The Horizontal and Vertical Movement Behavior of Silky Sharks (*Carcharhinus falciformis*) in the Western Atlantic

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Introduction

Globally, 62.6% of all elasmobranchs are threatened by extinction which is the highest percentage out of all vertebrate groups (Dulvy et al. 2014). Climate change, habitat loss and overfishing are the key extinction risks leading to many population declines.

The silky shark (*Carcharhinus falcimormis*), considered vulnerable by the IUCN Red List, is a circumtropical, coastal-pelagic species that is under pressure by these extinction risks. Silky sharks have faced population declines of 46-98%, yet they are poorly studied in the Atlantic Ocean (Cortés et al. 2007, Rigby et al. 2017). One reason that silky sharks have experienced such dramatic declines in this region is because they co-occur with tunas around fish aggregation devices (FADs). This leads to them being the second highest shark caught as bycatch (accidentally captured) around the world (Dulvy et al. 2014).

Our study focuses on the horizontal and vertical movement behavior of silky sharks. This information tells us where in the water column and ocean silky sharks prefer. By conducting our research in the Exuma Sound, we can increase the information known on the movements of silky sharks in the Atlantic, and better inform on conservation and management of this species.

Figure 1: (A) A silky shark *(Carcharhinus falciformis)* listed as vulnerable on the IUCN Red List, (B) Map of the Exuma Sound.

Objective

To characterize the horizontal and vertical movements of silky sharks in the Western Atlantic.

Methods

We targeted silky sharks through longlining and targeted fishing (Figure 2A and 2B). When a shark was caught, we secured it parallel to the boat where we took measurements, samples, and tagged the animal. These samples included blood, fin and muscle, and are used to help determine diet based on stable isotope analysis (Figure 2C).

To tag our sharks we use spaghetti tags for identification, and pop-up satellite archival tags (PSAT) for collecting movement data (Figure 2D). The PSAT tag, which will pop-off after 8 months, takes three measurements: temperature which gives us its thermal preference, light levels which show estimated location, and pressure which tells us depth.

Figure 2: (A) Students setting longline, (B) Targeted fishing, (C) Taking samples, (D) The PSAT tag and spaghetti tag.

Results & Discussion

A total of 20 silky sharks have been caught in the Western Atlantic thus far (Figure 3A). The average size of these 20 sharks was roughly 143 cm (Figure 3B). This tells us that we are catching mostly juveniles which are under the size of maturity for a silky shark (220cm).

A

Sex	Number Caught	Length (cm)
F	14	96-248
M	6	124-209

Figure 3: (A) Biological data of tagged silky sharks, (B) The map depicts the tagging locations of all silky sharks thus far in green, and the location of the Cape Eleuthera Institute (CEI) in yellow.

Horizontal Movement

We believe that all of the juveniles captured in the Exuma Sound stayed there. This is supported by the tagging information from Silky 1 (Figure 4A). This animal was originally tagged in March of 2018 with a spaghetti tag and recaptured and tagged with a satellite tag in April of 2019, both in the Exuma Sound. The tag popped off in the Exuma Sound as well, furthering the point that these sharks do not leave this habitat. In addition, the light-based geolocation data did not show a clear and distinct migratory pattern which led us to believe that the silky shark stayed in the Exuma Sound (Figure 4B).

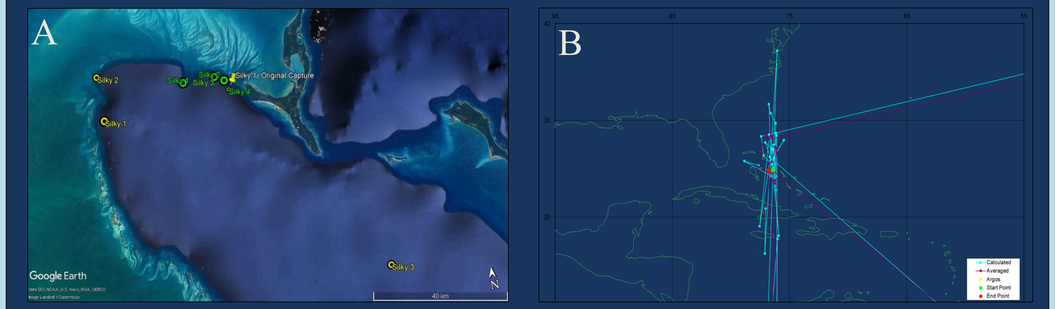

Figure 4: (A) A map of silky sharks tagged off of Eleuthera. The green dots represent the tag deploy locations, and the yellow dots represent the tag pop-off locations. (B) horizontal movement of Silky 1. The green dot represents the tag deploy location, and the red dot represents the tag pop-off location. The blue and purple lines are the estimated location based off of light levels.

