Introduction

Laughing Bird Caye National Park (LBCNP) was declared in 1996. Over the past ten years a significant volume of data has been collected on the resources contained within the park. In 2003 Friends of Nature (FoN) began to conduct more regular biological monitoring within the park. The goal of this report is to begin to evaluate the monitoring data that has been collected to date, with the ultimate objective of integrating findings into the park's management. This report was also written to offer suggestions as to monitoring gaps and make adjustments to monitoring methods to better aid in management decision making. Although this report is by no means comprehensive, it is meant to offer a glimpse into the strengths and weaknesses of the current monitoring program so as to make improvements to monitoring and management in the future.

Sea Turtles

Laughing Bird Caye and the cayes around it are known nesting sites for Hawksbill turtles (*Eretmochelys imbricate*) and it is likely that Green Turtles (*Chelonia mydas*) use the beaches in the areas as well. Hawksbill turtles are listed as an endangered species, and all marine turtles are protected under Belizean law. A good understanding of the numbers and health of the nesting turtle population is important for managers. Sea turtles are a charismatic and highly endangered group and careful management of the population is important to ensure their continued survival. Currently there is little to no monitoring of the nesting activities taking place and LBCNP. It is recommended that a basic monitoring protocol be developed to gather a better understanding of the nesting activities of turtles at LBCNP. This would include daily patrols for turtle nests on Laughing Bird Caye during the nesting season, the marking of nests and collection of data about hatchlings and nest success. This monitoring protocol would be based on the current monitoring which is on-going at the Sapodilla Cayes Marine Reserve.

Caye Bird Species

Laughing Bird Caye was so named for the nesting populations of laughing birds (*Larus atricilla*) who once used the northern portion of the caye. These nesting populations vacated the caye in the mid-1970's. The head ranger stationed at Laughing Bird Caye has indicated that nesting may be resuming at the northern part of the island. At this point it is necessary to implement a basic bird monitoring program similar to one currently being used at the Sapodilla Cayes Marine Reserve. This monitoring would focus on conducting weekly monitoring during the nesting season to count nests and eggs. Consistent monitoring is necessary and this will also include improved methods for data collection and data management. Bird identification books are needed and it is recommended that efforts be made to train biologists, rangers and other data collectors in basic identification and monitoring techniques. In addition to monitoring nesting birds it is recommended that a yearly bird census be carried out at the LBCNP. It is recommended that this census be conducted in a similar manner to the "Christmas Bird Count" currently conducted throughout Belize. However, as opposed to having the count around Christmas time it is recommended that the count be conducted during the migratory season either in October or March. This type of census will require greater

training in bird identification, but would provide valuable information about both resident and migratory birds who use the LBCNP.

Commercial Species

At the LBCNP a number of surveys have been conducted to specifically monitor the status of commercially important species. Laughing Bird Caye National Park is a completely closed no-take zone. This should mean that the fish stocks at LBCNP are representative of an intact fishery. The methodology used for commercial species monitoring follows Charles Acosta's Longterm Atoll Monitoring Program (LAMP) (Acosta). Monitoring at Laughing Bird has focused on fourteen sites located within and outside the boundaries of the national park. (See map in Appendix 1.) These sites represent a mixture of snorkel and dive sites and are fairly representative of the variety of ecosystems within LBCNP. Results from surveys conducted are presented below.
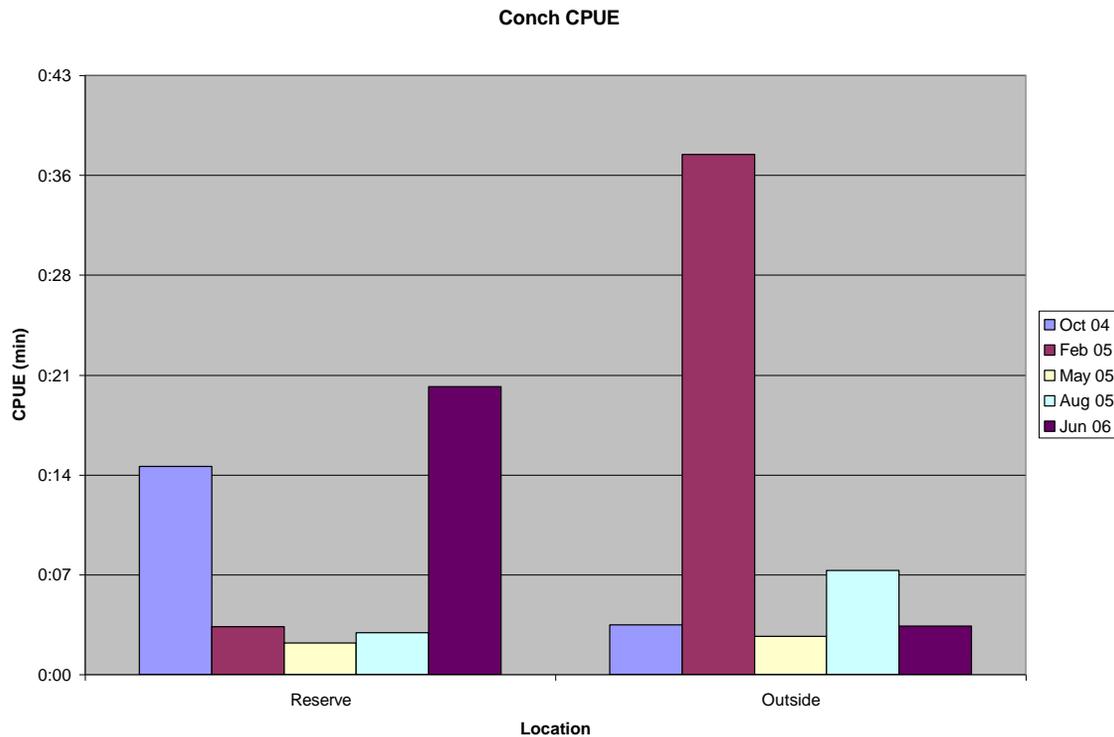
Conch

