The post-release survivorship of gulper sharks and Cuban dogfish

Noelle Henderson, Lucy Zachau, Khalil Addams-Pilgrim, Stephen Gallagher, Maya Abouhamad, & Olivia Rask
Advisors: Alp Gokgoz & Brendan Talwar

Introduction

Due to technological advances and overfishing in coastal waters, commercial fisheries have increasingly targeted deep sea fish stocks (Watson et al, 2013). Many species brought up by commercial fisheries are caught as bycatch —unwanted or unmanaged species. These species tend to be k-selected, meaning they have low fecundity, late maturity, and low reproduction rates (Roberts, 2002). Due to these characteristics, deep-sea species are less resilient to external fishing pressures than shallow water species. When caught on long lines, the species go through a stress response, which can affect their chances of mortality (Skomal et al, 2007). Fisheries assume that the total mortality rate of deep-sea shark bycatch is equal to the number of species dead at vessel, not accounting for the species that die post-release, meaning their estimate for total mortality is incorrect. Our two study species are Cuban dogfish and gulper sharks (Figure 1,2).

Figure 1: Cuban dogfish (*Squalus cubensis)* are commonly caught as bycatch in deep-sea snapper, grouper, and tilefish fisheries in the Northern Gulf of Mexico (National Marine Fisheries Service, unpublished data).

Figure 2: Gulper sharks (*Centrophorus* sp.) are commonly caught worldwide as bycatch and are also intentionally harvested for their liver oil.

Objectives:
1. To estimate the post release mortality rate of gulper sharks and Cuban dogfish when captured on longlines
2. To investigate the potential factors affecting post release mortality rate in cages
3. To assess whether or not caging is a sufficient method to answer questions 1 & 2

Methods

Figure 3: An aerial view of The Bahamas. The red dot represents our study site.

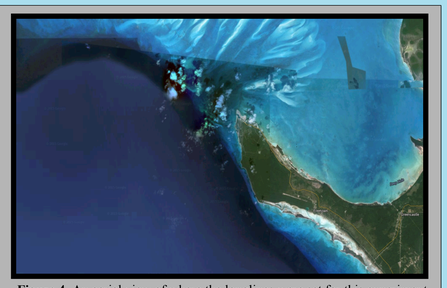

Figure 4: An aerial view of where the longlines were set for this experiment, located to the West of Cape Eleuthera, The Bahamas.

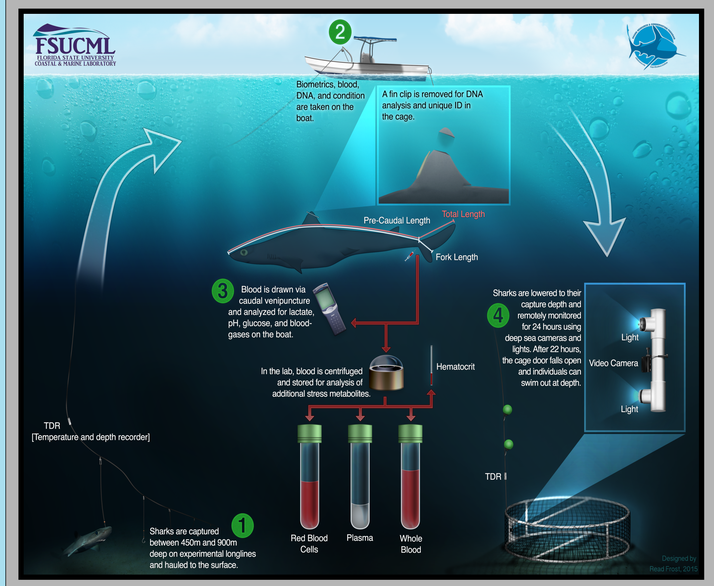

Figure 5: This diagram illustrates the methods conducted throughout this experiment

Sharks were caught on longlines to the west of Cape Eleuthera (The Exuma Sound), The Bahamas (See Figure 4). They are hauled onto the boat and measurements, blood samples, and fin clips are taken from each shark. The sharks are then returned to their capture depth in a cage for 24 hours where their activity is recorded by a video camera. Later, the blood samples are assessed to see how the lactate, glucose, and pH levels were affected by the stress of being caught on the long line.

