Assessing shark movements locally and internationally

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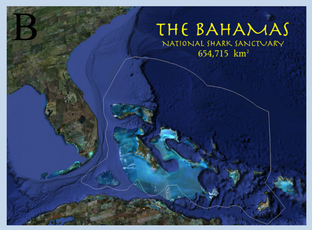
Introduction

Globally, numerous shark species are known to be apex predators, acting as important mediators of ecosystems, maintaining equilibrium and regulating the populations of lower trophic levels (Worm *et al*., 2013). In addition, sharks are vulnerable to extrinsic pressures due to conservative life history characteristics, including late maturation, low fecundity and low natural mortality (Worm *et al*., 2013).

Sharks are under increasing threats due to habitat degradation, overfishing, and bycatch from fisheries (Afonso *et al.,* 2011). Commercial interests in shark products continue to escalate, largely driven by the shark finning industry in Asia. The scale of such demand is immense, and therefore is inherently difficult to regulate.

Despite their importance within the environment, 48% of all shark species are considered data deficient by the International Union for the Conservation of Nature (IUCN, 2012). Lack of information regarding these species is the greatest challenge to the global conservation and management of shark species, and therefore information pertaining to even the most basic life history of these species has never been more critical.

Since 2011, The Bahamas has been a shark sanctuary, prohibiting both recreational and commercial shark fishing, as well as the trade of any shark products. However, many species are capable of migrating among great spatial scales, which may lead them to areas where they are vulnerable to exploitation. This research assignment addresses the issue of data deficiency by surveying and documenting shark populations around South Eleuthera, with an emphasis on bull shark migratory patterns.



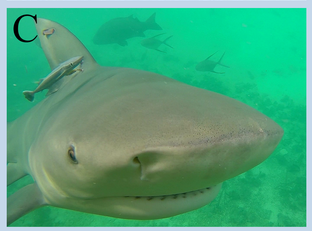


Figure 1. A) This figure shows a nurse shark in tonic immobility while caught on a longline. **B)** This figure shows the Bahamas Shark Sanctuary put in place in 2011. A shark Sanctuary banns all fishing both commercial and recreational along with any and all trade of shark products. **C)** A previously tagged bull shark in the Cape Eleuthera Marina.

Objectives

- Observe the local assemblages of shark species by assessing populations around Cape Eleuthera through a longline survey
- Monitor the migratory patterns of bull sharks (*Carcharhinus leucas*) using acoustic and satellite telemetry
- Use gathered data to fill data deficiencies and establish new potential protection areas outside of shark sanctuaries

Results

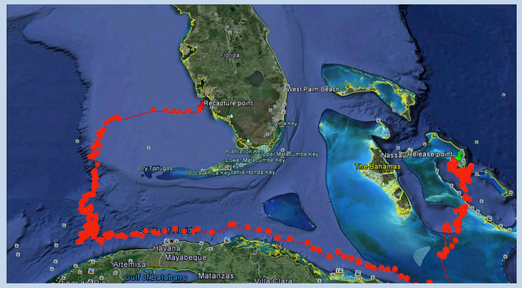


Figure 2. Data collected from PSAT tag number 107800 maps a bull shark's migration out of the Bahamian shark sanctuary, past Cuba and along the coast of Florida, where sharks are not protected under the same legislation.

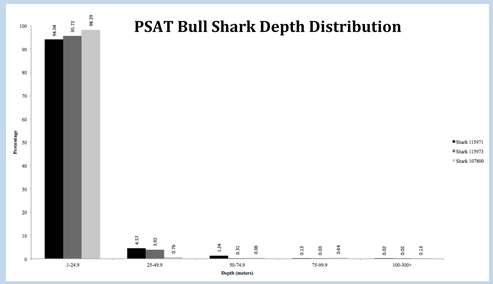


Figure 3. Bull shark depth distribution data from PSAT tags of three individuals.

Figure 4. Locations of the 351 bull shark receiver detections around Cape Eleuthera.

	Shark 115971	Shark 115973	Shark 107800
.1-24.9m	94.04%	95.72%	98.29%
25-49.9m	4.57%	3.92%	0.76%
50-74.9m	1.24%	0.31%	0.38%
75-99.9m	0.13%	0.03%	0.44%

Table 1. Bull shark depth data via PSAT

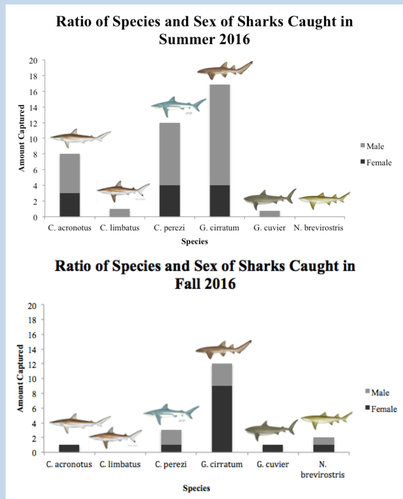


Figure 5. The seasonal local assemblages of sharks in Cape Eleuthera through the longline survey. Data from 42 and 23 sharks caught in the summer and fall respectively with sex ratios depicted.