Overview of Monitoring Activities-
Queen conch (Strombus gigas) is a major fisheries export for Belize. Since LBCNP was expanded to include the marine area of the faro atoll in 1996 no fishing has been allowed in the area. In 2001 a ranger station was established at the caye to provide more comprehensive enforcement of the rules and regulations. Given the large no-take area, Laughing Bird is thought to contain fairly healthy populations of most commercial species, including Queen Conch. In 2003 a monitoring program for conch populations was established. Based on Charles Acosta's Long-term Atoll Monitoring Program (LAMP), this monitoring strategy focuses on 14 sites chosen strategically throughout the reserve. At each site timed swims are conducted and for each conch encountered basic measurements are taken including shell length and lip thickness. These measurements allow for comparison across sites and time periods of conch abundance, size distribution and the current status of conch stocks.
Results-
Figure 1 shows a comparison of conch abundance between locations within the reserve and outside the reserve.

Figure 1

Conch CPUE

In this graph lower times indicate higher densities of conch. Catch per unit effort (CPUE) is equivalent to the amount of time necessary to locate one individual. As you can see from the graph there appear to be some fluctuations in conch abundance but does not seem to be noticeable difference between locations within the reserve and those outside the reserve. Further analysis is necessary to determine if there is indeed a significant difference between the two locations.

In addition to collecting information on conch abundance Figure 2 shows the average size for conch encountered both inside and outside the reserve. The red line on Figure 2 illustrates an average shell length of 178 mm, the legal size for harvest according to Belize Fisheries Regulations. It takes approximately 3-4 years for conch to reach maturity and a mature conch is usually identified by a shell flare with a lip thickness of 5mm (Gascoigne & Lipcius, 2004). Recent research has suggested that even individuals with a lip thickness of 5mm may not actually be sexually mature (Gascoigne & Lipcius, 2004). Unfortunately data on lip thickness is inconsistent, it does appear that the average size of conch encountered both inside and outside the park seems to be fairly consistent with the majority of individuals being of legal size.

