JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-8
SUBPROJECT NO.: F-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Stock Assessment Surveys of Marine Preserves and Control Sites

PERIOD COVERED: October 1, 1999 to September 30, 2000

SUMMARY

During FY00, the collection of baseline data was completed at the Achang Reef Flat Preserve. Strip transects, 50m x 5m, were laid out on the fore reef slope of the preserve. Transects on the fore reef slope were divided into 20, 30, 40, and 50 ft. depth habitats. Two divers, one on each side of the tape, moved along transects recording the number and sizes of important food fishes, butterflyfishes (Chaetodontidae), and visually obvious fishes.

Thirty-minute interval counts were conducted on the fore reef slope of the preserve. Interval counts on the fore reef slope were divided into the above-mentioned habitat types.

BACKGROUND

In order to restore fish stocks in the coastal areas around Guam, Public Law 24-21 established five Marine Preserve Areas (MPAs) and made changes to Guam's fishing regulations. The names of the preserves are listed as follows: Pati Point, Tumon Bay, Piti Bomb Holes, Sasa Bay, and Achang Reef Flat (Fig. 1). Under P. L. 24-21, the Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR) is required to monitor the areas for two years to determine the effects of the MPAs on food fish populations and report the findings to the legislature. Stock assessment surveys within MPAs and control sites need to be established in order to measure the effectiveness in the restoration of a dwindling fishery resource. Harvest and participation data obtained through the Inshore Fisheries Survey (DAWR 1999) was used to justify the establishment of the marine preserves.

OBJECTIVES

To evaluate the effect on sport fish populations caused by the creation of marine preserves by incorporating the following measures:

1) Conduct video and interval transect surveys within MPAs and control sites.

2) Establish baseline stock assessment surveys to measure the effectiveness of MPAs compared to control sites.

PROCEDURES

Logistics

The survey team on the reef flat consisted of 4 - 5 snorkel/divers while the team on the fore reef slope consisted of 4 - 5 divers and a boat person. Two persons were designated to count fish to reduce bias and one person recorded the video transects. Different counters were used at different times due to work scheduling conflicts.

Surveys required the following equipment: snorkel and SCUBA gear; a boat with safety gear; one Nikon Action 8 video camera with stingray video housing (47 inch rebar mounted on the left side); GPS; pencils with clipboards and underwater data sheets; two 50 m measuring tapes; PVC pipes (1 in. dia. and 3 to 6 in. lengths); and PVC caps (glued to their ends and tied with nylon cords).

Site Selection

The Piti Bomb Holes and Achang Reef Flat Preserves are the experimental sites for the stock assessment surveys. Cocos Lagoon is the control site for the Piti Bomb Holes reef flat, and the Asan fore reef slope, which is closer to Adelup (Fig. 1), is the control site for the fore reef slope of the Piti Bomb Holes Preserve. Pago Bay reef flat is the control site for the reef flat of the Achang Reef Flat Preserve. During FY99, the control site for the Achang Reef Flat fore reef slope was changed to the Cocos fore reef slope. Also, the Piti Observatory will be surveyed since commercial fish feeding operations appear to be aggregating fish.

Transect Selection

Strip transects, 50 m X 5 m, were laid out on the reef flats and the fore reef slopes of each site. Eight strip transects (2 at: 20 ft., 30 ft., 40 ft., and 50 ft. depths) were laid out on the fore reef slopes of the Achang Reef Flat, Piti Bomb Holes Preserves, Asan, and Cocos. Eight strip transects (3 on: seagrass and coral/algal/rubble; and 2 on sandy bottom) were laid out on the reef flats of the Piti Bomb Holes Preserve and Cocos Lagoon. Eight strip transects (4 on: seagrass and coral/algal/rubble) were laid out on the reef flats of the Achang Reef Flat Preserve and Pago Bay. In addition, 2 strip transects were laid out near the Piti Observatory.

Strip Transect Technique

Two to three snorkel/divers laid out a measuring tape to mark the length of each transect, while a PVC pipe was tied to a rock at both ends to semi-permanently mark it. As each transect was set, the fish counters (one on each side of the tape) moved along it to record the number and size of important food fishes, Chaetodontidae, and visually obvious fishes (Table 1). Transect widths were estimated visually and a new one was then laid with another tape measure while the counters recorded fish observations. The counters moved along the new transect once they completed recording observations of fish from the previous one. The measuring tape was retrieved from the previous transect, while the counters recorded fish observations along the new one. These processes continued until all transects were laid out and all fish counts completed.

