The Physiological and Behavioral Responses of Lemon Sharks *(Negaprion brevirostris)* to Capture

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Introduction:

- Global shark populations are decreasing from commercial fishing and as bycatch (unmanaged or unused catch) from fisheries (Baum & Meyers 2004).
- Bycatch is greatest perceived threat to shark populations (Oliver *et al.* 2015)
- 50% of global shark captures result from longline fishing (Oliver *et al.* 2015)
- When a shark is caught on a longline, it becomes stressed while trying to escape and this stress can result in mortality or sub-lethal consequences (reduced growth and reproduction)
- The physiological and behavioral responses of sharks to longline capture need to be understood to decrease sub-lethal and lethal effects of capture
- Longlining gear can be modified to reduce the stress of capture

Objectives:

1. **To define a relationship between behavioral and physiological responses to capture**
2. **To define variation in physiological (pH, glucose, lactate) and behavioral responses (mean, maximum, & sum acceleration) to capture with gangion length**

Results:

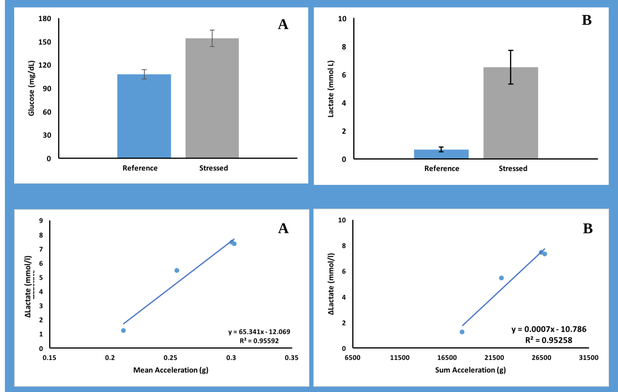


Figure 4. Each figure displays the average reference and stressed values taken before and after the experiment was run with portable blood analyzers. Average glucose (A), and lactate (B) are represented by bars and standard error is shown with error bars. T-tests were run to compare the changes in each of these values. Glucose had a p-value of 0.0026, and lactate had a p-value of 0.0038.

Figure 5. These data show acceleration and lactate levels of sharks after capture. Acceleration was recorded by using accelerometers and lactate was measured in a portable blood analyzer called an i-STAT. Mean acceleration and lactate (A), and sum acceleration and lactate (B) are represented on the graphs. There was a statistically significant correlation between mean and sum acceleration with lactate (Mean R^2= 0.95592, Sum R^2= 0.95285)

Discussion:

Relationships between acceleration and blood metrics:

The reasoning for the not statistically significant pH results could possibly be that lemon sharks have the ability to buccal pump (Dapp *et al.* 2015), and therefore might not have a significant increase in CO_2 in their blood. Buccal pumping allows sharks to run water over their gills while stationary, which efficiently expels CO_2. There was a statistically significant change in glucose throughout the capture event, suggesting that the shark was physiologically stressed. The increase in glucose is caused by the production of hormones in response to capture. Mean acceleration and sum acceleration showed correlation with the change in lactate. As the sharks activity increased, lactic acid was produced in the blood, and lactate is the byproduct of lactic acid. This relates back to lethal and sub-lethal effects because when lactate increases, the shark becomes fatigued. With acceleration, the maximum acceleration showed little correlation with any of the blood levels because it shows only one point of the acceleration. This can be supported by research done on behavioral and physiological response to longline capture which found that maximum acceleration was not a good indicator of physiological change (Gallagher 2015). Fishing gear and techniques could be modified to remove sharks from the line as quickly as possible to reduce the sub-lethal and lethal effects of longline capture.

Relationship between gangion lengths and stress responses:

Out of the 15 sharks that were caught and 22 trials that were run, only 7 were hooked and 6 out of 7 of them were tested with 100% total length treatments. Further research on this topic can be done, as only one species and 15 sharks were tested. The second objective of this study relating to gangion length could further modify fishing gear to reduce the impact of capture. .

Methods:

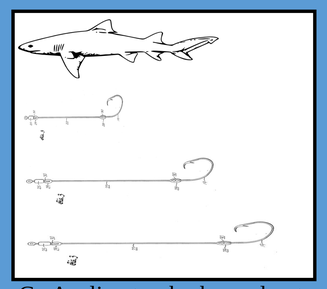
Figure 1. Capture locations of juvenile lemon sharks. The map shows the southern tail of Eleuthera. Sharks for this study were captured at three different tidal mangroves in south Eleuthera: CEI Beach, Kemps Creek, and Airport Flats.

Figure 2. Juvenile lemon sharks are used as a model species for this study because they have a lower post release mortality rates in comparison to other shark species (Gallagher 2015).

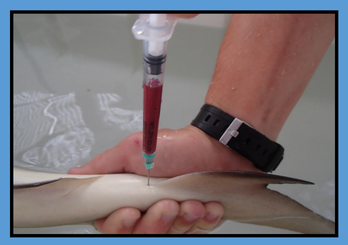
Figure 3. Methodology flowchart (A-H).

A. Set up seine net at capture site and collect juvenile lemon sharks

B. Transfer sharks to the CEI wetlab



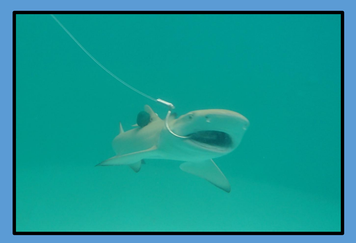
C. Acclimate sharks and set up longline, randomly choosing gangions 50%, 100%, or 150% of the shark's length



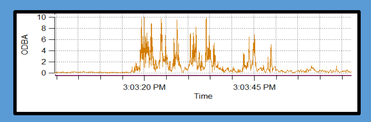
D. Collect **reference blood** after 24 hours of fasting

Reference blood:
The measure of pH, lactate, and glucose from a minimally stressed shark

E. Attach accelerometer



F. After another 24 hours of fasting, hook shark on baited gangion for a 60 minute period



G. Acceleration profile of a hooked shark measured in *g*'s

H. Collect and analyze the metrics from the **stressed blood** and gather the accelerometer data

Stressed blood:
The measure of pH, lactate, and glucose from a stressed shark after capture

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