Figure 2

Conch Average Shell Length
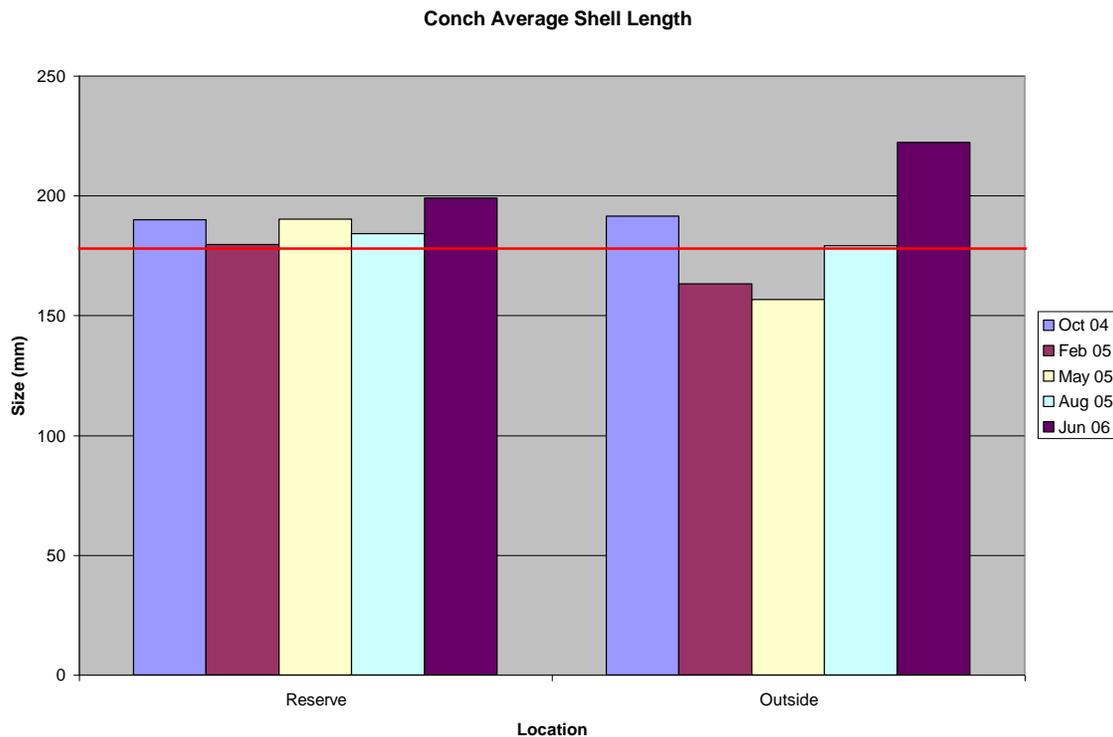
Evaluation and Recommendations-
Although the monitoring to date as yielded valuable results a number of considerations must be taken into account for 2008. Statistical analysis is necessary to determine if the changes in conch size and abundance between within the national park and outside. FoN is currently working with partners to develop improved methods for data management and analysis. Due to the monitoring strategy there is no data to date on conch density. Density is an important indicator for conch population viability as it is thought that at densities of less than 50 individuals/ha, successful reproduction is not likely (Stoner & Ray-Culp, 2000). Future monitoring should continue to include density at least once per year as it can offer valuable insight into population viability. In addition efforts should be made to collect data on lip thickness in addition to shell length. Continued and consistent monitoring of conch populations should provide important data for the improved management of this important fisheries resource. In addition, comparison between LBCNP and GSCCMR (and perhaps the SCMR) would be of interest as LBCNP represents an area that is completely closed to fishing. Initial comparisons indicate that the size and abundance of conch are indeed higher in LBCNP than at either GSSCMR or SCMR, however statistics will be necessary for further evaluation of this finding.
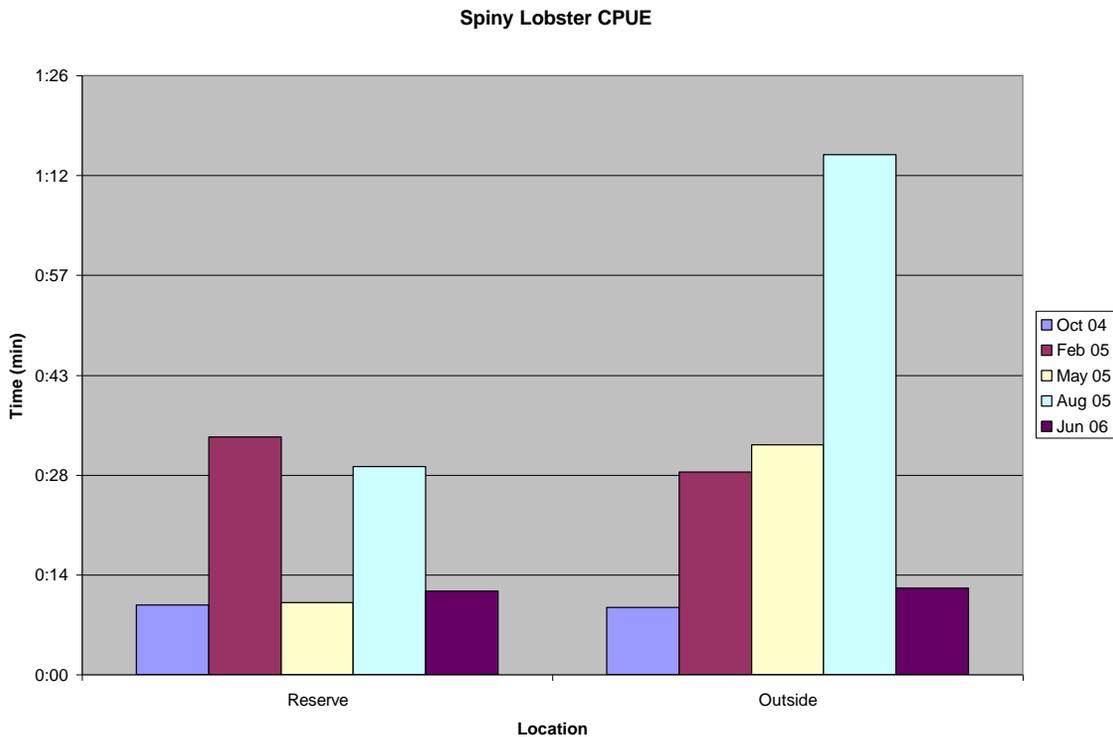
Lobster
Spiny Lobster (*Panulirus argus*) and to a much lesser extent Spotted Lobster (*Panulirus guttatus*), are the major lobster species facing commercial exploitation within Belize. Again due to the closed fishery LBCNP offers an interesting contrast to other locations in terms of evaluating lobster abundance and population dynamics. In 2003 a standardized monitoring method was established for lobster at LBCNP. Again this method was based on Charles Acosta's Long-term Atoll Monitoring Program (LAMP)

and focused on 14 sites strategically located within the reserve. At each site timed swims were conducted and each lobster encountered was evaluated for sex, egg presence and carapace length.

Results-

Figure 3 shows the abundance of spiny lobster found both inside and outside LBCNP. Again lower the CPUE's indicate higher abundance and as is expected the abundance appears higher within the reserve. However it is important to note that the sample size is very small and more analysis is necessary to determine whether this is a significant difference.

Figure 3

Additional data was collected about the size and sex of lobsters encountered. Due to inconsistencies in data collection the sex distribution data did not seem to be of value. Lobster size was estimated by measuring the carapace length, measured from the back of the carapace to between the eyes for each individual. Figure 4 shows the size distribution for lobsters encountered. There did not appear to be a significant difference in carapace length between the two locations