Transects were separated by at least 5 - 10 m. In addition to the placement of the PVC pipe markers, GPS coordinates were taken and maps were drawn in order to relocate transects.

Table 1. Target species identified during strip transect surveys in FY00.

Acanthuridae	**Labridae**	**Mullidae**
A. lineatus	*C. trilobatus*	*M. flavolineatus*
A. triostegus	*C. undulatus*	*P. barberinus*
A. xanthopterus		*P. bifasciatus*
N. lituratus		
N. unicornis		
Carangidae	**Lethrinidae**	**Scaridae**
C. ignobilis	*L. harak*	*B. muricatum*
C. melampygus	*L. obsoletus*	*C. bicolor*
C. papuensis	*L. xanthochilus*	*H. longiceps*
C. sexfasciatus	*M. grandoculus*	*S. altipinnis*
		S. frontalis
		S. microrhinos
		S. psittacus
		S. rubroviolaceous
		S. schegeli
		S. sordidus
Chaetodontidae	**Lutjanidae**	**Serranidae**
C. melannotus	*L. fulvus*	*C. argus*
C. ornatissimus	*L. gibbus*	*C. urodeta*
C. quadrimaculatus	*L. monostigmus*	*E. merra*
C. reticulatus		*E. polyphekadion*
C. trifascialis		
C. lunulatus (trifasciatus)		
Kyphosidae	**Mugilidae**	
K. cinerascens	*V. seheli*	
K. vaigiensis	*L. vaigiensis*	

Interval (Timed-Swim) Count Technique

Interval counts, which involved counting fish for thirty minutes near the transect areas, were conducted on the reef flats and the fore reef slopes of each site. Four interval counts (2 between: 20 - 30 ft. and 40 - 50 ft. depths) were conducted near transects on the fore reef slopes of the Achang Reef flat, Piti Bomb Holes Preserves, Asan, and Cocos. Six interval counts (2 on: seagrass; coral/algal/rubble; and sandy bottom) were conducted on the reef flats of the Piti Bomb Holes Preserve and Cocos Lagoon. Four interval counts (2 on: seagrass and coral/algal/rubble) were conducted on the reef flat of the Achang Reef Flat Preserve and Cocos Lagoon. Two interval counts were conducted near the Piti Observatory.

Video Transect Technique

The method to assess the percentage of substrate cover was changed to video transects during FY99. Video transects on the fore reef slopes of the Piti Bomb Holes Preserve and Asan were conducted. Because of poor weather and lack of a boat, video transects of the fore reef slopes

of the Achang Reef Flat Preserve and Cocos could not be conducted during FY00. The strip transects for the fish surveys were also used for the video transects. The procedures for recording substrates were similar to the strip transect method. Substrate was recorded from one end of each transect to the other. A rebar was used to guide the camera along the tape measure and to maintain camera and substrate distance.

RESULTS

The control and experimental forereef sites (Cocos and Achang) located on the south side of the island had the most individuals compared to the control and experimental sites located on the eastside (Fig. 1). Baseline results of all individuals minus the rabbitfish family Siganidae at the experimental sites on the forereef slopes of Achang and Piti had a mean number of 34 and 31 individuals respectively per 250 m^2 (Fig. 2). The control forereef sites (Asan and Cocos) had a mean number of 29 and 42 individuals respectively per 250 m^2. More individuals were observed on the forereef slope of the Cocos control site than at any other site.

Baseline results of all individuals minus siganids of the experimental sites on the reef flats of Achang and Piti had a mean number of 21 and 18 individuals respectively per 250 m^2 (Fig. 3). The control sites (Cocos Lagoon and Pago Bay reef flat) had a mean number of 32 and 22 individuals respectively per 250 m^2. Besides the slight difference in the number of individuals between Achang reef flat and Pago Bay reef flat, more individuals were observed on the experimental sites than on the control sites. The Piti Observatory had a mean number of 88 individuals per 250 m^2, and compared to the Observatory, the Piti reef flat had 80% less individuals.

