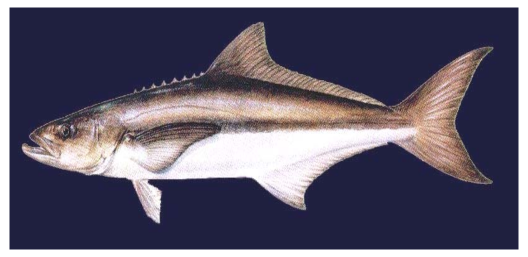
Observing and Minimizing Impact of Cobia (*Rachycentron canadum*) Aquaculture on Cape Eleuthera



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Introduction

Aquaculture is the growing of fish in a controlled selective environment for commercial, recreational, and or public purposes (Kaiser and Holt, 2005). Recently aquaculture has developed into a growing industry due to the increase in demand for seafood (Naylor, et al. 2000). There are still many problems with aquaculture however this system has huge potential for future success in relieving pressure from over fishing (Naylor et al., 2000).

The Cape Eleuthera Institute (CEI) and the Island School have been working to create an intensive and complete aquaculture system. The fish used in the system are cobia (Rachycentron canadum), a fast growing, pelagic fish. A challenge of intensive systems is susceptibility to disease due to high stocking density. Currently chemicals are being used to kill the parasites and bacteria, however they are harmful to the fish, the environment, and are also expensive (Kaiser and Holt, 2005).

This semester the aquaculture research group implemented cleaning organisms that could potentially clean the cobia in a more sustainable manner. Cleaning organisms create a mutual symbiotic relationship because the cleaning fish benefit by feeding off of the parasites and the cobia benefit because they are being cleaned (Deady et al., 1994).

The purpose of this study was to conduct ethograms or behavioral studies, to analyze the behaviors of cleaner organisms with cobia in onshore tanks to determine if the cleaning organisms were indeed cleaning the cobia. The second study conducted dealt with the offshore aquaculture cage. The cage was could be attracting above normal amounts of fish and potentially changing the composition of the local community (Tuya et al., 2006). **The purpose of our study was to determine if the cage was a fish aggregation device (FAD)**; a large object in the water that attracts fish towards it. By determining if the cage is a FAD, future measures can be taken to minimize impact on wild fish.

Offshore Aquaculture Cage Methodology

The offshore aquaculture cage is seventy feet in length, starting at fifteen feet below the surface extending to the ocean floor (Fig. 1). It is located near the wall of the Exuma Sound, approximately 1.5 miles offshore of Powell Point, Eleuthera. In order to determine whether the cage was a FAD, six dives were conducted, three at the cage and three at a control site, to examine the fish species and quantity. The control dives were conducted in open water with a buoy line approximately 0.5 miles from the cage site. The observations were recorded on dive slates and then tallied into number of species and quantity of each specific species (Fig. 2). The species were divided into three categories: herbivores, predators and scavengers.

Figure 1: The offshore aquaculture cage with the net on.

Figure 2: Students conducting a survey at the cage site.

