center.

Although the majority of the Caribbean has lost great amounts of live coral cover, Bonaire is an exception. Bonaire is an island of the Netherlands Antilles, located north of Venezuela. The reefs around Bonaire still look like much of the Caribbean did twenty years ago. Suzanne Arnold and Jeanne Brown, two dual masters students from DMC, chose Bonaire as a study site to find out more about why Bonaire's reefs have remained healthier than the rest of the Caribbean. Susie is investigating coral settlement, and

Jeanne is studying damselfish and algal relationships. Both individuals are working towards obtaining their marine biology and marine policy masters degrees from University of Maine's Darling Marine Center, in Walpole, Maine.

Discussion

In June, I visited the Darling Marine Center for orientation and helped prepare Susie for her trip to Belize later that month. I dusted and sun-dried 10 inch square terra cotta tiles, which were used as coral plates. Terra cotta is an excellent material for coral settlement. Each tile is drilled into dead sections of the reef, and baby corals settle on the underneath side of the coral plates (See Fig. 1).

I used a ballpoint pen to number the coral plates on each side. Numbers were coated with epoxy to prevent fouling and to insure legibility over time. Small dots were drawn on the topside of each tile to denote orientation. I also assembled coral plate hardware, which consisted of a metal bolt, two washers, a plastic spacer and anchor. The coral plates and hardware were placed on the reef in Belize in late June. Similar coral plates were placed in Bonaire last summer, and Susie has routinely visited Bonaire to document coral growth (See Fig. 2).

Jeanne, Susie and I typically dove three times a day in Bonaire (See Fig. 3). During the morning dive, we collected 4 metal rods of coral plates, with 10 coral plates on a rod. Each plate was unscrewed with a driver, being careful to keep hold of bolts, plastic spacers, washers, and anchors. A Bonaire Stinapa Marine Park dive tag was screwed in place of each plate with a corresponding number. Plates were placed on a metal rod with plastic spacers between them, being cautious not to disturb the underneath side of the plate where the baby corals are attached.

The metal rods were brought to shore in small plastic garbage cans full of seawater. Susie then spent hours sitting on the beach examining each plate under a microscope. She chose to keep plates at 10 meters (30-40 feet). She has numerous sites around Bonaire, totaling hundreds of coral plates (See Fig. 4).

Susie documented the growth and changes of coral spat from previous visits and she noted if any baby corals had been overgrown or were absent. She identified new coral species, their size, their location on the plate, and any other organisms present. This process took most of the day, and we frequently refreshed the seawater to keep the baby corals cool and healthy. On the second dive, I returned plates that Susie had finished examining. Surface intervals between dives were spent changing Mylar data sheets on our plastic forearm cylinders (See Fig. 5), and eating sandwiches and fruit we had brought from home.

I had a map of the dive tag numbers from the first dive on my forearm cylinder, to help me locate the belt of plates I was assigned to return. I matched each dive tag number with its corresponding plate, and repaired some of the corroded hardware as necessary. On the third dive, we returned the remaining plates to the reef and were out of the water before sunset each day.

I measured longfin and three spot damselfish territories for Jeanne's research (See Fig. 6). Damselfish are extremely territorial. They guard an area on the reef where turf algae grows, and aggressively chase away other fish that try to graze within their territory. Damselfish persistently continued to bite and nip at my hands and face, while I measured the size of their territory with a meter stick. They are fearless and amazingly effective. Parrotfish and surgeonfish even jet away from the strikes of damselfish that are one-tenth their size (See Fig. 7).

Since parrotfish and surgeonfish are primary grazers of turf algae (See Fig. 8). Jeanne is studying how effective damselfish are at gardening their territories. Can damselfish keep turf from overgrowing without the aid of large herbivorous fish? Their territories are so frequent in places that they almost overlap. It becomes difficult to determine the end of one territory and the beginning of the next.

I measured the turf algae from the center of damselfish territories in millimeters, and recorded turf height in three places, at each 10-centimeter section of a meter stick. I also had a transparent plastic ruler on the end of my meter stick, which was used to estimate damselfish size. Maximum vertical height up and down within the territory were also recorded.