Vertical Movement

Additionally, data from the tag mentioned above indicate the temperature and depth preferences. Of these data, most points fall between 23º and 27º Celsius and 0-150m in depth. These points indicate that the shark preferred shallower, warmer water, also known as the epipelagic zone. This puts silky sharks at an increased risk of being caught as bycatch in tuna fisheries because silky sharks and tuna have coexisted in the same portion of the water column (Figure 5).

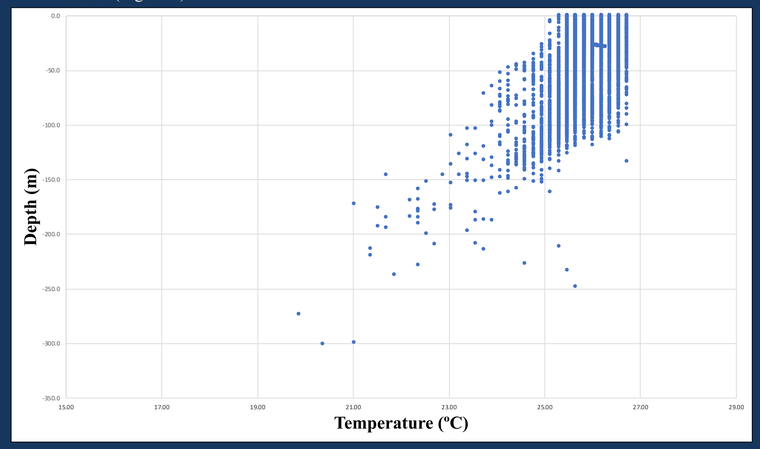

Figure 5: Vertical movement of Silky 1. Each point represents a two minute period where the shark's depth and temperature was measured. This is over a two-month period.

Conclusions

This study is the first to focus on the long-term movements of silky sharks in the western Atlantic Ocean. All of the silky sharks that have been caught in the Exuma Sound have been juveniles. Thus far, the tagging data have indicated that they all stayed within the Exuma Sound.

This has led us to believe that there is something unique about the habitat of the Exuma Sound as the juvenile silky sharks chose to stay in this area instead of making larger scale movements like others of similar size do in different habitats. This is beneficial for these animals because if they remain in the Exuma Sound they are protected within the Bahamian national shark sanctuary (Figure 6).

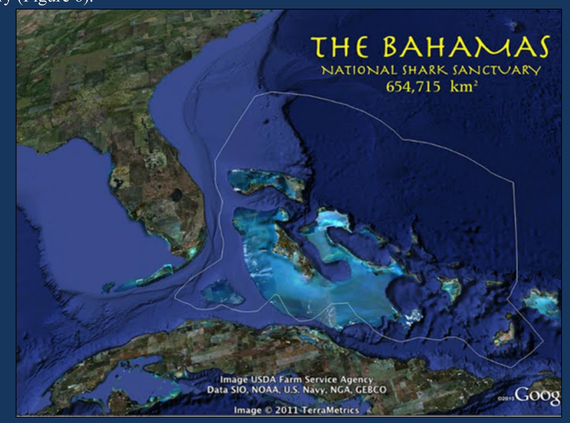

Figure 6: A map of The Bahamas shark sanctuary.

As these sharks mature, it is likely that they will begin to make larger scale movements outside of the protected area of The Bahamas into open, international waters. This will greatly increase their susceptibility to both targeted fisheries and bycatch which is a major cause of mortality in silky sharks. Because of this, we will be shifting the focus of our study to tagging only adult silky sharks because we need to know where they are going in order to implement conservation methods. Understanding their movement is important so we can begin communicating with law makers in the future to make conservation possible. The information in this study has the power to help conserve silky sharks throughout the entirety of their lifetime.

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