Validating a Novel Non-Invasive Method for Surveying Sharks

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Introduction

Sharks, a member of the elasmobranch fauna, influence the entirety of the global marine ecosystem, acting as influential apex predators (Myers et al. 2007). Sharks have K-selective life history traits, meaning they are slow growing, long living, have a late age of maturity, low natural mortality rate, and a low reproduction rate. As a result of these characteristics in conjunction with anthropogenic disturbances, the shark species has experienced a significant, global decrease in abundance (Baum et al. 2003). The main disturbance influencing the shark population decline is overfishing. For example, in Asia, shark fin soup is a delicacy, driving the high demand for sharks.

There is currently a lack of information surrounding the shark population and the reason for its decline. Therefore, methods of conservation research must be evaluated before further information is collected. This study examines two developed methods: longline surveys (Pikitch et al. 2005) and baited remote underwater video surveys, or BRUVS (Meekan et al. 2006). These techniques convey data known as relative abundance, the measure of population specific to an area and time. The common method used for shark research is longline surveying, an invasive practice that can potentially inflict stress and mortality. An alternative technique used to generate the same type of data is BRUVS, which The Cape Eleuthera Institute is pioneering in the Western hemisphere. Both long-line fishing and BRUVS provide data known as catch per unit effort (CPUE), a measure of shark abundance in relation to observation time.

The purpose of this study is to determine the accuracy of baited remote underwater video surveys in comparison to longline surveys in reflecting trends in relative abundance. The hypothesis for this study is that longline surveying and baited remote underwater video surveys will reflect the same trend in terms of the relative abundance of sharks.

Figure 3: A tagged Caribbean reef shark being placed in tonic immobility before being released from the longline.

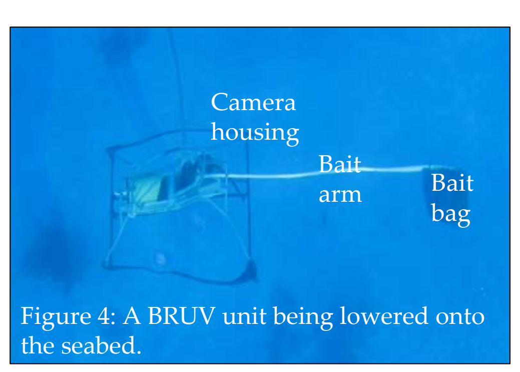

Figure 4: A BRUV unit being lowered onto the seabed.

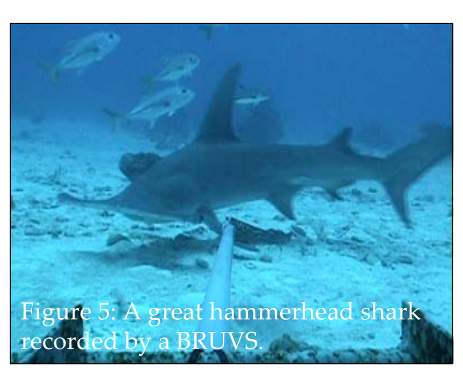

Figure 5: A great hammerhead shark recorded by a BRUVS.

Literature Cited

Baum, J.K., Myers, R.A., Kehler, D.G., Worm, B., Harley, S.J., Doherty, P.A. 2003. Collapse and Conservation of Shark Populations in the Atlantic. *Science Magazine* 299:389-392.

Meekan, M., Cappo, M., Carleton, J., Marriot, R. 2006. Surveys of Shark and Fin-fish abundance on the reefs with in the MOU47 Box and Rowley shoals using Baited Remote Underwater Video Surveys. *Australian Government Department of the Environment and Heritage*: 1-28.

Myers, R.A., Baum, J.K., Shepard, T.D., Powers, S.P., Peterson, C.H.. 2007. Cascading Effects of the Loss of Apex Predatory Sharks from a Coastal Ocean. *Science Magazine* 315:1846-1850.