In addition to turf measurement, I also surveyed the complexity of Bonaire's reefs. I used 4 one meter-long plastic piping pieces to make a square and laid this m^2 on the reef at designated areas. Each side was marked in 10cm sections along each meter. Jeanne laid out four 25 meter transect lines, and I surveyed the meter squared area at 5m, 15m, and 25m. Imagining 100 smaller squares within my plastic square to equal 100%, I recorded the percentage of live stony coral, invert, soft coral, rubble, sand, caverns (where fish can hide), and edible algae for grazing fish. I also measured the vertical height up and down within the square, the maximum vertical height, and noted whether or not a damselfish territory was present within the m^2 area.

A different method of examining reef complexity was also part of my responsibility. This method measured five 10 meter transect lines with a weighted rope. The transect lines were straight along the reef surface, and the weighted rope was used to measure exactly along each drop, curve, coral head, and change in elevation (See Fig. 9). In other words, the weighted line perfectly touched every centimeter within the straight transect line, whereas the transect line itself was in the water column just above the reef (See Fig. 10).

The weighted line was also 10 meters in length, yet I had total measurements of often 25 to 30 meters due to the complexity of the reef. The weighted rope was repeated when its length ran out, and understandably covered more area. I recorded the amount of centimeters within each transect that contained live coral, rubble, sand, macro algae and its height, turf algae and its height, coralline crust, encrusting organisms, invert, caverns, and maximum vertical drop (See Fig. 11).

Conclusion

Every reef organism competes with other reef organisms for space, protection, and food. Narrow niches within a coral reef ecosystem house few individuals of many different species (Garrison, 2002). There are countless intricate balances and relationships within a coral reef ecosystem due to the varied living organisms within a small area. This summer I helped investigate the relationship between algae and coral, algae and damselfish, and algae and reef health.

Baby corals first live within the water column and are chemically cued to find places to settle and grow on the reef. At this time, the decrease in live coral cover and increase in algal cover is believed to affect coral settlement. Baby corals cannot settle where algae is growing, and if they are able to settle in such a place, the algae will overgrow and kill the young coral before it has the chance to mature into adulthood.

This summer data was collected on the subjects previously described. At this time, the research has not been completed, analyzed or compared to other areas. Bonaire is believed to have healthier reefs because there are still significant amounts of large parrotfish and surgeonfish. Much of the Caribbean only has high numbers of medium predatory fish and this is one of many factors to consider. Large parrotfish continue to eat in damselfish territories and are less disturbed by damselfish aggression. However, it is important to remember that the sea urchin *Diadema* is a primary algae grazer, and the 95% loss of their population has greatly affected many other coral reef relationships including increased algal growth.

Reflection

My overall experience as the DMC summer 2005 intern was impressive, rewarding, and greatly inspiring. I am amazed at how much the experience changed me, and I feel extremely fortunate to have experienced such an exceptional opportunity (See

Fig. 12). The internship reminded me how much I miss the marine environment. For the past year outside of college, I have been hesitant to select a graduate degree program. I still feel that taking time off to wisely investigate the best type of marine program for me is important. There are so many things I do not know about underwater career possibilities. However, I have decided to apply for graduate school this fall, as a result of my internship experience. If I can dive and travel while working towards a general marine science masters, then I don't understand what I've been waiting for. I have faith that opportunities will continue to surface, if I just continue to advance myself in the things I love (See Fig. 13).

Appendix A

Fig. 1. A 10 inch coral plate. You can see the bolt on the top of the plate that holds the plate securely on the reef. The bolt was drilled into a dead piece of the reef.

Fig. 2. A 10 inch coral plate that has been fouled with turf algae. Baby corals settle on the underneath side of the plate. Many plates were fouled like this, yet other tiles did not have any algae on them. It was very interesting to see the reef take over plates. I often found brittle stars, fire worms, sponges, and all sorts of other reef organisms living on the plates.

