A Preliminary Investigation into the Spatial Abundance, Diversity and Habitat Use of Deep Water Sharks in the Exuma Sound

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THE ISLAND SCHOOL cape eleuthera bahamas

Introduction

Overfishing

Over the past 50 years, global fisheries have been overfished to the extent of massive decline in resources (Morato et al. 2006). Since the 1970's shallow water resources have been declining, causing fisheries to move further offshore, in search of more available fish stocks (Morato et al. 2006). 70% of the world is covered in water, and 90% of that is deep water, which is considered 200 meters or deeper. This makes it the largest ecosystem in the world, but one that little is known about. This movement into deeper waters is detrimental because 581 shark and ray species (49%) live in deep water, making them extremely difficult to study.

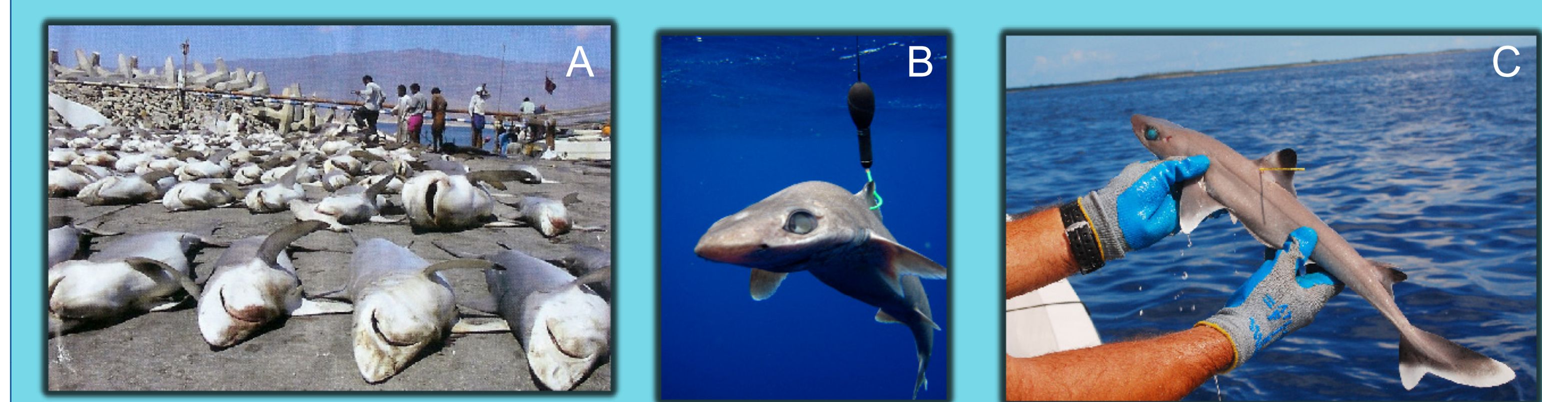


Figure 1. A) Shark finning, B) Gulper shark (*C. granulosus*), C) Cuban dogfish (*S. cubensis*).

Sharks & The Marine Ecosystem

As K-selected fish, sharks display many characteristics such as slow growth, late maturity, and low fecundity (McLaughlin et al. 2004). Sharks hold the lowest intrinsic rebound potential among fish, at 2.2%, which leaves them highly vulnerable to overfishing (Fig. 1). Sharks have an important role in their ecosystems as the apex predator. If they are removed, a trophic cascade may occur such as off the coast of New England with hammerhead sharks, cownose rays and scallops (Myers et al. 2007).

Capture Stress

Studies have shown that there are sub-lethal effects on sharks caused by post-capture stress. Even if they are returned live to the ocean, the trauma that they go through could be harmful. Handling from hooks, predation on the line, and exhaustion from capture, are some examples of these stress factors. Further research assessing these factors will lead to better management policies for global deep-water fisheries.

