Background and Introduction

Shark populations are declining globally due to anthropogenic exploitation, with an estimated 97 million sharks killed in 2010 (Reiwald and Wem 2003). Worm et al. (2013) Longline fishing is one of the biggest contributors to this decline; it is the method used for approximately 80% of the reported sharks caught annually (Jensen and Worm 2003). Worm et al. (2013) in commercial fisheries, sharks are often left on the longline for substantial periods of time, which can result in physical and physiological disruptions that may affect post-release survival chances. The physiological effects are reflected by changes in the blood chemistry. A shark’s body mass is 30% muscle tissue; hence, and it is directly shown in the blood (Skomal et al. 2007). Very little information is known about shark’s response to the stress of longline capture (Mandelman and Stuani 2011). A better understanding of the physiological and behavioral effects of stress is important because this population decline has the potential to cause unpredictable cascading effects throughout the ecosystem, as sharks are vital to maintaining balance in the marine environment (Metzka et al. 2008).

Hypothesis

The stress induced by longline capture will cause a greater physiological disturbance in the Caribbean reef shark than the nurse shark.

Methods

The methods required to conduct this experiment are represented by Figure 4. A 32m longline is set with six gangions spaced along its length in the study area seen in Figure 3. The parts of the gangion are detailed, as well as the behavioral categories used to classify actions seen in the accelerometer study area seen in Figure 3. The parts of the gangion are detailed, as well as the behavioral categories used to classify actions seen in the accelerometer study area seen in Figure 3. The parts of the gangion are detailed, as well as the behavioral categories used to classify actions seen in the accelerometer study area seen in Figure 3.

Figure 3: A map of the area where the longlines were set for this experiment.

Results and Discussion

Species: Total Sharks: Capture Date: Sex: Range TL (cm)

<table>
<thead>
<tr>
<th>Species</th>
<th>Total Sharks</th>
<th>Capture Date</th>
<th>Sex</th>
<th>Range TL (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcharhinus perezi</td>
<td>8</td>
<td>10-12 May 2013</td>
<td>M, F</td>
<td>200-250</td>
</tr>
</tbody>
</table>

Table 1: Our research group recorded a total of 8 sharks, male and female, in 2013. 1: Total number of sharks recorded over the duration of capture in longline. The points on the bar represent average standard of sharks at varying distances of capture. Nurse sharks exhibited, on average, an overall lower duration in response to capture than Caribbean reef sharks.

Purpose

The project fits into a multi-species study comparing nurse sharks (Ginglymostoma cirratum) and Caribbean reef sharks (Carcharhinus perezi), which represent distinct evolutionary lineages. The goal of this study is to understand how life history characteristics (e.g., respiratory rates) may influence species’ response to longline capture by comparing and analyzing physiological and behavioral responses to anthropogenic stress, our research will work to fill gaps in our knowledge of species-specific responses to stress. Hopefully these findings will be used in the future when designing and implementing effective conservation and management strategies for shark populations.

Figure 1: A nurse shark next to the boat.

Figure 2: A Caribbean reef shark next to the boat.

Figure 10: Shark research team holding a nurse shark in tonic immobility.

Figure 5: This graph shows maximum acidosis for the nurse shark at one hour and 20 minutes after capture. The nurse shark was the most active out of all shark species, and it is important in determining energy expenditure because red blood cells directly influence the red blood pH. The reef shark indicates an increase in oxygen consumption and respiratory rate, which suggests increased stress. The nurse shark suggests increased activity and respiratory rate, which suggests increased stress.

Figure 9: This graph shows the two species. Data for haematocrit, which is the percentage of red blood cells in a blood sample, was collected in order to determine differences in oxygen and hemoglobin levels. The data collected for both species suggest that there is a difference in oxygen and hemoglobin levels. The reef shark has a higher oxygen consumption and respiratory rate, which suggests increased stress. The nurse shark’s haematocrit levels continue to increase with time after capture, which may indicate stress. The nurse shark’s data for hemoglobin levels are higher.

Figure 4: This diagram represents the methods followed in order to conduct this experiment.

Figure 6: This graph shows changes in glucose blood levels. The nurse shark has a higher blood glucose level than the reef shark. When stressed, the nurse shark becomes either gluconeic or higher.

Figure 8: This graph shows the highest levels of CO2 seen in any shark species. The blood pH is directly influenced by respiratory rates. The nurse shark has a lower blood CO2 level than the reef shark, indicating that it respire less than nurse sharks.

Conclusion

The data shows a distinct difference between the nurse and Caribbean reef shark physiological and behavioral responses to longline capture. Although there is some recovery in parameters such as pH, CO2, and haematocrit, better baselines are required for a more thorough comparison. Longlining, however, does get because the nature of this study, which is limited stressful. It was seen in the data that the reason the two species have such distinct physiological responses is because of their distinct evolutionary lineages and life history characteristics, more specifically, their respiratory traits. Nurse sharks are strong buccal pumps (they do not need to swim to breathe), which seems to allow them to recover better than Caribbean reef sharks, which are weak buccal pumps.

The emerging field of conservation physiology focuses on the importance of studying the physiological response of declining species in order for conservation strategies to be successful. With our project, which analyzes nurse sharks as a model for benthic species and reef sharks as a model for reef-associated species, we are contributing to the understanding of sharks physiological response to longline capture. Overall, it was found that Caribbean reef sharks (seen in Figure 11 and 12) are more susceptible to longline induced stress than nurse sharks and are therefore more negatively affected by longline. The data collected will help inform policy makers on how to develop effective conservation and management strategies that regulate the use of longline worldwide.

Citations