Pikitch, E.K, Chapman, D.D., Babcock, E.A., Shivji , M. S.. 2005. Habitat use and demographic population structure of elasmobranchs at a Caribbean atoll (Glover's Reef, Belize). *Marine Ecology Progress Series* 302: 187-197.

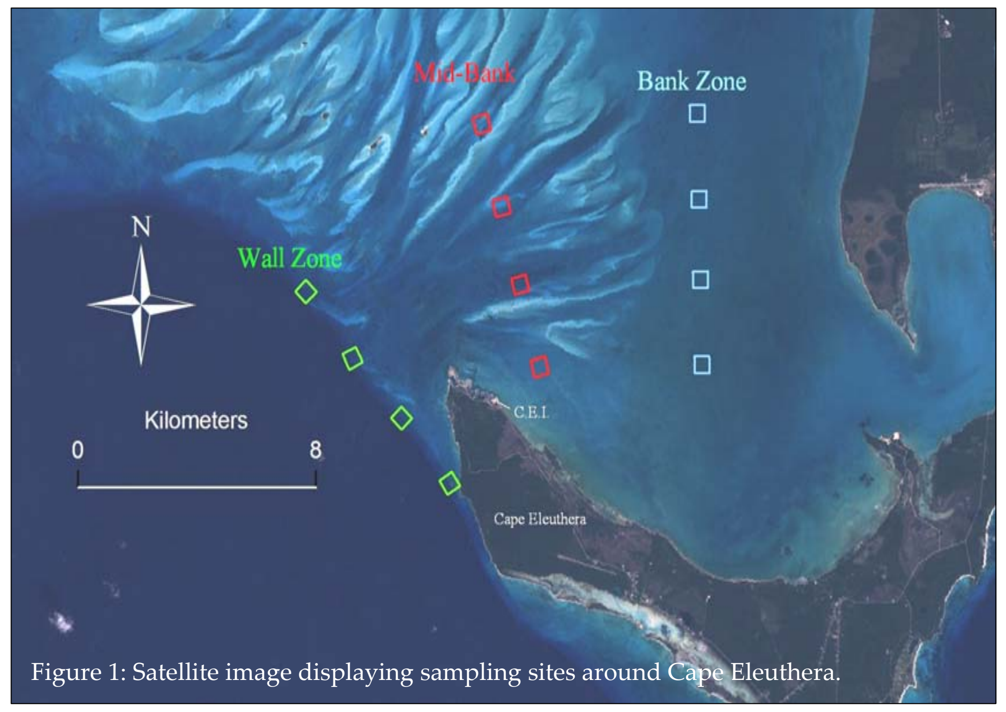

Figure 1: Satellite image displaying sampling sites around Cape Eleuthera.