Methods

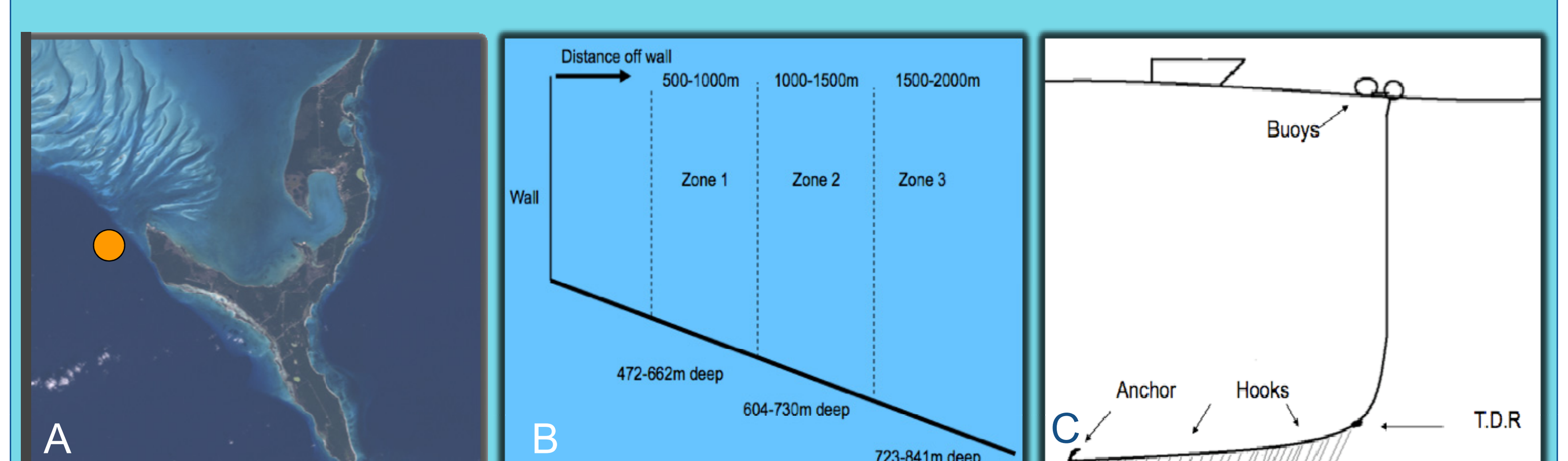


Figure 2. A) Map of South Eleuthera and study site B) Map of zones off the Wall C) Vertical Longline Survey.

Scientific Longlining

The study was conducted off Eleuthera (Fig. 2A) and concentrated throughout three different zones off of the wall which is a vertical slope (Fig. 2B) providing an easily accessible area for research. A vertical long line, 1100 meters deployed straight down with the section of hooks aligned on the bottom, was implemented for this study (Fig. 2C). A Temperature and Depth Recorder was attached ten meters before the first hook. The line was soaked for four hours, before being retrieved. Through manual labor, the line is hauled, until sharks reach the surface, and were available to be measured.

Objectives

1. **Assess the relative abundance of deep-water sharks in the North Eastern Exuma Sound, Eleuthera**
2. **Analyze their movement patterns using pop-off acoustic satellite tags.**
3. **Examine the post-capture stress on deep-water sharks.**

Measurements

Sharks were measured for pre-caudal length, fork length, total length, and stretch length. Sex was recorded, and condition upon release was visually assessed on a scale of 1-5: 1 being healthiest, 5 being dead. A DNA sample was also taken from the dorsal fin of a shark to confirm species.

Blood

Blood was taken from a shark to assess the blood biochemistry of the shark. Once the blood is pulled the I-STAT system is used to analyze blood parameters such as lactate, pH, glucose levels and pCO_2.

Results and Discussion

Ten different species of deep-water sharks were caught (Table 1). 43 vertical long line sets were completed, and 98 individual sharks were caught. There has been a 9% by-catch rate and a 13% mortality rate, which are extremely low. There has been a 2% recapture rate, which is normal compared to other studies.