Figure 4

Spiny Lobster Average Carapace Length
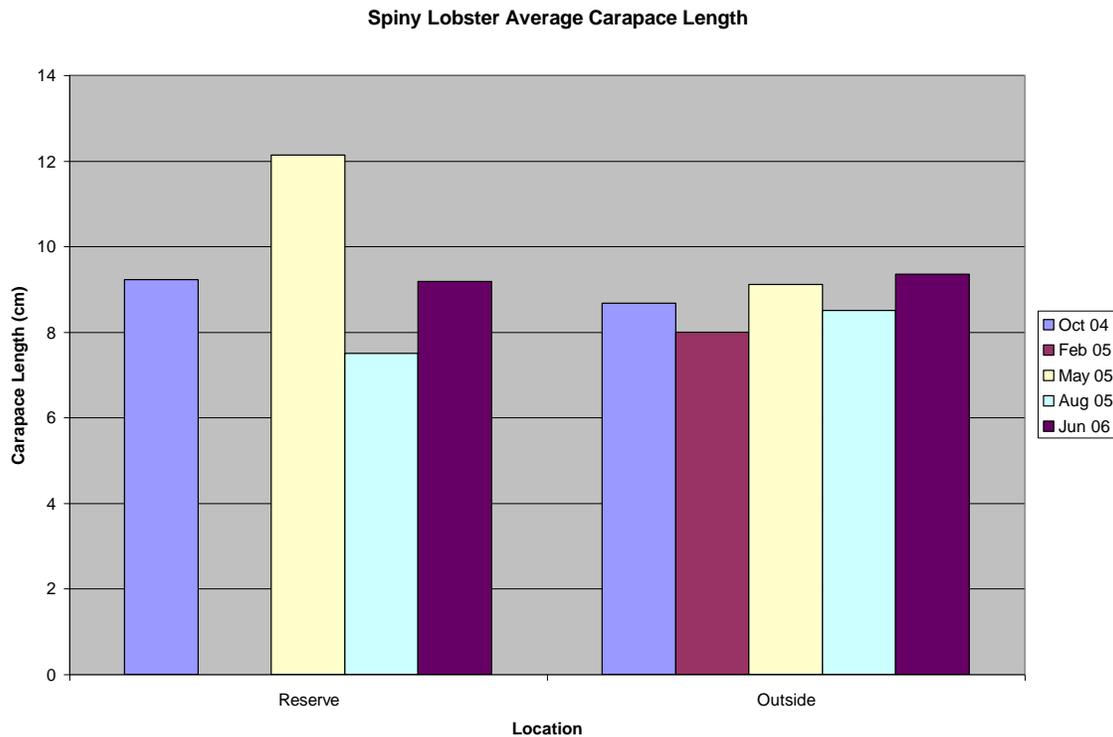
Evaluation and Recommendations-
This is one of the first attempts to try and synthesize the data collected over a five year period and much time and energy has been spent trying to organize and make sense of the existing data. Because there was no centralized database for commercial species data and no truly standardized methods, comparison between years is slightly tenuous. FoN and TASTE are currently working to develop a standardized database for this data to prevent these problems from continuing in the future. Despite this fact the data presented above is of use to managers and offers insight into a number of improvements that could be made to the monitoring protocol and data analysis to provide more accurate and useful information about the lobster populations. Further statistical analysis will be necessary to determine if visible trends are indeed significant. In addition to greater capacity for data management and analysis, efforts are underway to standardize monitoring methodology to ensure more consistent data collection. Due to a high level of staff turnover there is a desperate need to improve the regularity of monitoring events, despite the no-take nature of the park. Similarly to the conch data plans are in the works to start to compare data between LBCNP, GSSCMR and SCMR.

Finfish
Again considering the fact that LBCNP is a no-take reserve it would be expected that the commercial finfish populations would be high. In order to get a better picture of the status of the commercial fish populations within the LBCNP monitoring has again followed Charles Acosta's LAMP protocol. This focuses on conducting timed swims for a specified species list. These swims allow researchers to calculate catch per unit effort (CPUE) similarly to how a fishermen might look for fish to spear. Acosta's original species list includes includes: Nassau grouper (*Epinephelus striatus*), Hogfish (*Lachnolaimus maximus*) , Queen Trigger (*Balistes vetula)*, Black Grouper

(*Mycteroperca bonaci)*, Mutton Snapper (*Lutjanus analis)*. However, sampling at LBCNP includes the majority of snapper (Lutjanidae*)* and grouper (*Serrinidae)* species, barracuda (*Spyraena barracuda)* and a number of jacks (*Carangidae)*. For each fish of from the specified list an estimate of size is made to allow comparisons of CPUE and size between sites.   As with all of the commercial species monitoring this monitoring protocol is carried out at 14 strategically selected sites within the reserve.

   Results-

Analysis on finfish data is pending. Due to the nature of the finfish data no analysis has been conducted to date. This will be further discussed below.

   Evaluations and Recommendations-

As mentioned above the analysis has yet to be completed for the data collected to date on commercial fish species. After a number of discussions with a number of local organizations who use this monitoring methodology it was unclear exactly how to use the data collected to date. The key characteristics that are of importance to managers such as fish density were difficult to calculate due to the monitoring protocol. In addition the high levels of staff turnover have led to some inconsistency in the types of fish sampled and the sampling method. FoN is currently working with partners TASTE, TNC, WCS and others to look more closely at how commercial species data for finfish is collected. Managers need to carefully evaluate the protocol to ensure that the information necessary for management is being collected. It is suggested that the species list be finalized and made comparable to that at the SCMR and GSSCMR. In addition to revaluating the species list it is necessary to develop improved methods for data analysis including statistical analysis. FoN is hoping that this will be completed early in 2008 with the development of an improved commercial species database and systems for basic statistical analysis.