Fig. 3. Jessica Straw (left) and Suzanne Arnold (Right) standing at English Gardens dive site. In Bonaire, we typically dove three times a day, in order to finish all of our research and have appropriate surface intervals between dives. Surface intervals between dives allow divers to off-gas residual nitrogen. This keeps dives at lower risk of getting Decompression Sickness, DCS, also known as the bends.

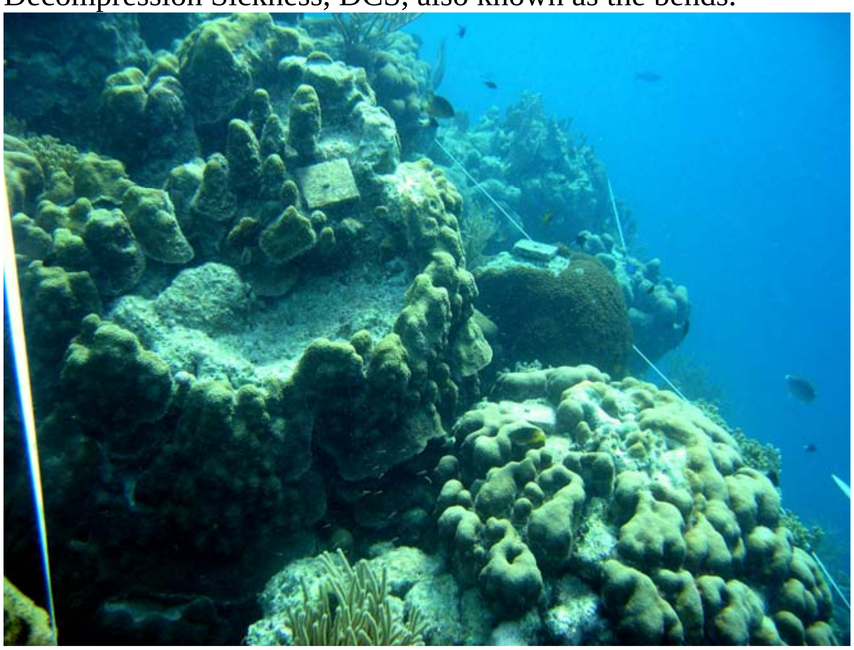

Fig. 4. Coral reef complexity in Bonaire was measured using 25m transect lines at 30-40ft (10m).

Fig. 5. Jessica writing on a wrist cylinder and surveying reef complexity. Writing cylinders were covered with Mylar sheets. They were used to record data and communicate between divers.

Fig. 6. Damselfish territories tend to have a concentrated amount of turf algae in the center. Turf measurements decreased from the center outward within damselfish territories. This photograph illustrates an ideal parrotfish or surgeonfish snack, if it were not so aggressively guarded by a damselfish.

Fig. 7. Spotlight parrotfish chopping on turf algae. This area is not within a damselfish territory. If the parrotfish were grazing within a damselfish territory, they would immediately be chased away.