Table 1. Summary of mean abundance (CPUE) and standard deviation, mean length, and sex of species caught.

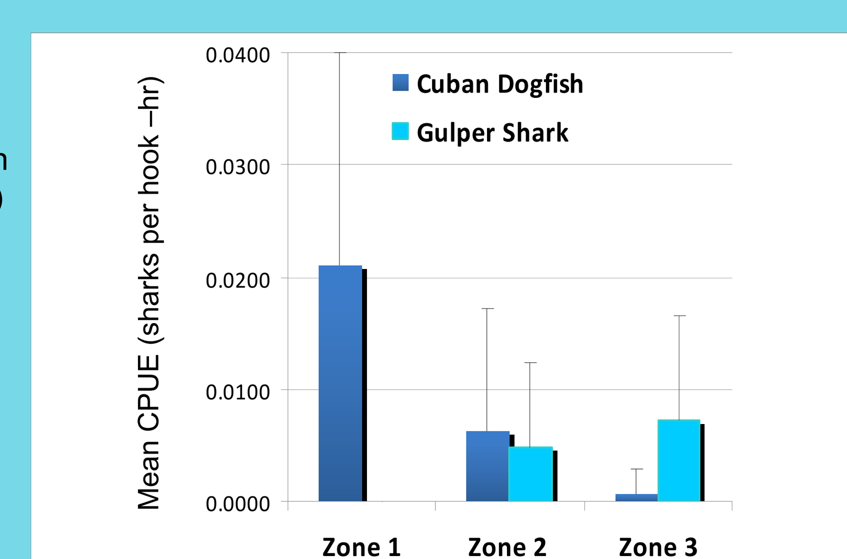
Species	Common Name	Total	Mean Abundance (CPUE) (±SD)	Mean Length (cm)	Female	Male
Squalus cubensis	Cuban Dogfish	44	0.0087 (±0.0146)	62	24	20
Mustelus canis insularis	Dusky Smoothound	7	0.0014 (±0.0044)	92	6	1
Centrophorus granulousus	Gulper	20	0.0042 (±0.0075)	86	16	2
Hexanchus griseus	Bluntnose sixgill	5	0.0008 (±0.003)	279	4	1
Hexanchus nakamurai	Bigeye sixgill	8	0.0017 (±0.0042)	148	2	6
Galeus springeri	Sawtail catshark	3	0.0008 (±0.0026)	42	2	1
Centroscymnus owstoni	Roughskin dogfish	3	0.0006 (±0.0041)	75	1	1
Centrophorus niaukang	Taiwan gulper	6	0.0013 (±0.005)	141	6	0
Carcharhinus falciformes	Silky	1	0.0002 (±0.0013)	112	1	0
Pseudotriakis microdon	False catshark	1	0.0002 (±0.0013)	227	0	1

This survey proved to be specific to catching sharks by having the hooks deployed on the ocean floor. By the line only being soaked for 4 hours, this also contributed to the low mortality rate of this study. The mean release condition for the sharks caught was a 3. There was a final recapture rate of 2.2% with a recapture of a Cuban Dogfish and a Dusky Smooth hound.

Distribution over zones

Out of all 10 species caught, only the following 2 species showed significant differences in their distribution. More Cuban dogfish were found in Zone 1 ($p=0.015$), while significantly more Gulper shark were found in Zone 3 ($p=0.042$) (Fig. 3).

Figure 3. Relative abundance (CPUE) and standard deviation of Cuban dogfish (*S. cubensis*) and Gulper sharks (*C. granulosus*) between survey zones.



Cuban dogfish appear to prefer shallower waters (Zone 1), this is where physical structures are more present. Also note that there was one Cuban dogfish caught in zone 3. Along with this, all of the Gulper sharks were caught in zone 2 and 3, we can conclude that Gulper sharks prefer deeper waters. Therefore, the habitats of the Cuban dogfish and the Gulper shark do not appear to overlap within the deep-water ecosystem too frequently.