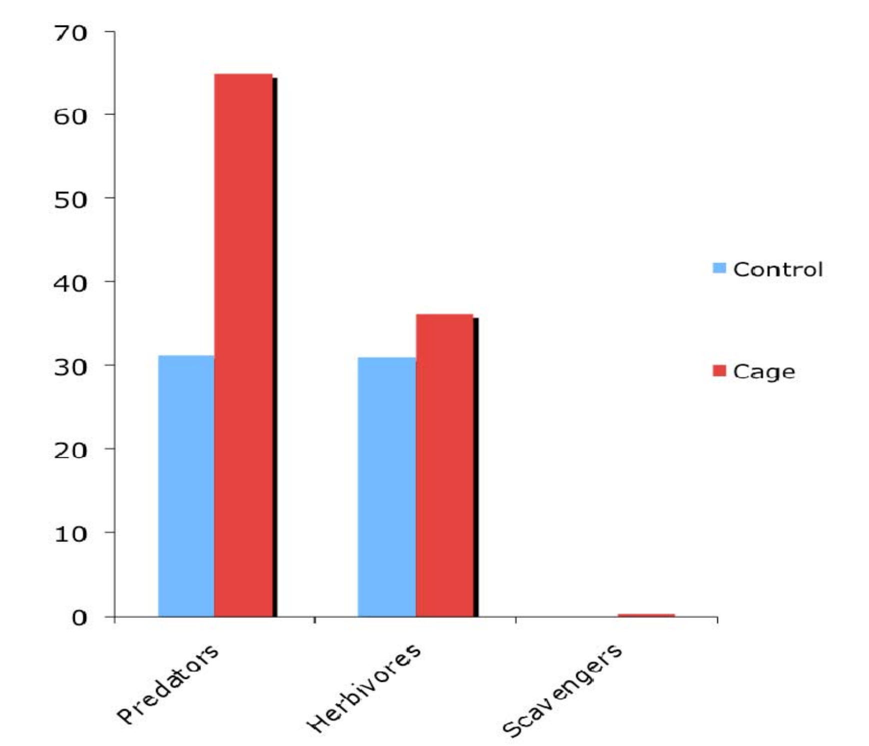

Figure 3: Mean fish abundance in three categories at the cage and control site.

Offshore Aquaculture Cage Results

It was found that the offshore aquaculture cage attracts unnatural amounts of fish. There were two significant observations found through the data, the first being that the populations of herbivores and predators were larger at the cage than the control site while little to no scavengers were found at either site (Fig. 3). The second finding was that there was more fish species observed at the control site as opposed to the cage site ($p < 0.05$, Mann-Whitney U-test) (Fig. 4).

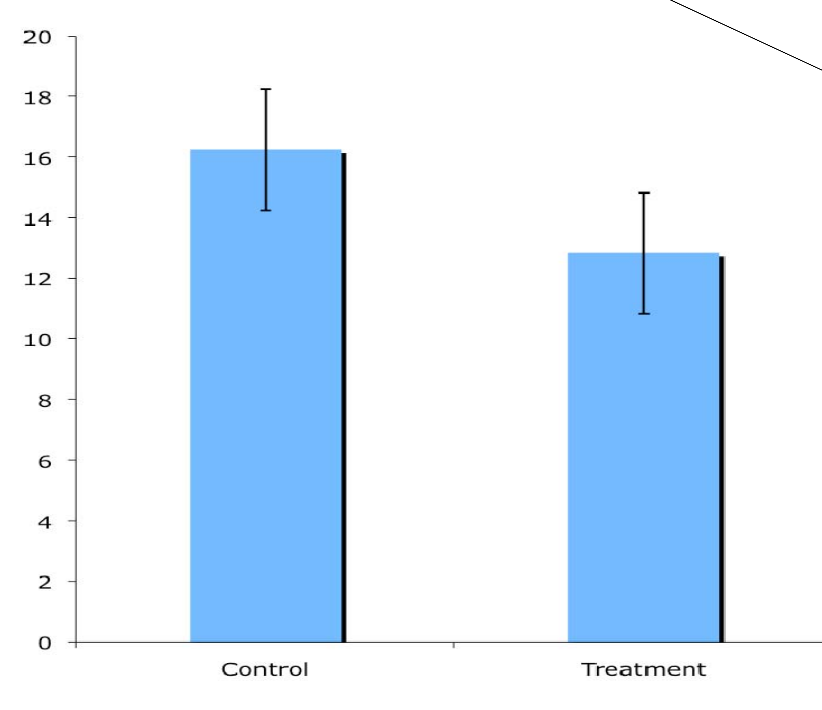

Figure 4: Mean number of species at the control and cage site.

Figure 5: Sharknose goby (*Gobiosoma evelynae*).

Figure 6: Students conducting ethograms at CEI.