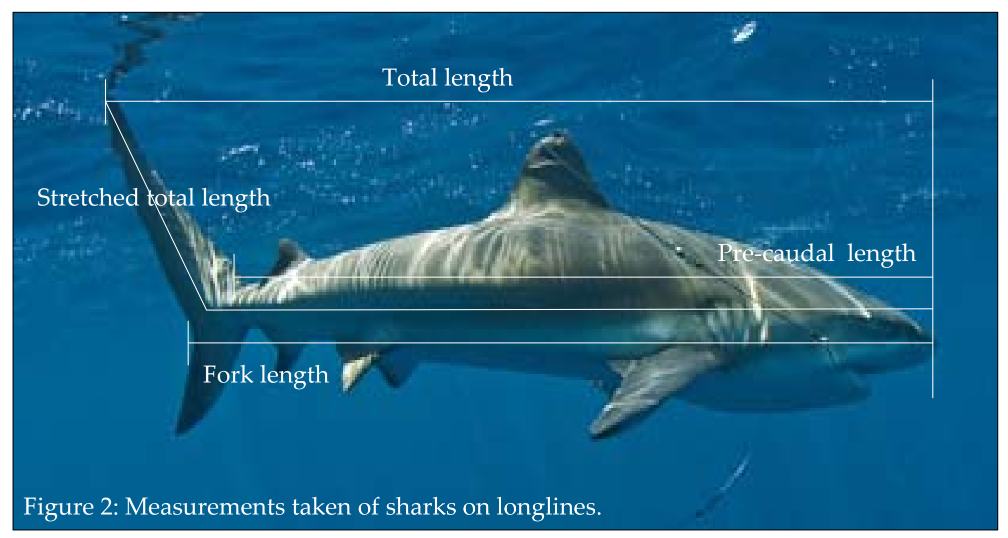

Figure 2: Measurements taken of sharks on longlines.

Methods

Study Site

Data were collected on seasonal sampling periods. To date, surveys have been conducted in the summer (July-August) and the fall (October-November). Data is collected in three different zones (Fig. 1). The wall zone consists mostly of coral reefs, with an average depth of 12.7 meters. The mid-bank zone has a habitat of deep channels and shallow sandy banks, with an average depth of 4.2 meters. The bank zone has mostly sea grass beds and patch reefs, with an average depth of 4.3 meters.

Longlining

A 500-meter mainline is deployed at the survey site with an anchor at each end. Each set has 35-45 gangions, which are circle hooks baited with bonita tuna, attached by rope and hooked to the mainline. Longlines have a 90-minute soak time, which is the amount of time they are left in the water. When a shark is caught, four measurements are taken (Fig. 2). Sharks are tagged with dart and dorsal tags (Fig. 3). CPUE for longlining is calculated by dividing number of caught sharks by number of hooks and soak time.

BRUVS

Baited remote underwater video surveys consist of a camera in an underwater housing. A baited extension with bonita tuna is suspended in front of the camera (Fig. 4). The tapes have an 82-minute recording time. CPUE for BRUVS is calculated by dividing number of sharks recorded by recording time, when the unit is on the seabed. Fig. 5 shows an example of a shark captured during a baited video survey.

Data Analysis

A non-parametric test was used since data was not normally distributed. Statistical analysis, Kruskal-Wallis on Systat 10.2, was used to generate a p-value. A p-value of 0.05 or less means that the data was statistically significant.

Results

A total of 61 longline surveys and 120 BRUVS sets were conducted, with 222 and 62 sharks caught, respectively, throughout the two sampling seasons (summer and fall). Species seen were Caribbean reef *Carcharhinus perezi*, nurse *Ginglymostoma cirratum*, tiger *Galeocerdo cuvier*, lemon *Negaprion brevirostris*, Caribbean and Atlantic sharpnose *Rhizoprionodon terraenovae*, blacktip reef *Carcharhinus limbatus*, and great hammerhead sharks *Sphyrna mokarran*. As Caribbean reef and nurse sharks accounted for 84% of the observed population, focus was shifted to these two species for analysis.

The abundance of reef and nurse sharks shown by longlines and BRUVS were compared spatially as well as seasonally. In the summer, both methods showed that reef sharks were the most abundant in the wall zone, followed by the mid-bank zone, and least abundant in the bank zone (Fig. 7). Both methods also showed that nurse sharks were the most abundant in the mid-bank zone, then the bank zone, and finally the wall zone. Differences between the two methods were significant for both shark species (Kruskal-Wallis, reef: $p\leq0.001$, nurse: $p\leq0.05$). Trends in relative abundance as shown by longlines and BRUVS were similar in the summer.

In the fall, longline data was similar to the summer trends, with reef sharks shown to be the most abundant in the wall zone and nurse sharks shown to be the most abundant in the bank zone (Fig. 8). However, the BRUVS data did not follow the same trends. BRUVS showed that reef sharks were the most abundant in the bank zone. Nurse sharks were shown to be the most abundant in the wall zone. Differences between the two methods were statistically significant for reef sharks, but not significant for nurse sharks (Kruskal-Wallis, reef: $p\leq0.001$, nurse: $p=0.096$). The trends of the two methods in the fall contradicted each other.