Methods

- Sharks were caught on a 500 meter longline
- Morphometric measurements (fork length, pre-caudal length, and total length) are taken in addition to species and sex being determined
- White-muscle and DNA samples are taken via dermal punch, and 1 mL of blood is collected via caudal blood vessels
- All bull sharks caught receive a Pop-up Satellite Archival Tag (PSAT, Figure 8, Microwave Telemetry, Inc) fitted to their dorsal fin via a tether and an acoustic tag (Vemco V16, Microwave Telemetry, Inc) that is surgically implanted into the body cavity via a surgical procedure
- The PSAT stays attached to the dorsal fin for six months before popping off and transmitting the data it has collected
- The acoustic tag has a battery life of roughly ten years. It sends a ping to a receiver when the tagged shark passes within approximately 300 meters

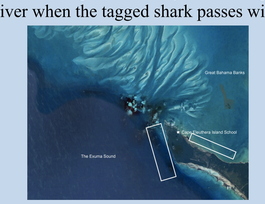


Figure 7. The two site locations are the Great Bahama Banks zone, and the Exuma Sound Shelf zone. These are heterogeneous sites, the banks zone being a largely shallow, soft sediment dominated area, and the shelf zone a deeper coral and biogenic reef.

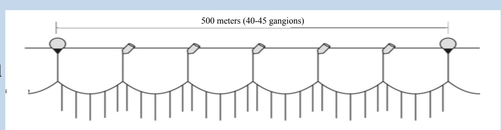


Figure 6. In the survey, a 500 meter longline is used, with a total of 40-45 gangions, which are placed every five meters.

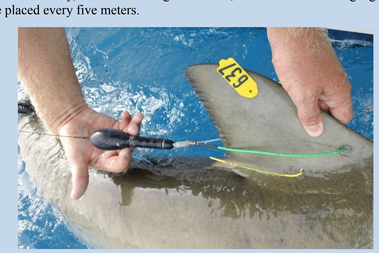


Figure 8. Each shark receives a cattle tag and a dart tag. Both provide information that can identify the shark in case of recapture. In addition, Bull sharks are given a PSAT tag.

Discussion

Data provided here demonstrates large-scale migrations among tagged bull sharks, clearly demonstrating international movement among multiple countries. This scale of migrations will have the capacity to potentially increase vulnerability to exploitation as individuals move between protected and unprotected waters. The three individuals that were fitted with PSATs spent around 96% in a depth ranging from 0-25 meters. This is relevant because it can be used to provide frameworks for commercial or recreational fishermen to adjust depths in order to avoid unwanted bycatch.

This data will provide baseline assessments which will assist in further understanding different aspects of these species ecology. For example: temperature ranges, species interactions, and specifically what species they might prey on, all leading to a better understanding of how bull sharks play a role in their ecosystem. Acoustic telemetry data suggests that over 70% of detections were occurring within the marina, likely due to the fact that bull sharks here are being provisioned by local fishermen who regularly clean their catch there.

Historical longline surveys up to and including this semester's research has determined that blacknose and reef sharks were caught in higher abundances during the summer compared to the fall, which could potentially allude to species-specific migration patterns. Lemon shark populations increased in the fall, demonstrating a similar trend. There were more male nurse sharks caught in the summer due to mating season, while more females were caught in the fall.

Future Research

Data retrieval of the one juvenile tiger shark (*Galeocerdo cuvier)* tagged is expected mid December. In the future, catching and tagging juvenile tiger sharks will assist in filling the data deficiency surrounding migratory patterns. In addition, comparing bull sharks to other species will give insight into differences in depth and movement patters. Lastly, by continuing to fill the larger data set collected from the longline survey a study can be conducted to learn about annual population trends of different shark species.

Literature Cited

- Afonso A.S., Hazin F.H.V., Carvalho F., Pacheco J.C., Hazin H., Kerstetter D.W., Murie D., and G.H. Burgess (2011). Fishing gear modifications to reduce elasmobranch mortality in pelagic and bottom longline fisheries off Northeast Brazil. *Fisheries Research,* 108, 336-343.
- Brooks, J.E., Sims W.D., Danylchuk J.A., and K.A. Sloman. (2013). Seasonal abundance, philopatry, and demographic structure of Caribbean reef shark (*Carcharhinus perezi)* assemblages in the north-east Exuma Sound, The Bahamas. *Marine Biology,* 160, 2535-2546.
- Diaz, G.A., and J.E. Serafy. (2005). Longline-caught blue shark (*Prionace glauca*): factors affecting the numbers available for live release. *Fisheries Bulletin*, 103, 720-724.
- IUCN 2011. IUCN Red List of Threatened Species. Version 2011. 2.
- Worm, B., Davis, B., Kettemer, L., Ward-Paige, C.A., Chapman, D., Heithaus, M.R., Kessel, S.T., and S.H. Gruber. (2013). Global catches, exploitation rates, and rebuilding options for sharks. *Marine Policy*, 40, 194-204.

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