Coral Reef

Unfortunately any data collected to date on the status of the coral reefs within LBCNP is not available at Friends of Nature. The data presented below on the status of the reefs was collected at only four sites during the 2006 WWF sponsored Atlantic and Gulf Rapid Reef Assessment Program (AGRRA). Further discussion of the plans for expanding monitoring of coral reefs at LBCNP will be discussed below.
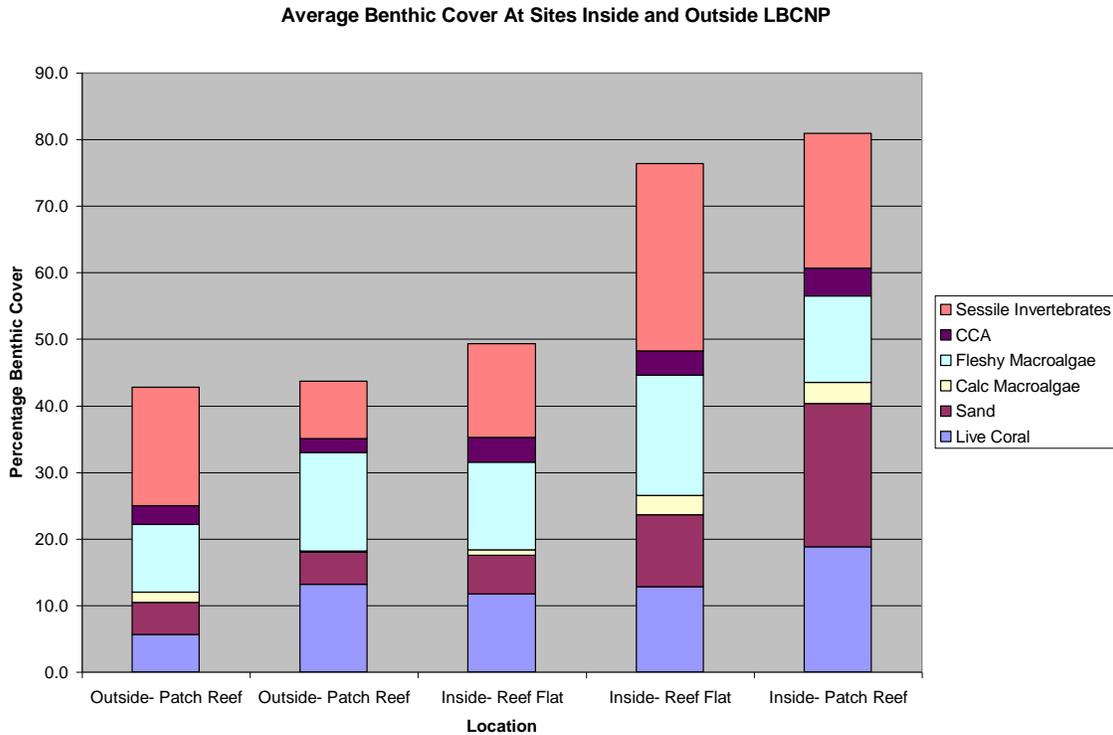
Benthic Cover

Benthic cover is basically a description of what different components make up the reef. By understanding changes to the percentage of live coral cover, algal cover, gorgonians, sand and other benthic indicators managers are able to track changes in reef health. Shifts in dominant cover type from live coral to algae may indicate changes in coral health, predation or nutrient availability. The data presented here was collected with the support of WWF using the AGRRA method. This method uses six 10m transects and estimates the coverage for six key factors along the length of the line. The six components measured include: live coral, calcareous macro algae, fleshy macro algae, crustose coralline algae, sand and other sessile invertebrates (such as gorgonians, palyothoa, sponge, etc.). The collection of this data should provide valuable information about the current status of the reefs within the SCMR.

   Results-

Figure 5 shows the benthic cover percentage for the five surveys conducted in the LBCNP area. Live coral cover varies between 8-18% and was slightly higher within the park. Macroalgae is responsible for between 11-21% of the cover. Although the low coral cover is of some concern, the low algal cover is a good sign . It is important to note that these sites have only been surveyed once and were randomly chosen from

satellite images and there fore may or may not be representative of the reefs within the park.

Figure 5

Average Benthic Cover At Sites Inside and Outside LBCNP

In addition to information about benthic cover additional information was collected about the species composition at each site. Figure 6 shows the coral composition for each of the locations sampled in 2006. This graph reflects the contribution of each coral species to the total coral cover at each site. . Approximately seventeen different coral species were observed in and around LBCNP, this number is consistent with other surveys done across the MBRS region (Salgado et al., 2006). With the exception of one of the sites there seemed to be a fairly consistent distribution of coral types. It would appear that the most common corals include the massive reef building corals *Montastrea annularis* and *Montastrea faveolata* along with *Agarica tenuifola*, *Colpopyhilla natans, Porites asterodies* and *Porites porites* were the most common coral species encountered. On average fire coral *Millepora spp.* made up a significant portion of the coral species at a number of sites. Dominance by a limited number of species is not surprising given the survey method.