Longline data showed decreases in both shark populations from the summer to the fall (Fig. 9). Neither species showed significant changes (Kruskal-Wallis, reef: $p=0.158$, nurse: $p=0.592$). BRUVS showed a decrease in the reef shark population in the fall. Contrastingly, BRUVS also showed an increase in the nurse shark population in the fall. Only the reef shark population showed a significant difference (Kruskal-Wallis, reef: $p\leq0.05$, nurse: $p=0.844$). These trends showed more inconsistencies with the BRUVS data.

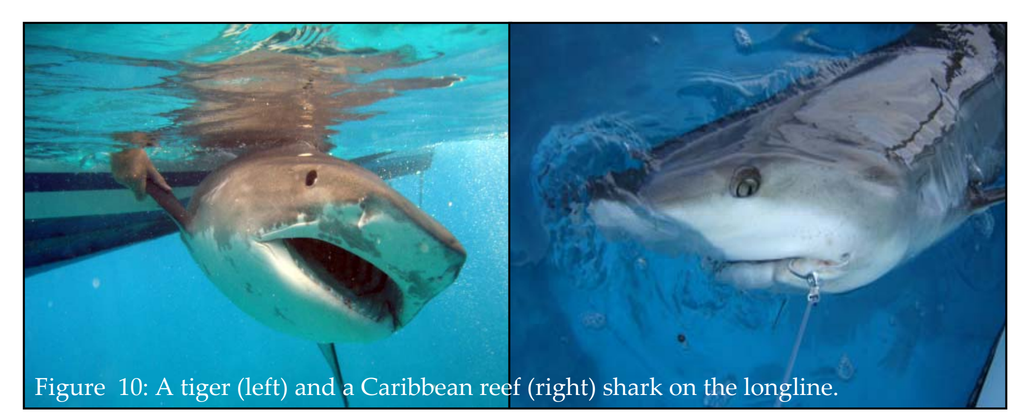

Figure 10: A tiger (left) and a Caribbean reef (right) shark on the longline.

Figure 11: Students preparing a BRUV unit for deployment.

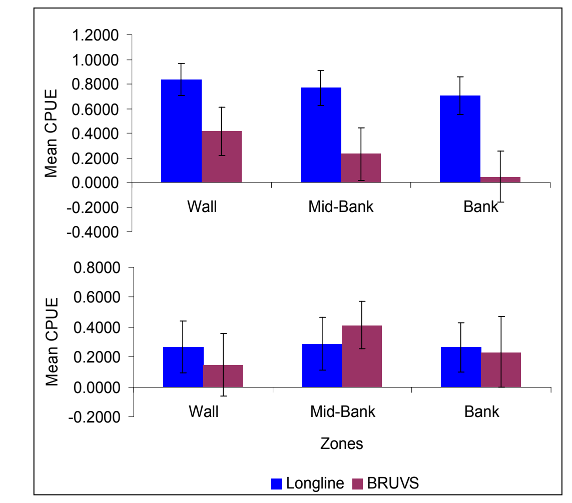

Figure 7: Reef (top) and nurse (bottom) shark spatial distribution in the summer as reflected by longlining and BRUVS in summer 2008. Error bars represent standard error. Longline values are calculated per 50-hook hours.