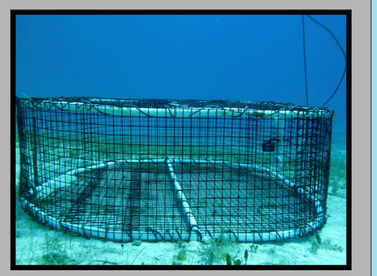

Figure 6: The cage that is used in our study

Results

Table 1: Capture characteristics and post-release survivorship of *S. cubensis* and *Centrophorus* sp. caught in the Exuma Sound, The Bahamas from July 2014 to April 2015 on experimental longlines. Post-release survivorship rate (PRS) shows the percentage of the sharks that survive post-release. The PRS rate for *S. cubensis* was equal to 50.2 ± 7.9%, which is far higher than current fisheries management assumes. *Centrophorus* sp. suffered mortality 100% of the time. However, this PRS rate could be inaccurate due to the fact that caging may not be a sufficient method for *Centrophorus* sp.

Species	n	Mean Tl (cm) ± SE	Mean Capture depth (m) ± SE	Mean capture temp (C°) ± SE	Post-release survivorship rate
S. cubensis	61	58.5 ± 1.55	606 ± 8.22	12.5 ± 0.25	50.2 ± 7.9%
Centrophorus sp.	7	94.1 ± 2.25	801 ± 10.08	8.3 ± 0.71	0%

Significant Predictors of Post-Release Mortality

Eleven variables were measured at vessel to find significant predictors of post-release mortality in the Cuban dogfish. Lactate, blood pH, and release condition were significantly different variables between sharks that were alive after 24 hours and those that did not survive.

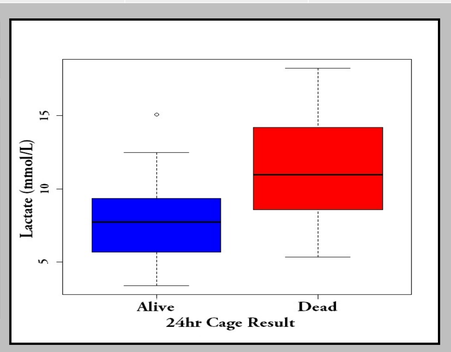

Figure 7: Shows the mean lactate levels at vessel for Cuban dogfish when caught on longlines from July 2014 to May 2015. Cuban dogfish that survived 24-hours post release had a significantly higher lactate level at vessel than those that died in the cage (two sample T-test, 38 d.f.,p< 0.01). Lactate is produced in the white muscle and is a result of increased activity and stress (Skomal and Mandelman, 2012). Higher lactate indicates that the sharks actively fight against the line to escape from the hook and likely would be more exhausted when pulled onto the boat.

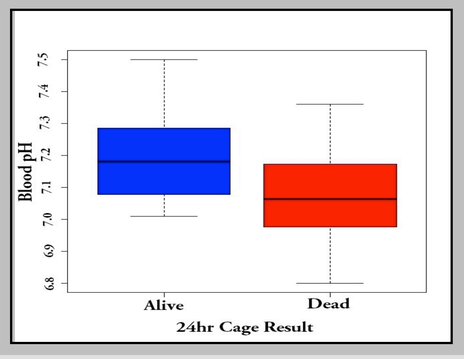

Figure 8: Mean pH levels at vessel for Cuban dogfish when caught on longlines from July 2014 to May 2015. Cuban dogfish that survived 24-hours post release had a significantly higher blood pH level at vessel than those that died in the cage (two-sample T-test, 47 d.f., p < 0.01). Low pH levels are an indicator of high stress levels driven by metabolic or respiratory acidosis (Skomal and Mandelman, 2012). Therefore, it can be assumed that the Cuban dogfish with lower blood pH levels suffered greater amounts of stress due to the hooking and hauling process.

