Studying the physiological and behavioral stress responses of Nurse sharks (*Ginglymostoma cirratum*) to longline capture

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Introduction

Overfishing and Longlining

Longline fishing has contributed to an 80% decline in large pelagic fishes in 15 years (Myers and Worm, 2003), with longlines stretching up to 60 miles and including hundreds of hooks. Each year, 26-73 million shark mortalities occur on these lines (Clarke et al., 2007).

Background

While some sharks die on the line, others die post-release due to their metabolic capacity and the nature of the capture event (Brooks et al., 2012). While hooked, sharks experience primary responses (hormone releases), which, along with exhaustive exercise, elicit secondary responses (blood chemistry disruptions) (Mandelman and Skomal, 2012). While Brooks et al. showed that shark behavior varies across hook duration, few studies have investigated both the behavioral and physiological responses to longline capture.

Purpose

The purpose of this study is to analyze the physiological and behavioral stress responses of nurse sharks to longline capture.

Nurse sharks are a model species for this investigation given their ability to buccal pump, making them resilient to mortality on longlines.

Methods

Figure 1. Our research was conducted at The Island School in Cape Eleuthera, The Bahamas.

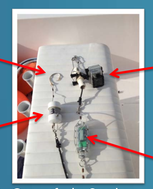

Figure 2. One of six 2m long gangions, with an accelerometer, GoPro, hook timer and circle hook. Gangions attach to the main line.

Figure 3. A 120m long line was set with four buoys and 2m long gangions at 10m apart. Data was collected at three hook durations: short (0-30 mins), medium (about 2 hrs) and long (about 4 hrs).

Figure 4. Once a shark is on the long line for the appropriate amount of time (short, medium or long hook duration), it is pulled up to the side of the boat and secured with a tail rope.

Figure 5. Blood is drawn using caudal venipuncture.

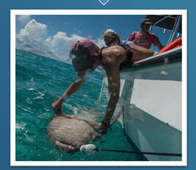

Figure 6. The shark is flipped into tonic immobility.

Figure 7. Lactate, pH, pCO2 and pO2 levels are recorded using an iStat (Heska Corporation, Fort Collins, CO USA). The blood is later tested at CEI.

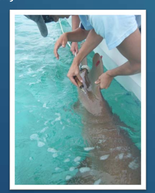

Figure 8. Biological metrics are taken. The shark is also tagged with both a dart and dorsal tag before it is released.

Results & Discussion

Sex	No. Captured	Blood Drawn	Mean Total Length (cm)	Range Total Length (cm)
M	9	5	199.33	172-227
F	29	16	215.38	106-256
Total	38	21	207.36	106-256

Table 1. Mean total length and length ranges of male and female nurse sharks caught by scientific long lines around Cape Eleuthera, Bahamas between September and December 2012. Out of 38 nurse sharks captured, 29 were females and 9 were males. We took blood samples from 21 sharks and behavioral data in the form of video and accelerometer data from all 38 sharks.

Physiological Results

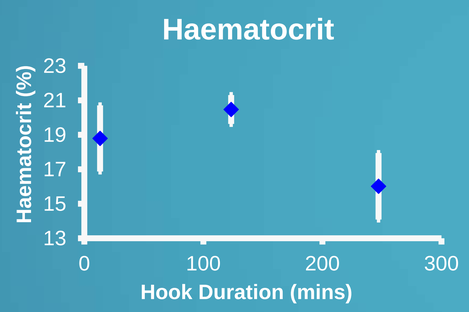

Figure 9. Haematocrit (ratio of red blood cells to total blood volume) levels peaked at medium hook durations and decreased at longer hook durations. After the initial high energy escape response, the shark releases more red blood cells, making the haematocrit increase to compensate for oxygen loss. The shark then exhibits lower levels of activity and recovers from its physical activity, making the haematocrit drop.

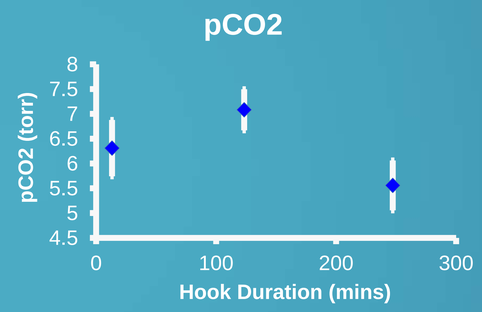

Figure 10. pCO2 was highest at the medium hook durations and lowest at the long hook durations. After the sharks' high energy escape response there is a build-up of CO2 as a result of physical exercise. As the shark calms down it is able to release the CO2 and recover.