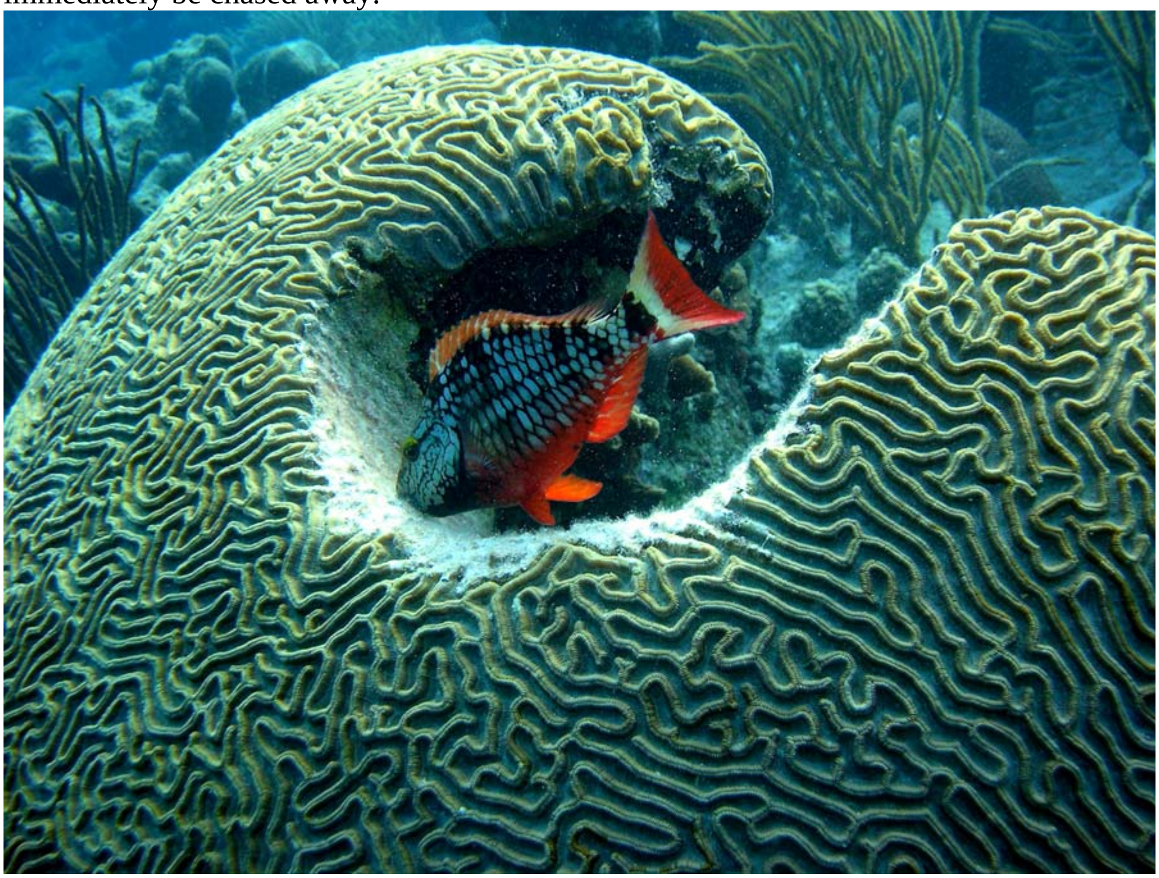

Fig. 8. Parrotfish eat turf algae off coral reefs. Grazing parrotfish and surgeonfish are crucial herbivorous contributors to overall reef health. Baby corals cannot settle in a place where algae is growing.