Figure 6

Coral Species Composition
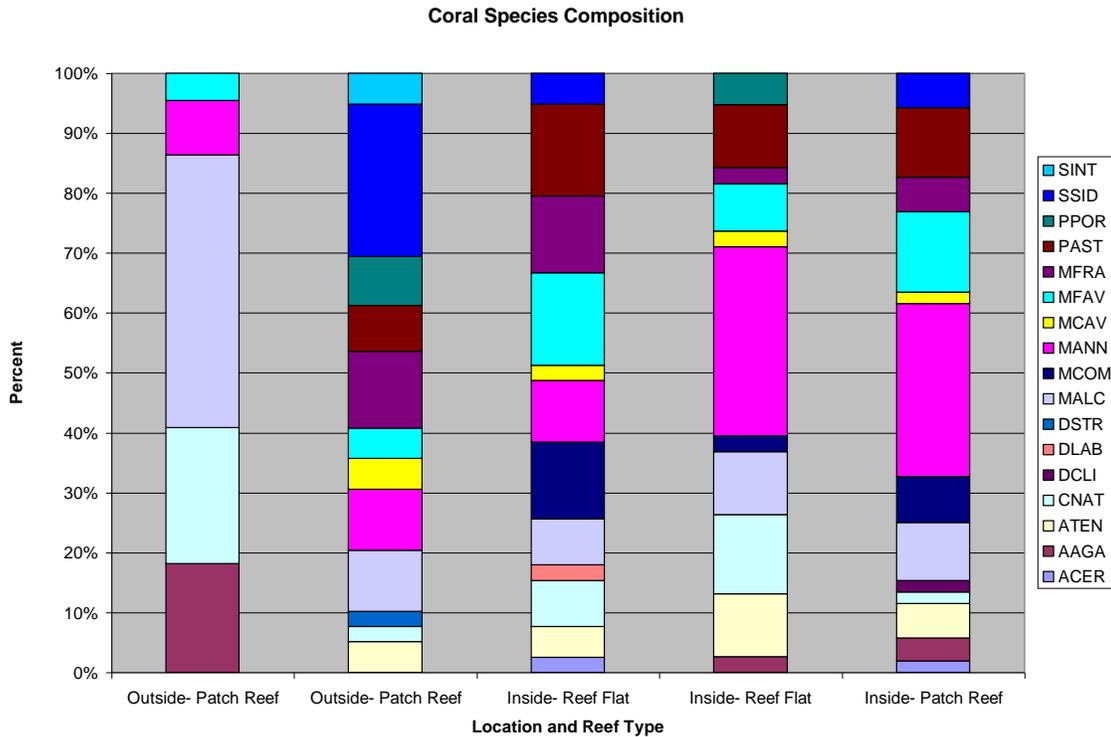
Evaluation and Recommendations-

Although the data collected during the AGRRA surveys in 2006 provides some good information about the benthic and coral composition more data is necessary in order to establish a solid baseline as to the status of the reefs. There have been a number of surveys carried out at LBCNP in the past few years, unfortunately FoN does not have these on record. Efforts should be made to try and gather existing data on coral reef health so as to build a better baseline about the status of the reefs within the reserve. Additionally, starting in 2008 FoN will establish at least 5 MBRS monitoring sites within the reserve. These sites should be located in a variety of habitats and be strategically chosen so as to cover areas currently being used by tourists and more unknown areas. The development of a MBRS monitoring program which is carried out systematically will provide more detailed information about the status of the reefs within LBCNP. Finally, more statistical analysis is necessary to be able to determine if the results presented here are significant.

Coral Health

Again, data presented here is taken from the surveys completed by WWF in 2006. AGRRA uses six individual 10m transects to sample coral health. Each of the corals encountered along the 10m line are measured and their health is assessed. The preliminary results from this evaluation are presented here.

Results-

Figure 7 shows the average mortality for the corals encountered along the line. The graph illustrates the amount of recent and old dead which make up the average total mortality for each of the sites. Further analysis of this data might indicate differences in species mortality and any significant variations between sites.

Figure 7

Average Mortality
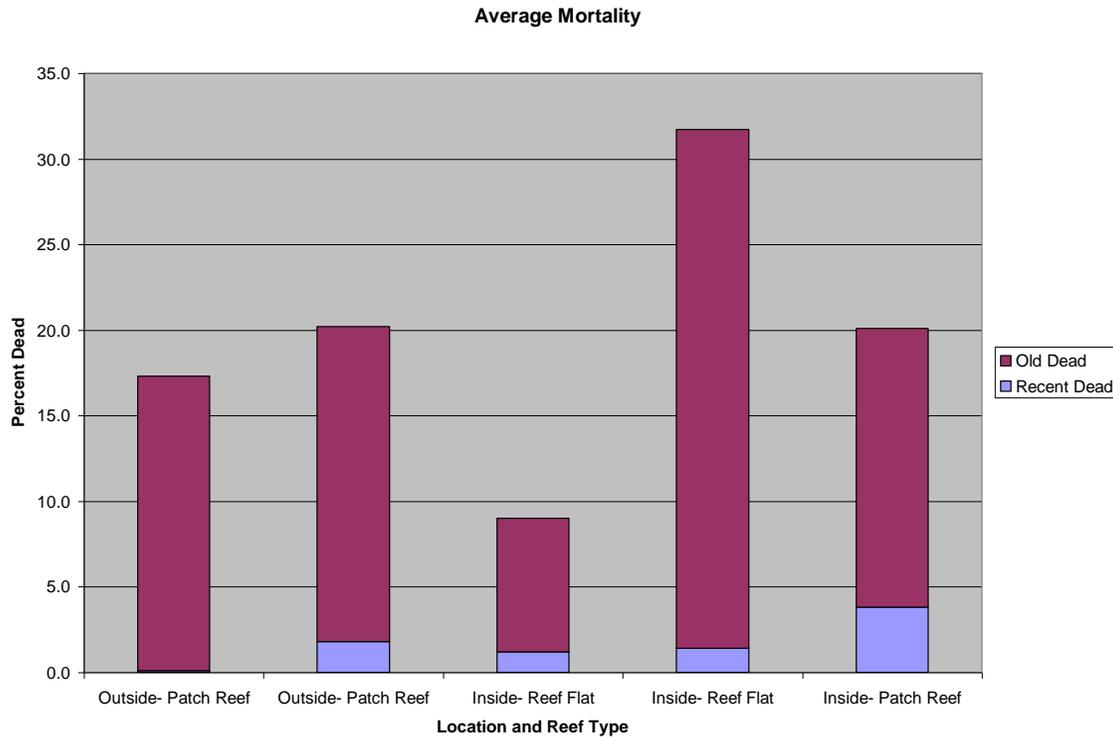
Evaluations and Recommendations-
Further analysis of the data collected during the AGRRA surveys is necessary in order to have a better idea about the health of coral colonies sampled. As mentioned above the addition of MBRS sites within LBCNP should provide much greater information on the health of corals within the park. There have been noted increases in bleaching and coral disease over the past few years and more information is necessary to allow managers to develop appropriate plans of action to combat these threats. In addition, efforts should be made to work with other scientists working in the area to gather a more substantial baseline on coral health.