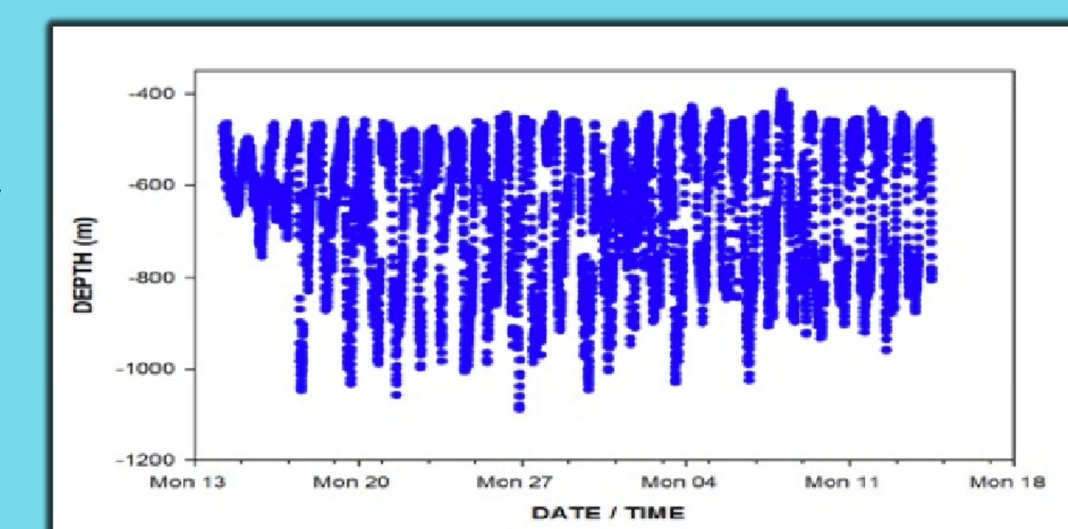
Distribution between day and night

The Bigeye sixgill was only caught during the day, which could be a result of the small sample size (n=6), or the possible diel patterns, which could be similar to the Bluntnose sixgill (Andrews, K.S. 2008). If the Bigeye sixgill does follow the same diel movement pattern as the Bluntnose sixgill, then it could be assumed that the depths it is found in at night would be considerably shallower than those in the day. If this is concluded, then this may have put the Bigeye sixgill out of the depth range for this project during the night hours.

Movement Patterns

The Bluntnose sixgills vertical movement patterns were irregular throughout the first couple days of release; due to post capture stress effects, shown by the PSAT. However, it continued to follow diel movement patterns in a more regular pattern over the following weeks. These movement patterns are based on food availability. As the plankton move up in the water column during the night the fish follow causing the apex predator, the shark, to follow.

Figure 4. Diel movements patterns of a Bluntnose sixgill (*H. griseus*) over the course of 30 days, recovered from a PSAT.



Blood Parameters Analysis

Analysis of the glucose levels showed significant difference between the rates that Gulper sharks and Cuban dogfish mobilize glucose in response to stress ($p=0.025$), and between the Taiwan gulper and Cuban dogfish ($p=0.007$), with Cuban dogfish showing significantly higher glucose levels. This indicates a species-specific response to stress.

Conclusions

The post-release survivorship of the deep-water sharks was assessed by analyzing blood parameters, PSAT data, and recapture rates. Movement patterns of the sharks such as the Bluntnose sixgill were recorded over a minimal time period but this data indicates that some species follow a diel movement pattern. Although there is still a general lack of knowledge on deep-water sharks, this data can help towards a future goal of providing fisheries with information to create better management plans.

Future Directions for Research

- Test Baited Remote Underwater Video Surveys as a method to assess the behavior of deep-water sharks.
- Continue to survey throughout the year to compare species abundance and identify possible seasonality in behavior and distribution.
- Investigate interspecies tropho-dynamics in the deep-water ecosystem.

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