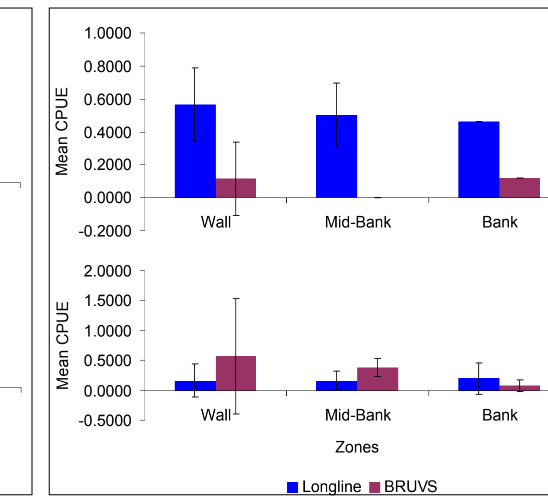

Figure 8: Reef (top) and nurse (bottom) shark spatial distribution in the summer as reflected by longlining and BRUVS in fall 2008.

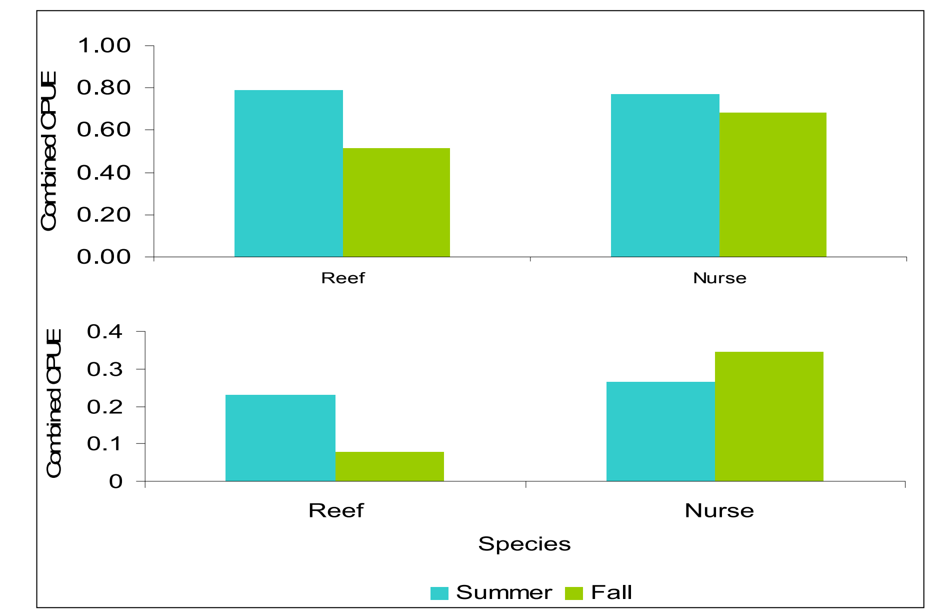

Figure 9: Reef and nurse shark seasonal abundance as reflected by longlining (top) and BRUVS (bottom). CPUE values are mean averages of all zones.

Discussion

The analysis of this study focused on the most abundant species in the Cape Eleutheran waters; the Caribbean reef and the nurse shark. The Caribbean reef sharks were mostly found in the deeper wall zone while nurse sharks were found in the shallower bank and mid-bank zones. These trends reflect feeding habits of the species; Caribbean reef sharks are a pelagic species that hunt in the water column, whereas nurse sharks are bottom feeders that are prevalent in shallower waters.

Longline surveys and BRUVS were compared through analysis of the two species' relative abundance. The data collected in the summer showed common trends in relative abundance. The fall data showed the opposite of the summer data, potentially reflecting environmental factors, such as water temperature, tides, or the season. These environmental factors could cause temporary fluctuations in shark populations in the given area.

The data collected thus far is not conclusive. Further data from winter and spring will hopefully reflect common trends in relative abundance between longlining and BRUVS.

If BRUVS were shown to be comparable to longlines, they would be a viable, non-invasive alternative for measuring the relative abundance of sharks. However, there are still restrictive elements of BRUVS, including the difficulty in determining a shark's sex and the inability to tag, measure, and track sharks. With the further development of this new surveying method, the global shark population can be further evaluated to determine management and conservation of these important organisms.

Acknowledgements

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