Reef Fish
The final area evaluated through the AGRRA surveys that will be included here were surveys done on reef fish. The methodology calls for eight 30m transects to be conducted at each site. The number and size of fish from a specified list are recorded. This method allows for the calculation of both density and biomass for specified species.
Results-
Figure 8 shows the biomass observed for both herbivores and piscivores. At most of the sites there does not appear to be a large difference between the two classes. This seems to indicate a fairly healthy ecosystem. Figure 9 shows the total fish biomass observed at each site and then compares that to the biomass for commercially important species such as grouper, snapper, jack and a few others. Further comparison of this with data from other sites might yield some insight as to the effect of MPA management.
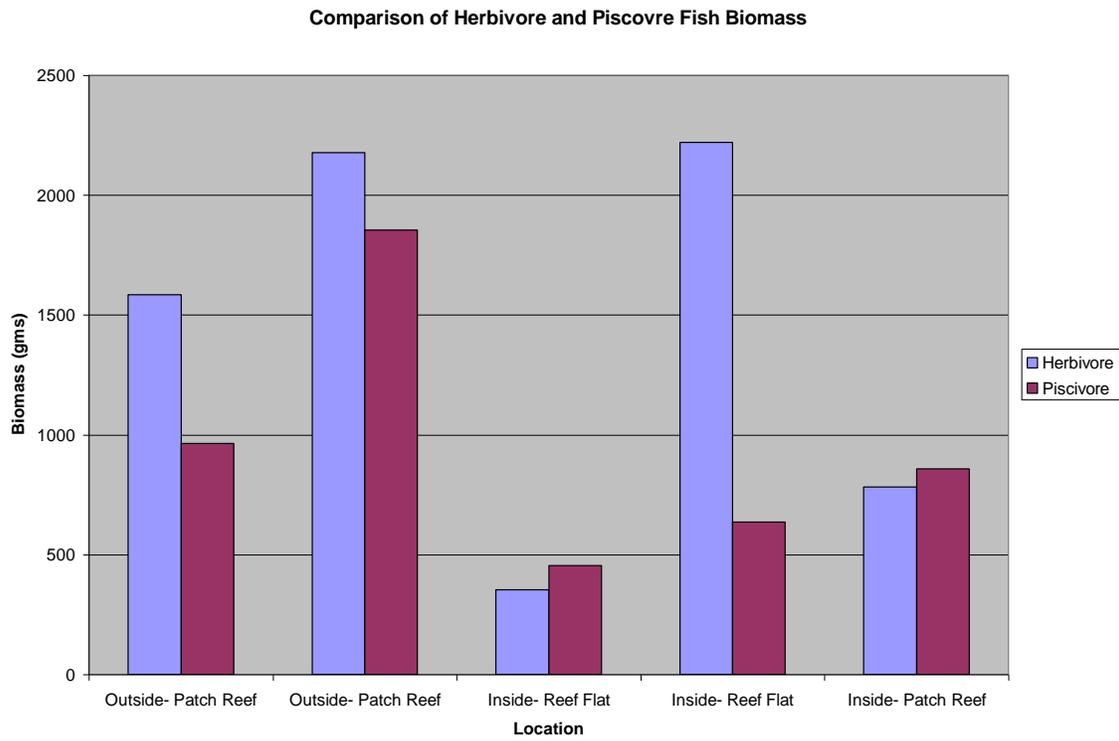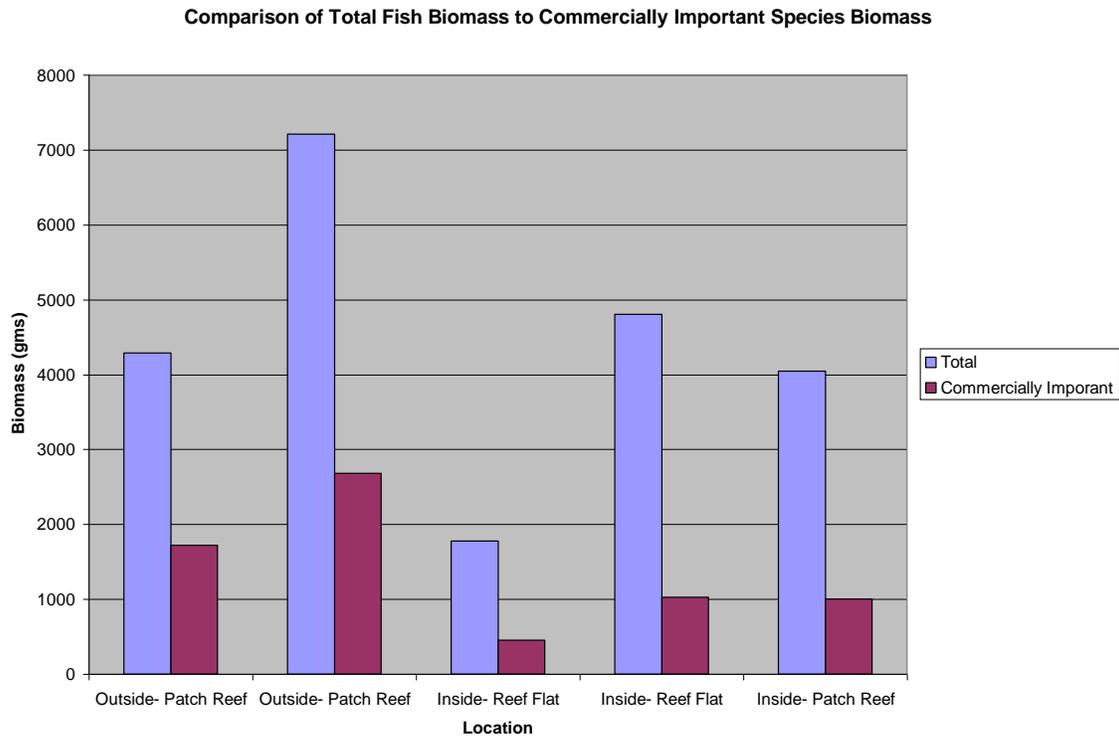
Figure 8