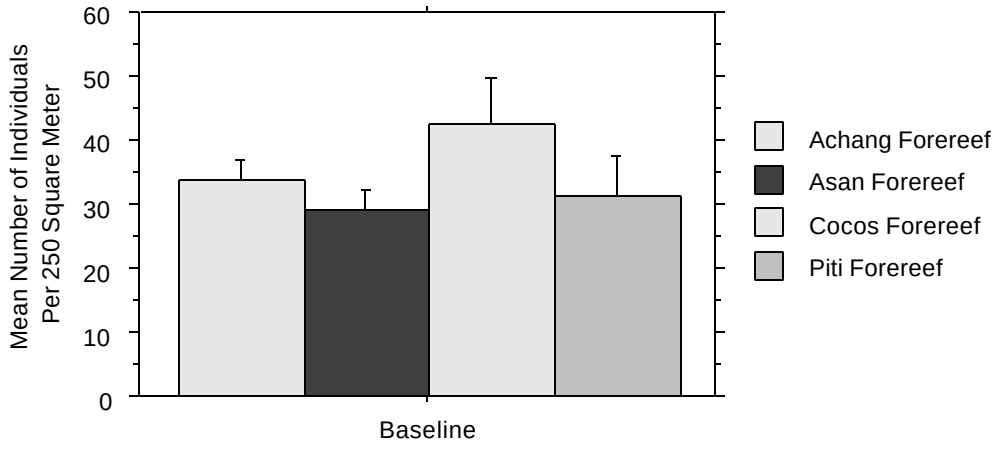

Figure 2. All individuals minus the rabbitfish family Siganidae: Mean number of individuals per 250 m^2 on the forereef slope of all sites.

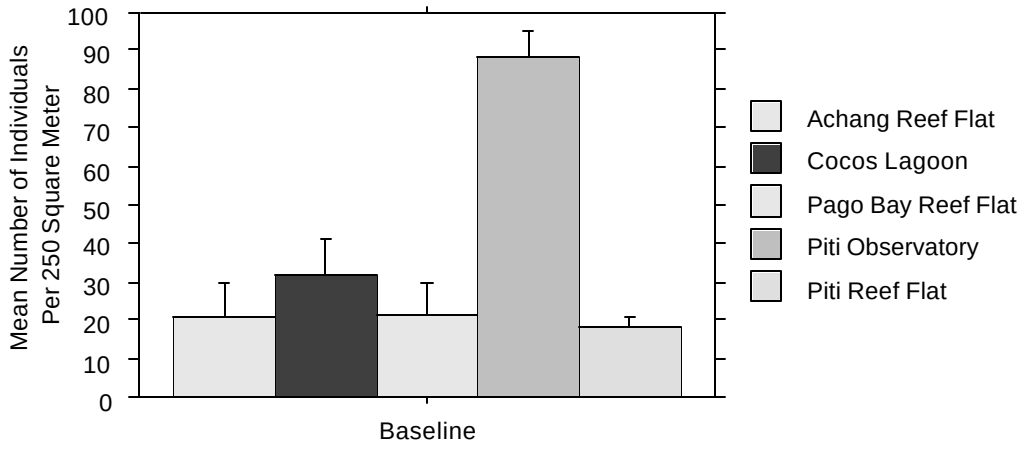

Figure 3. All individuals minus the rabbitfish family Siganidae: Mean number of individuals per 250 m^2 on the reef flat of all sites.

Baseline results of the top families of fish on the fore reef slopes of all sites had the highest mean number of individuals per 250 m^2 in the families Acanthuridae and Scaridae (Fig. 4). More individuals of these two families were observed on one control site, the Cocos forereef, as compared to the other sites. Fish in the families Carangidae, Kyphosidae, and Mugilidae were not observed in any transects on the fore reef slope. More families of fish were encountered on the Achang forereef while the rest of the sites had an equal number of families.