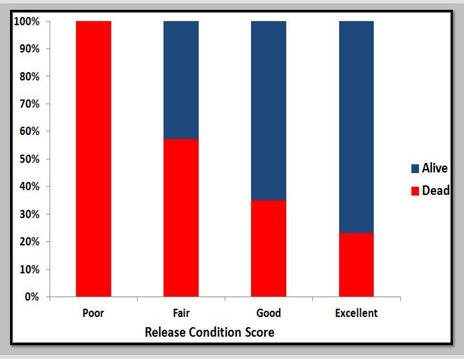

Figure 9: Shows percent alive/dead for each category that describes the state of the shark when put in the cage. Rated on a scale from 1-4, 1 (excellent), 2 (good), 3 (fair), and 4 (poor). A Chi squared test yielded that release condition scores for Cuban dogfish were significantly different (X^2= 12.63, df=3, P=0.005) with sharks given a score of 'fair' or 'poor' more likely to die than those given a score of 'excellent' or 'good'. Time on the hook may be a reflection of the score given to the sharks at cage.

Behavioral Response to Caging

Video analysis showed that Cuban dogfish's locomotion increased over time. There was no visible compression or injury from the cage and the density of sharks within the cage had no significant effect on the mortality of the Cuban dogfish (GLM, P>0.05, binomial). Immediately after the cage reached the ocean floor, Cuban dogfish usually rested on the bottom of the cage for the first 1-2 hours, and then swam around the perimeter of the cage. Eventually they swam out of the door after the 24-hour period had elapsed.

Gulper sharks had a delayed deterioration while in the cage. As the cage dropped, the gulper sharks positioned themselves ventral side up against the top of the cage. They continued to pump water through their spiracles for the first 2-6 hours in the cage, however after this period of time all the gulper sharks stopped breathing and perished.

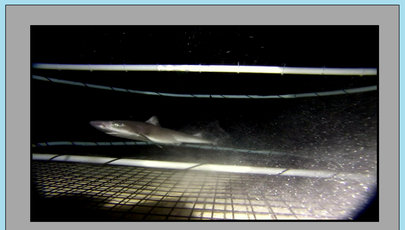

Figure 10: A Cuban dogfish while in the cage

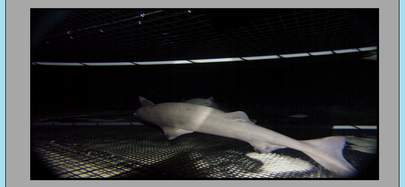

Figure 11: A gulper shark ventral side up while in the cage

Conclusion

The results from this study aim to inform fisheries management about the effects of commercial fishing on deep-sea species. With the results, fisheries management will be able to use three factors (lactate levels, pH levels, and release condition) to accurately predict the post-release mortality rate of Cuban dogfish caught as bycatch. Accounting for the sharks that die post-release as well as at-vessel will allow fisheries to better estimate their overall impact on a given population.

From these three predictors, release condition is the easiest method for fisheries management to use. Without having to take a blood sample, managers can visually inspect a species' liveliness and predict whether they are likely to survive post-release using the release condition scoring system. Using the yielded post-release survivorship rate of 50.2%, fisheries management will be able to better predict the outcome of their Cuban dogfish bycatch.

Although our study was accurate in predicting the post-release mortality of these two species, there were factors that may have affected the outcome of our study. There was no control group since the stress of these deep-sea sharks in their natural environment cannot be measured. The long-term sublethal effects of the sharks that survived 24-hour post-release could not be measured. Additionally, the cage prevented possible predation on the species inside the cage, which could have resulted in a overestimate of the post-release mortality rate.

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Literature Cited

Roberts, C.M. 2002. Deep impact: rising toll of fisheries in the deep sea. *Trends in Ecology & Evolution*, 17: 242-245.

Skomal G.B. 2007. Evaluating the physiological and physical consequences of capture on post-release survivorship in large pelagic fishes. *Fisheries Management and Ecology* 14: 81-89.

Skomal G.B., Mandelman J. W. 2012. The physiological response to anthropogenic stressors in marine elasmobranch fishes: A review with a focus on the secondary response. *Comparative Biochemistry and Physiology*, Part A 162: 146-155.

Watson R.A., Morato T. 2013. Fishing down the deep: Accounting for within-species changes in depth of fishing. *Fisheries Research* 140: 63-65.