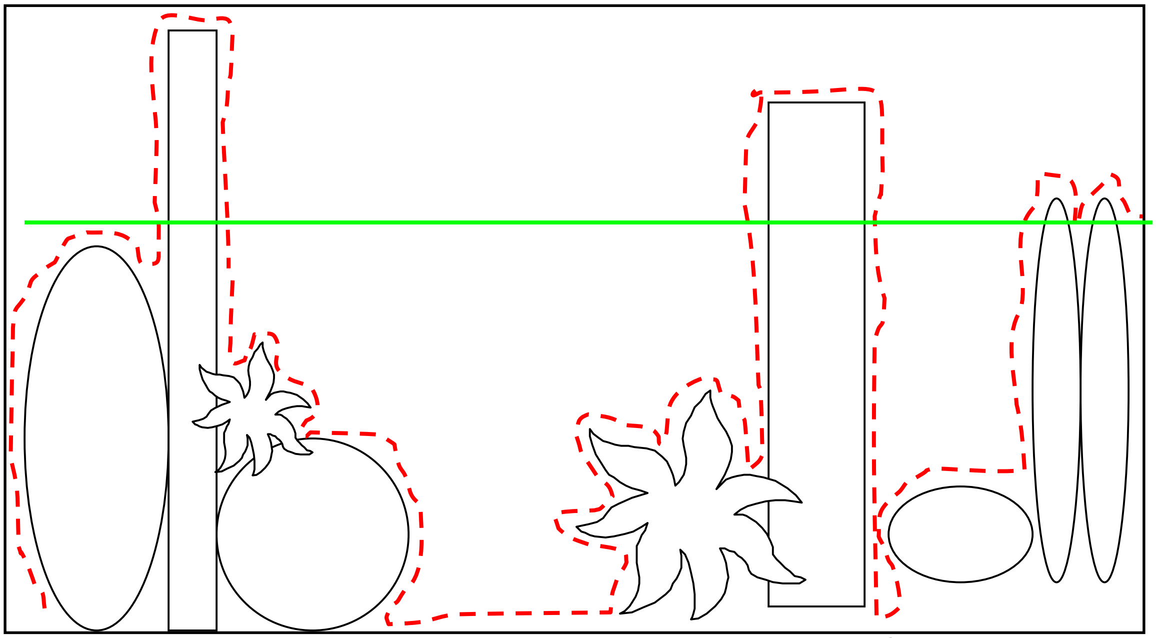

Fig. 9. The solid green line represents the transect line along the reef. The dashed red line represents the weighted line, which more accurately follows the varying surface of the reef, and therefore better estimating reef complexity.

Fig. 10. Although it is difficult to see, the transect line is in the center of the photograph, and the weighted line is along the coral below the transect line.

Fig. 11. Jessica, recording measurements from a coral survey via the weighted line method.

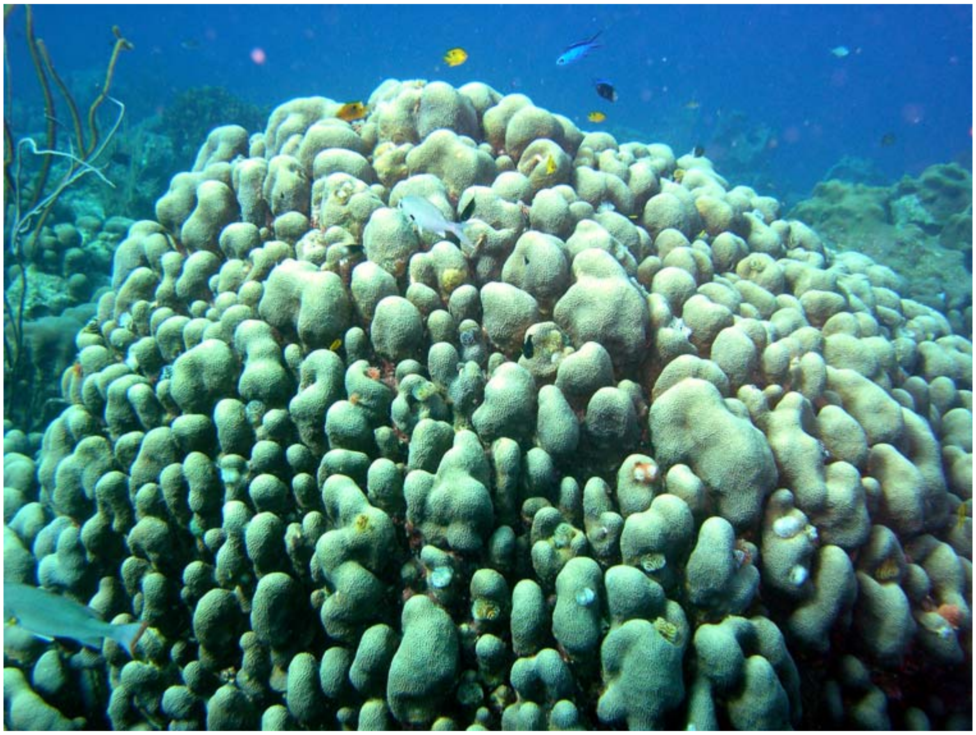

Fig. 12. A large coral head with Christmas tree worms and juvenile three spot damselfish.

Fig. 13. Jessica finishing her last research dive in Bonaire.

Literature Cited

Garrison, T. 2002. Oceanography: An invitation to marine science. 4th ed. Thomas Learning, Inc. Pacific Grove, CA.