Comparison of Herbivore and Piscovre Fish Biomass

Figure 9

Comparison of Total Fish Biomass to Commercially Important Species Biomass

Evaluations and Recommendations-

Overall the data collected on finfish by the AGRRA surveys provides some interesting information. Further analysis is necessary in order to break down the species composition. Additional statistical analysis is also necessary in order to determine if trends are significant. The establishment of MBRS sites will contribute greatly to knowledge about reef fish within the reserve.

Diseases and Other Natural Phenomenon
Currently there are no established monitoring programs which target diseases or other natural phenomenon. Coral health and disease are specifically targeted under the MBRS project such that if MBRS SMP monitoring is implemented at LBCNP some data will then be collected on key coral health indicators. It is highly recommended that managers work together to develop an emergency response plan for disease, bleaching and hurricanes. In order for managers to react appropriately do these threats it is vital that the mapping undertaken by Lisa Carne be finalized. This program should seek to ground truth the existing habitat maps for the LBCNP generated by the Coastal Zone Management Authority and Institute. A good understanding of the locations and current status of the reef will allow managers to properly address outbreaks of disease and other threats to the reef.

Water Quality
There is no water quality monitoring currently occurring at Laughing Bird Caye National Park. Discussions are currently on going to develop a basic water quality monitoring program for the park, similar to the system that was developed for the Sapodilla Cayes Marine Reserve. In addition, efforts are underway to develop links between the work that Tim Smith is conducting in the lagoon and water quality issues at Gladden, Laughing Bird and along the coast. It is hoped that this program can be initiated in mid-2008, although it will be necessary to identify additional finances for this program.

Meteorological Data
No meteorological data is currently being recorded. It is recommended that rainfall and temperature data be collected daily at Laughing Bird.

Visitation
Information on recreational activities is collected by the rangers at Laughing Bird daily. This information includes the number and type of guests as well as information about their activities within the park.
      Results-
Unfortunately due to time constraints it was not possible for visitation data to be thoroughly included in this report.
      Evaluation and Recommendations-
Visitation data about the LBCNP is currently being well collected. It is hoped that FoN will continue to work to improve its ability to utilize this data for management purposes. This will include developing more comprehensive reporting systems for visitation data.

Conclusion

Overall there has been a concerted effort to collect valuable data about the status of the resources at LBCNP. All staff who have contributed to data collection and analysis should be commended on their efforts to contribute to the existing information about the park. One of the major set backs to these efforts has been the high levels of turnover for biologists. This coupled with the lack of a written plan for monitoring has made data

collection sporadic. This has also left a number of gaps (many of which have been highlighted here) in the data that has been collected. A concerted effort should be made to try and formalize the monitoring plan for Laughing Bird so as to ensure more consistent data collection. A large quantity of data has been collected at LBCNP in recent years; however, FoN does not have record of this data or findings. FoN should continue to work with partners to ensure full disclosure of research results and data to feed into existing monitoring databases.   Along with improvements to the data collection methodologies additional statistical analysis of the data presented here is essential to determining the significance of these findings. Biologists and technical staff should be trained in basic statistics so as to ensure better integration of monitoring activities and management actions. It is hoped that this report will represent the continuation of FoN's efforts to try to improve links between science and management.

References

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Appendix 1

Laughing Bird Caye National Park

Commercial Species Sites

SITE	X	Y
CS1	374392	1821000
CS2	371000	1816666
CS3	369280	1816000
CS4	374000	1824458
CS5	371991	1818330
CS6	372436	1818571
CS7	379216	1815710
CS8	368805	1819981
CS9	375905	1816609
CS10	368072	1817869
CS11	367682	1814862
CS12	372283	1818079
CS13	372121	1817972
CS14	372006	1817967

Laughing Bird Caye Demarkation Buoys

Site ID	Eastings	Northings
Points A	375904	1821478
Points B	374630	1825363
Points C	372904	1825363
Points D	368860	1819430
Points E	368860	1815416
Points F	371073	1815416

Legend

- Wreck Coordinates LBC Site
- LBC Commercial Species Sites
- LBC_Buoys_Points_GOB
- Belize Coastline
- Laughing BirdCaye National Park

UTM: NAD 27 Zone 16N

1,300 650 0 1,300 2,600 3,900 5,200

Meters Prepared By: Muschamp