Cleaning Organism Methodology

In the onshore aquaculture tanks, an experimental study was conducted using gobies and cleaning shrimp (Fig. 5) to clean the cobia. In two of three tanks were Sharknose gobies (*Gobiosoma evelynae*), and in the other tank were three Pederson cleaning shrimp (*Periclimenes pedersoni)*. Multiple cleaning organisms were observed in order to distinguish the cleaner organism that cleaned the cobia for the longest amount of time. Ethograms were conducted to determine the relationship the cleaning organism had with the juvenile and brookstock cobia (Fig. 6). Ethograms were conducted during four different periods of the day to understand the effect of time on cleaning. For each ethogram twenty observations were recorded at thirty-five second intervals to make a total of eleven minutes and forty seconds of observation time in order to calculate easy percentages. Behaviors were grouped into four categories: swimming, resting, hiding and cleaning.

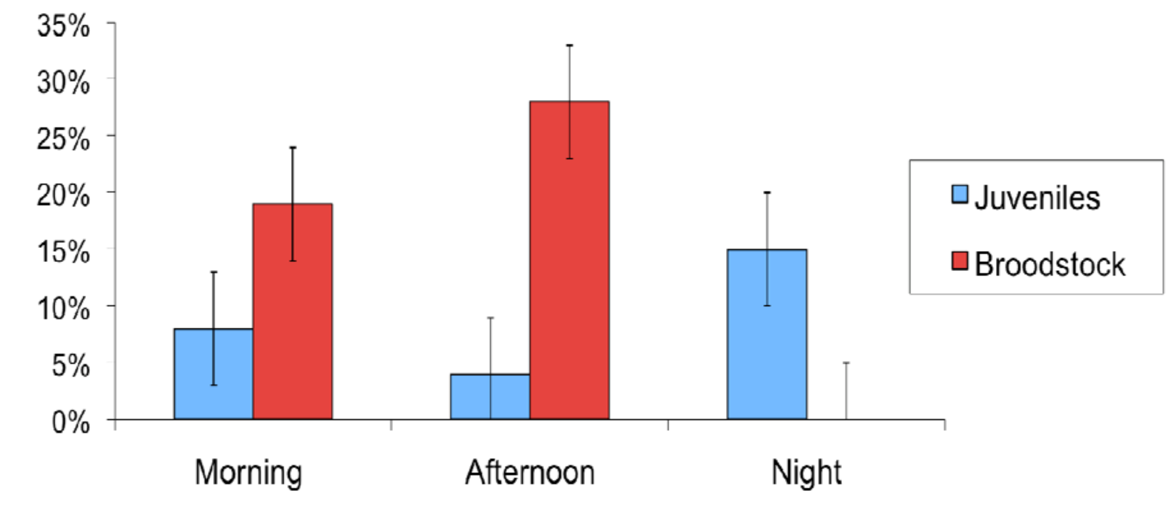

Figure 7: The percent of time the Gobies spent cleaning during the different times of day.

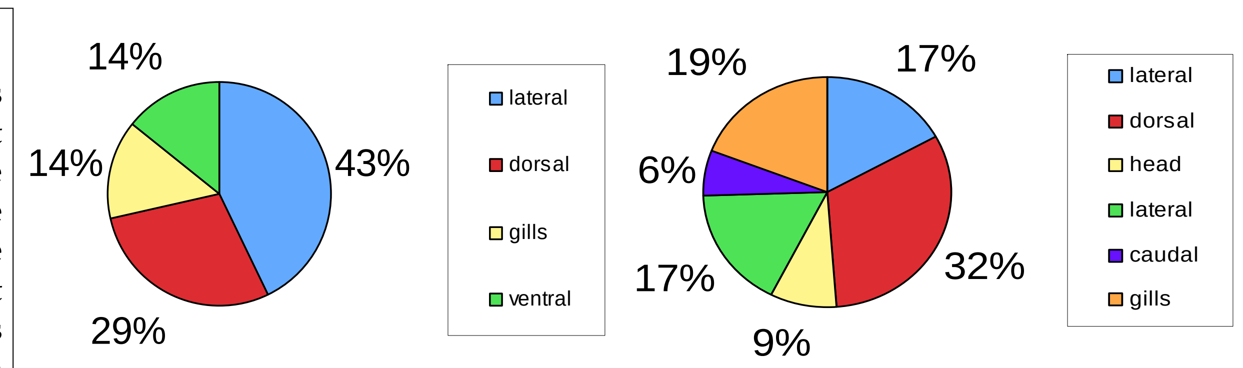

Figure 8: The parts of juvenile cobia cleaned (left) and parts of the broodstock cleaned by gobies (right).