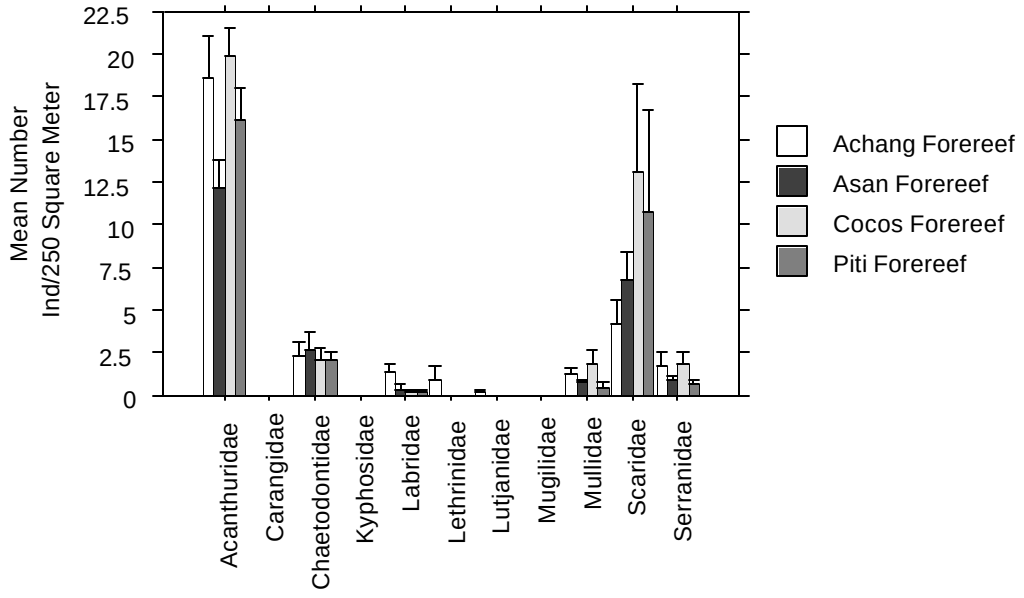

Figure 4. Top Families: Mean number of individuals per 250 m^2 on the forereef slope.

Baseline results of the top families of fish on the reef flat of all sites excluding the Piti Observatory had a mean number of individuals per 250 m^2 that were more evenly distributed, except in cases where schools of acanthurids and siganids were encountered (Fig. 5). In the case of the Piti Observatory, more individuals per 250 m^2 were encountered in the families Chaetodontidae and Scaridae. Although more individuals were encountered in the Observatory, more families of fish were not encountered as compared to the other sites. The observatory was the only site, in which, individuals were encountered in the family Carangidae.

Baseline results of all species (food fish and Chaetodontidae) of the experimental sites on the Achang forereef and the Piti forereef had a mean number of 11 and 8 species respectively per 250 m^2 (Fig. 6). The control sites, Asan forereef and Cocos forereef, had a mean number of 10 and 9 species respectively per 250 m^2. Besides the Achang forereef experimental site, more species of fish were seen in each of the control sites. The top 3 species with the most individuals were: *Odonus niger*; *Scarus sordidus*; and *Ctenochaetus striatus*.

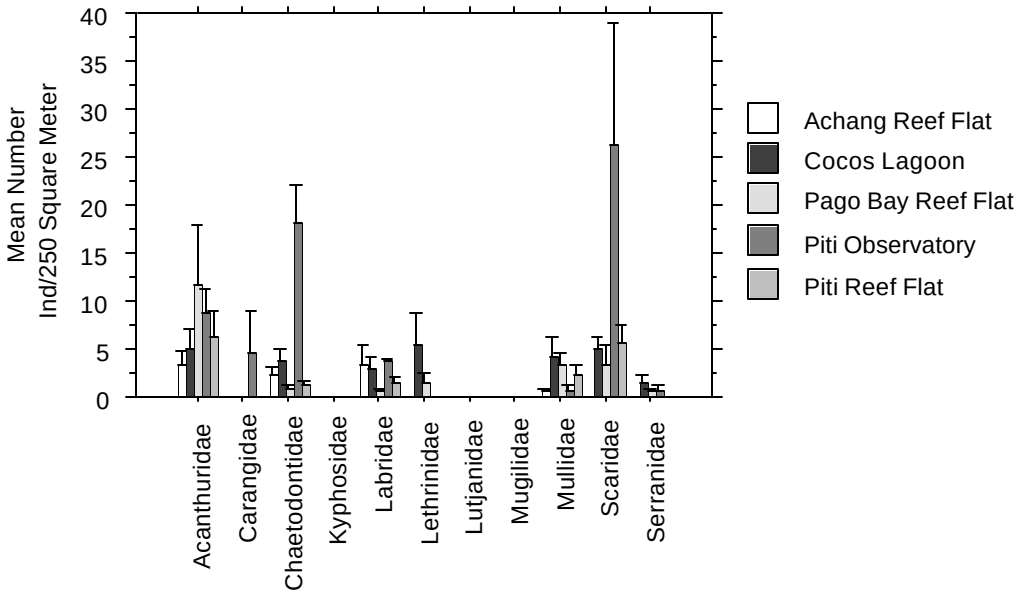

Figure 5. Top Families: Mean number of individuals per 250 m^2 on the reef flat.

