The Distribution, Diversity and Abundance of Elasmobranches in the Mangrove Creeks of South Eleuthera, Bahamas

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INTRODUCTION

Over the past several decades, shark populations have been declining at an increasing rate (Myers et al. 2007). All elasmobranchs have k-selected life histories meaning that they have a long lifespan and take many years to sexually mature. Elasmobranchs also have a low fecundity, thus it is very difficult for their populations to recover from any unnatural decline in their populations. Bull (*Carcharhinus leucas*) and Sandbar (*Carcharhinus plumbeus*) shark populations have decreased over the past 38 years by rates of 87% and 99% respectively. Declining elasmobranch populations have strong top-down effects on the food chain affecting other species populations (Myers et al. 2007).

Longline fishing, the predominant capture method for commercial shark fisheries, has been banned in the Bahamas since 1993. However other anthropogenic threats such as coastal development can be very detrimental to local species. For example in Bimini there was a 23.5% decrease in first year survival rates of juvenile lemon sharks due to the destruction of their natal grounds (Jennings et al. 2008). Juvenile lemon sharks demonstrate particularly high site fidelity towards their nursery grounds (Chapman et al. 2009), so the destruction of their natural habitat has particularly damaging effects. South Eleuthera is home to many shallow creeks used by an array of juvenile elasmobranchs, development destroys the creeks, which provide an ideal habitat for juvenile lemon sharks. Recent developments on Cape Eleuthera and in Cotton Bay have contributed to the loss of many mangrove habitats along the coast. Currently 60% of The Bahamas' GDP is generated by tourism (Buchan 2000), so this development is likely to continue all over the Bahamas.

There is currently little to no data on the elasmobranchs in South Eleuthera, so the purpose of this empirical study was to establish a baseline data set composed of abundance, diversity and distribution of the elasmobranches that reside in mangrove creeks.. This study seeks to demonstrate the degree to which the stage, sex, and CPUE of elasmobranches in South Eleuthera, The Bahamas vary with, and are dependant upon creek location.

FIGURE 2: A dart tag attached to the pectoral fin of a juvenile lemon shark

FIGURE 3: Students search for organisms caught in a seine.

METHODS

The research was conducted in Broad Creek, Page Creek, Plum Creek, Kemps Creek, and Deep Creek in South Eleuthera, Bahamas between March and June (FIG. 1).

The 100-meter survey line has ten, 1-meter long gangions with a float above each one to keep the line on the surface. Size 11/0 circle hooks are attached on the end of the leaders. Every four gangions, a weight is set in order to keep the line from floating away. At the eighth gangion, water depth is recorded. Bonito is used as uniform bait. The line is set for two hours and the gangions are checked every half hour to re-bait if necessary.

Captured sharks are measured (recording the total length, precaudal length, fork length, and stretched length) and then weighed. Dart tags are then implanted in sharks (FIG. 2) and a small piece from the tip of the dorsal fin is taken for a DNA sample. The shark is sexed, observing the stage by its umbilical scar. The shark is then released and the time is recorded in military time to the second.

The second method uses a "seine," or a 150-meter long, 2 cm wide mesh net, used to observe the diversity and abundance of potential prey items in the same five creeks (FIG. 3). The seine is circled around a designated area then closed off, trapping all organisms inside. The top of the seine has floats and the bottom has weights in order to prevent escapes. Each organism collected is weighed (in grams) and measured (in centimeters), and released unharmed.

A Catch Per Unit Effort variable is important because it calculates the amount of effort it takes to catch one shark in the field. Three statistical tests: ANOVA, Kruskul Wallis, and Spearman Rank Correlation are used to analyze and compare different variables such as CPUE, or the sex of sharks, and help us generate our P-Values.

RESULTS

The study period lasted from February 9th through May 6th.. Fifty-one young-of-the-year (YOY) lemon sharks were caught over the course of this study, with fork lengths ranging from 51 to 96 centimeters. Two nurse sharks and three southern stingrays were also caught, accounting for 10.53% of our total catch. Thirteen previously tagged lemons were recaptured, twelve in the same location they were originally caught in, and only one in a different but nearby creek, denoting 92.31% site fidelity among recaptured lemons. The mean fork length of sharks caught in each creek ranged from 58.75cm to 84.30cm with an overall mean of 65.82cm. (FIG. 4) The mean CPUE in the sampled creeks ranged from 0.0096 to 0.0563, with an overall mean of 0.02818 (FIG. 5.), and a P value of 0.035 when comparing all five creeks using a Kruskal Wallis test, indicating a significant difference in the relative abundance of sharks between the five creeks. Significant differences were found using a Mann-Whiteny test between Broad Creek and Deep Creek (P=0.013) and Broad Creek and Plum Creek (P=0.017), as well as between the Rock Sound (North) side of Cape Eleuthera, including Kemps Creek, Page Creek and Broad Creek, and the Exuma Sound (South) side of Cape Eleuthera, including Deep Creek and Plum Creek (P=0.002) (FIG. 6). There is a direct relationship between the CPUE's of mojarra and lemon sharks. Using a spearman rank correlation test there was a 0.8 correlation between the mean CPUE's of mojarra and lemon sharks. The P-value of the relationship was 0.0517 showing that there was no statistical significance (FIG. 7). The ratio of male to female sharks and number of sharks caught varied between creeks. There was also a large gender divide between the Rock sound and Exuma sound sides of the cape. (FIG. 8).