Cleaning Organism Results

The survival rate of Sharknose gobies was not 100% however for the Pederson shrimp it was 0%. The ethograms showed that the Sharknose gobies cleaned the most at night followed by the morning and lastly the afternoon (Fig. 7). The trends for the broodstock were much different with the afternoon being the most common time to clean followed by the morning and then the night. On the juvenile cobia, the dorsal area was cleaned the most, 43% of the time spent on cleaning, followed by the lateral area at 29%. For the broodstock, the dorsal area of the cobia was most commonly cleaned at 32%, followed by the gills at 18% (Fig. 8). Overall the gobies spent 4% of the observed time cleaning the juvenile cobia compared to 17% of the time for the broodstock (Fig. 9). After running a t-test it was found that the p- value was 0.001 and therefore we can confirm that our results are significant.

Cleaning Organism Discussion

Over the course of the study, the series of ethograms led to support several significant discoveries. The results show that the gobies cleaned the broodstock more frequently than the juveniles. The gobies were proven to clean bigger fish and it was inferred that the gobies were more comfortable with the cobia after longer periods of time. The gobies' cleaning of the juvenile cobia increased over the semester as the gobies adapted to the cobia tanks. Secondly, the gobies cleaned the juveniles mainly during the night. In contrast, the broodstock were cleaned primarily during the afternoon. It is concluded that the time of day and amount of light affected the goby's methods and efficiency of cleaning. Also, the graphs show that the gobies cleaned the juvenile cobia mostly in the lateral in dorsal areas. The gobies cleaned the broodstock cobia in mainly the gills, dorsal, and lateral areas. The gills are an important section to be cleaned because when the *Amyloodinium* enters the gills and prevents the fish from breathing. This study has demonstrated to be important because Sharknose gobies proved to be a sustainable alternative treatment method to clean the cobia.

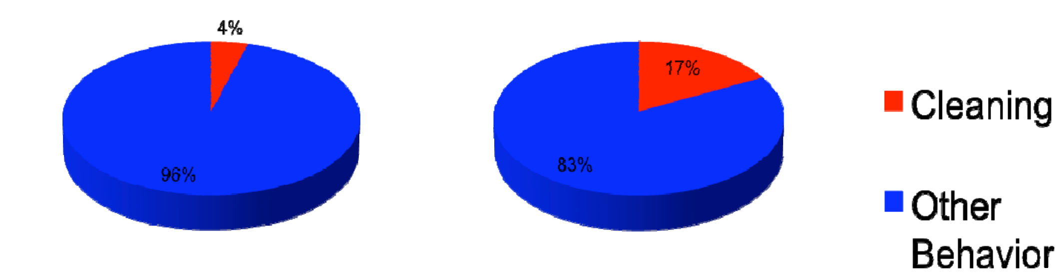

Figure 9: Time the gobies spent cleaning the juvenile cobia (left) and broodstock (right)..

Offshore Aquaculture Cage Discussion

It was determined that the cage attracts above normal amounts of species and quantity of fish, and therefore is a FAD. After analyzing the data in the three groups (scavengers, herbivores, predators), it was concluded that the cage attracts herbivores and predators. When focusing on diversity of species at the cage and control locations, it was found that there is a greater variety of species at the control site than at the cobia cage. It is hypothesized that this difference in species number is due to the fact that a reef is more accommodating to different types of organisms as a home whereas at the cage, there is only the cage and an area of sand around it; an area like that is more appealing to larger, pelagic fish than to benthic fish. This is unhealthy because the composition of local ecosystems can change when unnatural quantities of certain types of fish are concentrated in one area. These alterations may have a negative effect on the natural environment. This information is important in discovering what fish are attracted to the cage and can assist in determining how to prevent future problems with fish aggregation.

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