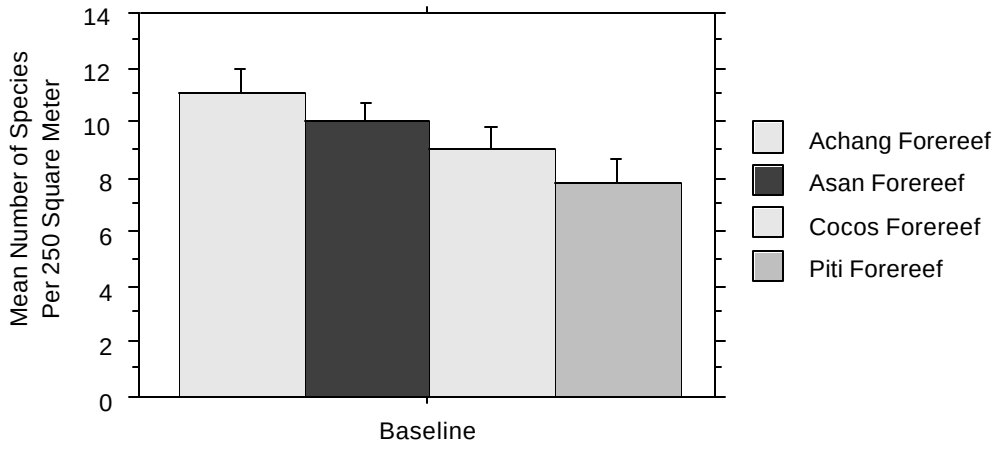

Figure 6. All Species (food fish and Chaetodontidae): Mean number of fish species per 250 m^2 on the forereef slope of each site.

Baseline results of all species (food fish and Chaetodontidae) indicate that the experimental sites (Achang and Piti) and one control site (Pago) had a mean number of species that were evenly distributed as compared to the other control site, Cocos Lagoon, and the Piti Observatory (Fig. 7). Both experimental sites, the Achang reef flat and the Piti reef flat, had a mean number of approximately 6 species per 250 m^2. The control sites, Pago reef flat and Cocos Lagoon, had a mean number of approximately 6 and 10 species per 250 m^2. The Piti Observatory had a mean number of approximately 18 species per 250 m^2. The top 3 species with the most individuals were: *Siganus argenteus*; *Mypristis* sp.; and *Acanthurus nigrofuscus*.

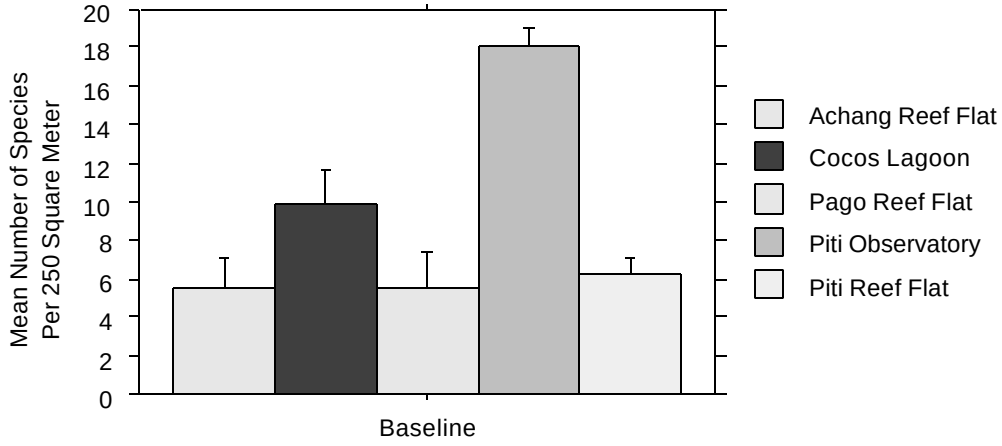

Figure 7. All Species (food fish and Chaetodontidae): Mean number of fish species per 250 m^2 on the reef flat of each site.

Baseline results for target species on the transects of the forereef slope (Fig. 8) indicate that the Cocos forereef control site had the highest number with approximately 0.36 individuals per 250 m^2 while the Piti forereef experimental site had the second highest number with approximately 0.25 individuals per 250 m^2. The Asan forereef control site had the third highest with approximately 0.22 individuals per 250 m^2 followed by the Achang forereef experimental site with approximately 0.16 individuals per 250 m^2.