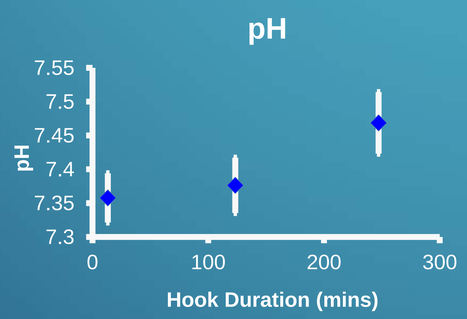

Figure 11. The pH levels were lowest at the short hook durations and increased over longer hook durations. After the sharks' initial high energy escape response, acidity increases (meaning the pH decreases) due to a build-up of carbonic acid as a result of physical exercise. As the pH rises over hook duration, the shark is calming down and recovering from its behavioral response, causing pH levels to return to normal.

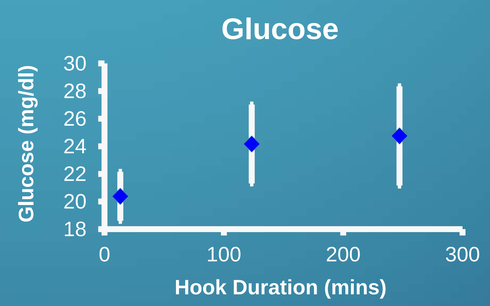

Figure 12. Glucose levels gradually increased across hook duration. The release of stress hormones (primary stress response) causes the mobilization of glucose. Therefore, the increasing glucose shows that the shark is continuing to release stress hormones, keeping its body on mental high alert.

Behavioral Results

The behavioral stress was measured in g's, which is a proxy for activity level. G's per second were recorded for each shark, but displayed on the graph in thirty-second bins (Figure 13).

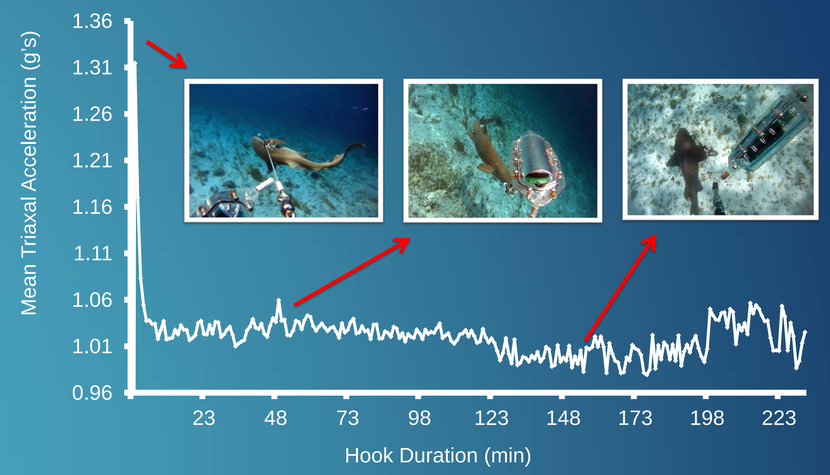

Figure 13. The behavioral stress responses of nurse sharks to longline capture around Cape Eleuthera, The Bahamas, between September and December 2012. The relationship between hook duration and behavioral responses is represented in g's per second (as determined by accelerometer data).

Conclusion

We conclude that nurse sharks recover from their physical activity (behavioral response). The changes in haematocrit, pCO2 and pH occur as a result of exercise and show trends of recovery across hook duration. Changes in glucose occur due to hormone releases (primary stress response); continuously rising trends of glucose show that the nurse sharks continue to release stress hormones, keeping their body on high alert. So while the nurse sharks do recover from the physical exertion, they fail to recover from the stressful nature of the capture event.

The overall purpose of our research is to reduce the impact of longline fishing on shark populations. To reach this goal and prevent shark mortality, it must be known why sharks are dying on the line. With the data found in this study as a baseline, future research could investigate the specific physiological systems that may be failing within the shark and causing mortality.

Literature Cited

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