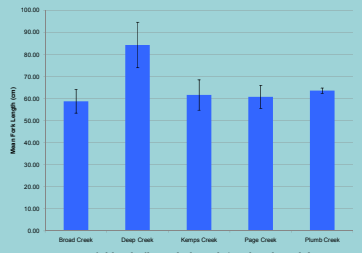

FIGURE 4: Mean fork length of lemon sharks caught in each creek sampled.

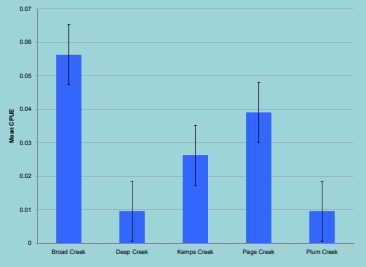

FIGURE 5: Mean CPUE of lemon sharks in each in five sampled creeks. Error bars indicate ±1 standard deviation.

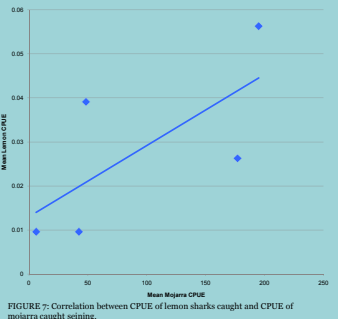

FIGURE 7: Correlation between CPUE of lemon sharks caught and CPUE of mojarra caught seining.

FIGURE 9: Shallow Mangrove Creek

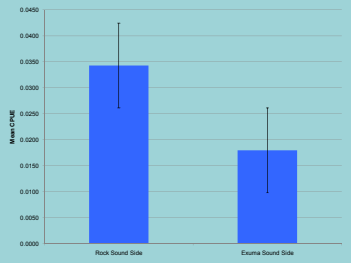

FIGURE 6: Mean CPUE of creeks along the Rock Sound (North) and Exuma Sound (south) sides of Cape Eleuthera.

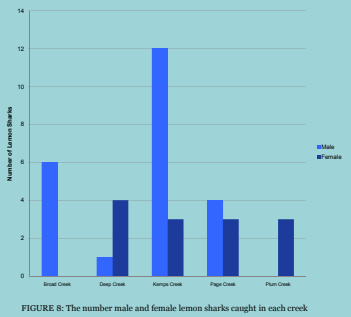

FIGURE 8: The number male and female lemon sharks caught in each creek

DISCUSSION

The data does support the hypothesis that the stage, sex and abundance of juvenile lemons sharks vary between creeks.

Studies have demonstrated that lemon sharks exhibit strong site fidelity towards their nursing grounds (Chapman 2009). The high recapture rate within original tagging location supports this theory.

The differences in CPUE between creeks may be a result of potential prey abundance. Studies show that lemon sharks prefer mojarra as a source of food (Newman 2010); the correlation between mean CPUE of mojarra and mean CPUE of lemons sharks supports this theory. The non-significance of this correlation (FIG. 7) may be attributed to our small data set.

Physical differences between the Rock Sound and Exuma Sound sides of the island may be accountable for CPUE variations. The Rock Sound side contains more juvenile shark habitats such as shallow mangrove creeks (FIG. 9) and more access to patch reefs, whereas the Exuma Sound has deeper water, a drop off right off shore, more predator access, and is more exposed . There was some sexual segregation between the two sides of the island, however, there is insufficient data to conclude why this may be.

Physical differences may also be the cause of the demographic variation between creeks; significantly larger sharks were caught in Deep Creek, possibly because Deep Creek is larger and has deeper water than other study sites, creating a habitat more suited to larger, and more mature sharks.

Future research should examine other variables such as light level, temperature, time of day, creek size, and water depth to determine which factors affect CPUE data. Seining research must be expanded to account for natural variation. Additionally, data must be collected from more creeks to obtain a more conclusive data set. Lastly, physical and environmental variations in nursing grounds must be investigated. This research helps to understand shark populations on a global scale and will help manage any proposed coastal development in South Eleuthera and The Bahamas.

ACKOWLEDGEMENTS

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