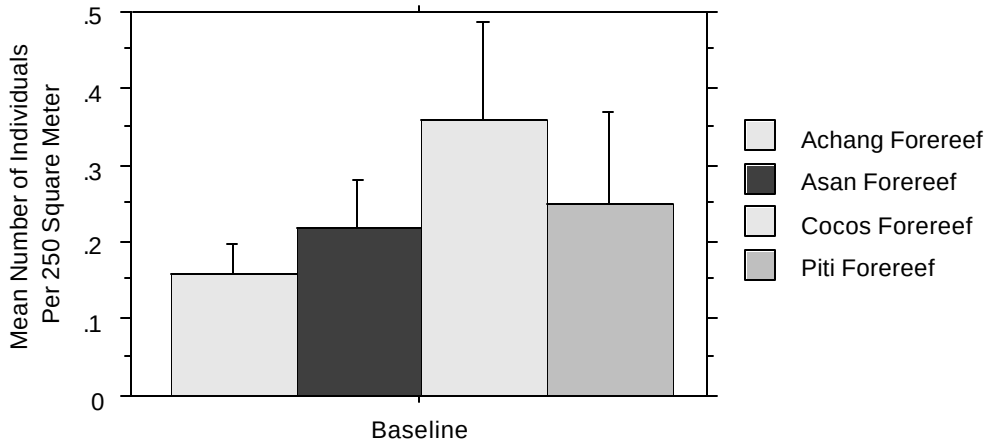

Figure 8. Target Species: Mean number of individuals per 250 m^2 on the forereef slope of each site.

Baseline results for target species transects of the reef flat (Fig. 9) indicate that the control sites, Cocos Lagoon and Pago Bay, had more individuals per m^2 (0.23 and 0.16) than the experimental sites, Achang and Piti (0.08 and 0.14). The Piti Observatory had more individuals (0.67) per m^2 than both the control and experimental sites.

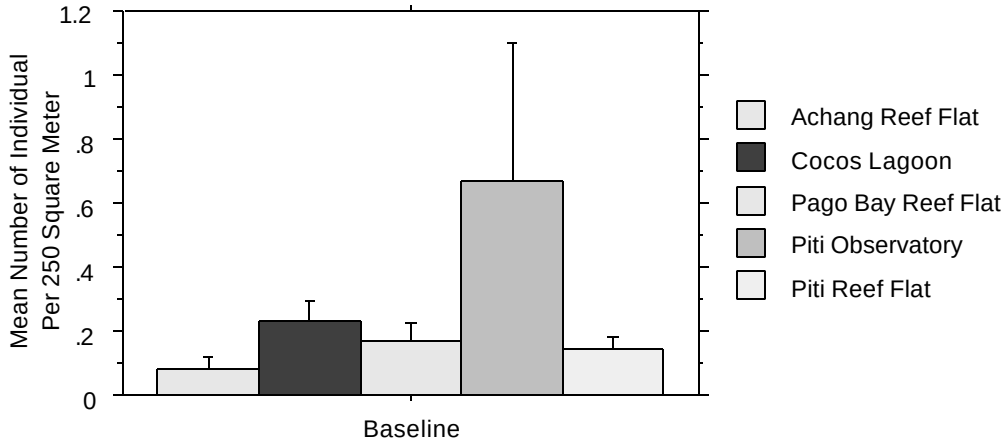

Figure 9. Target Species: Mean number of individuals per 250 m^2 on the reef flat of each site.

Baseline results for target species (>15 cm - <30 cm) transects of the forereef slope (Fig. 10) indicate that the experimental sites, Achang forereef and Piti forereef, had more individuals (>15 cm - <30 cm) per 250 m^2 than the control site, Asan and Cocos forereefs. Achang and Piti forereefs had approximately 0.05 and 0.08 target individuals (>15 cm - <30 cm) while Asan and Cocos forereefs had approximately 0.02 and 0.03.

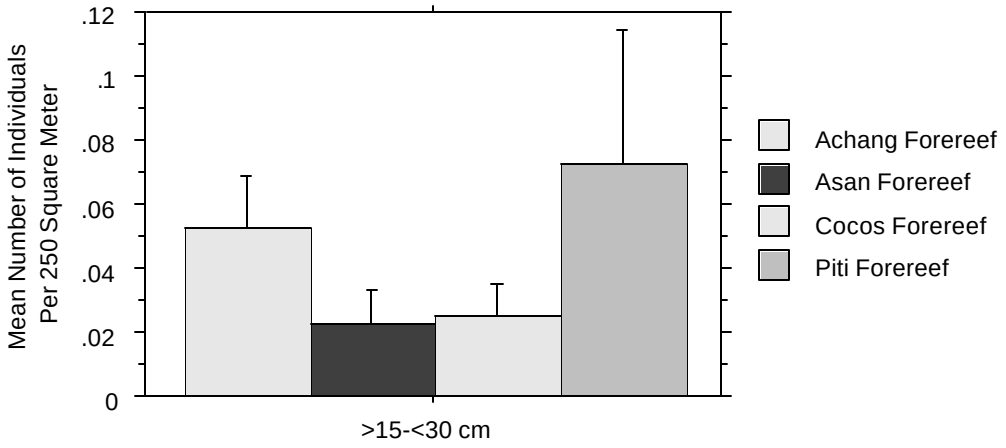

Figure 10. Target Species: Mean number of individuals (>15 cm - <30 cm) per 250 m^2 on the forereef slope of each site.

Baseline results indicate no individuals of target species (>15 cm - <30 cm) on transects of the control and the experimental sites on the reef flat (Fig. 11). The Piti Observatory was the only site that had individuals (>15 cm - <30 cm). The Observatory had approximately 0.9 individuals per 250 m^2 (>15 cm - <30 cm).

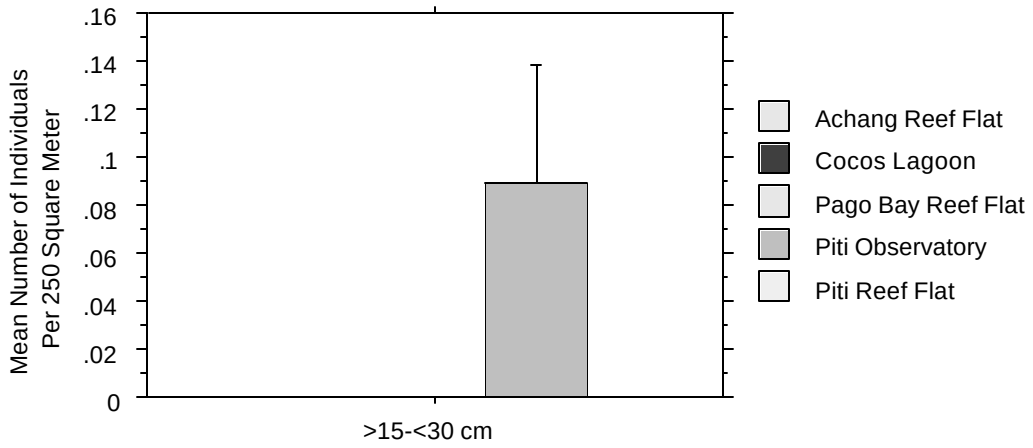

Figure 11. Target Species: Mean number of individuals (>15 cm - <30 cm) per 250 m^2 on the reef flat of each site.

Baseline results indicate that the percent cover of live coral was <10 % for the control site, Asan forereef, and the experimental site, Piti forereef (Fig. 12). Rock made up over 70% of the substrate cover on both the control and experimental sites. Dead coral, silt, soft cover, and other substrate were not encountered during the survey.

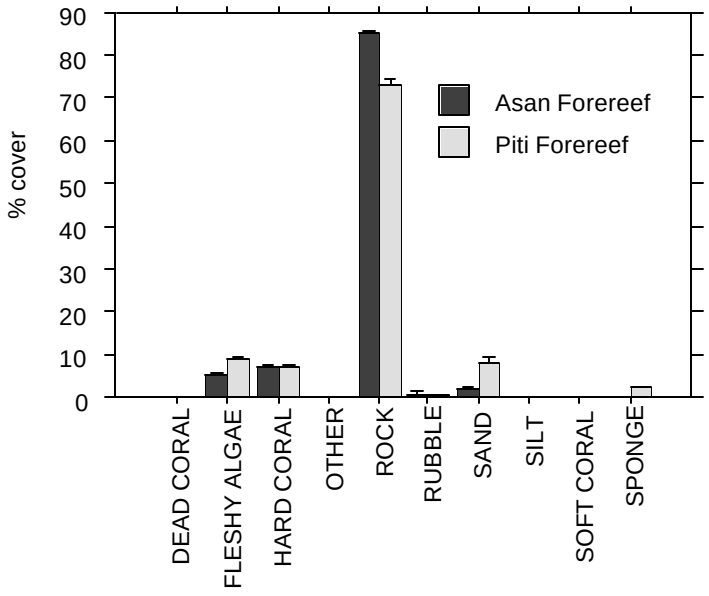

Figure 12. Percentage cover of substrate on the Piti and Asan forereef slopes.

DISCUSSION

The baseline data indicate that fish density and diversity are low in the control and experimental sites. Surveys conducted in the past indicate much higher densities and diversities. Amesbury

(1993) surveyed Tumon Bay in 1991 and found 0.245, 0.474, and 0.476 individuals of fish per m^2 at each of his 3 transect sites. The Cocos forereef site with the highest mean density of 0.168 individuals of fish per m^2 was low in comparison. In the same study, Amesbury compared fish densities and diversities from his 1991 to his 1977 survey in Tumon Bay. He found that there had been a decline in fish communities of approximately 30 to 50 % from 1977 to 1991. In another survey by Amesbury (1993), he also found much higher fish densities and diversities from baseline data collected at the Pati Point Preserve. Fish densities and diversities were 2 - 3 times higher in the Pati Point Preserve in 1993 as compared to the control and experimental sites for this study. Baseline data also indicate low coral cover in the control and experimental sites. The average live coral cover on the fore reef slopes was approximately 50% in the 1960's (Randall 1971). Today, many fore reef slopes have less than 25% coral cover and only a few have over 50% live cover (Birkeland 1997).

With the recent establishment of Guam's marine preserves, fish stocks should begin to replenish themselves. Similar studies in other marine preserve areas have shown an increase in fish populations. Russ and Alcala (1994) reported the results from the Sumilon Island Reserve in the Philippines, in which, fishing was open and closed during certain years from 1983 to 1993. They found that the density of large predatory fishes and Fusilers increased when fishing was closed as compared to when it was open. McCormick and Choat (1987) estimated the abundance of *Cheilodactylus spectabilis* from a marine preserve and an adjacent section of coast in New Zealand. They found that the preserve had 2.3 times more *C. spectabilis* than the non-preserve area. The success of Guam's marine preserves will depend on the continued enforcement and public education about the benefits of the preserves.

RECOMMENDATIONS

1) Investigate alternative methods such as underwater GPS and the use of a camera in conjunction with maps to relocate transects.

2) Explore the development of a computer-based database system for the monitoring of the marine preserves. A database provides data consistency, efficiency, data quality, and data integration as compared to a spreadsheet.

3) Pursue the hiring of more SCUBA certified technical staff, which are needed for the MPA monitoring program.

PROJECT COST

The estimated cost of the program was approximately $100,000.

This report was prepared by: Jay T. Gutierrez, Fisheries Biologist III.

LITERATURE CITED

Amesbury, S. 1993. Biological communities in Tumon Bay, 1977 - 1991. University of Guam Marine Laboratory, Technical Report No. 99, 111 pp.

Amesbury, S. 1993. Andersen Air Force Base Marine Resources Preserve Baseline Survey Of Marine Resources. University of Guam Marine Laboratory, Environmental Survey Report No. 27, 61 pp.

Birkeland, C.E. and R.H. Grigg 1997. Status of the Coral Reef in the Pacific. UNIHI-SEAGRANT-CP-98-01. Pp 91 - 100.

Division of Aquatic and Wildlife Resources (DAWR). 1999. Job Progress Reports – Federal Aid to Fish and Wildlife Restoration. Guam Department of Agriculture, Mangilao.

McCormick M. I. and Choat J. H. 1987. Estimating Total Fish Abundance of a LargeTemperate Reef Fish Using Visual Strip Transects. Marine Biology 96. Pp 469 -478.

Randall, RH. 1971. Tanguisson-Tumon, Guam Reef Corals before, during, and after the Crown-of-Thorns Starfish (Acanthaster) predation. M.S. Thesis, University of Guam Department of Biology. 119 pp.

Russ G. R. and A.C. Alcala. 1994. Sumilon Island Reserve: 20 Years of Hopes and Frustration. NAGA, The ICLARM Quarterly. July. Pp 8 – 12.