The Effects of Predation on the Growth Rate of Different Size Classes of Juvenile Lemon Sharks (*Negaprion brevirostris*) in South Eleuthera

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Introduction

Overfishing and destruction of marine habitats highlights the global importance of sharks in maintaining healthy and balanced ecosystems. Top-down control of the trophic food web is regulated by apex predators, such as sharks (Jacques, 2008). Fortunately, in The Bahamas, sharks are legally protected and cannot be intentionally removed from the environment (July 2011). However, many species still face significant threats from natural predators such as larger sharks. The effect of this predator-prey interaction on juvenile lemon sharks has not been thoroughly studied, but is highly relevant in understanding how metabolic growth rates are affected by environmental pressures. Predator-prey interaction has strong potential to influence the growth and development of juvenile lemon sharks, and the presence of predators can affect juvenile behaviour and have major energetic consequences.

Literature shows that the presence of predators has a direct effect on the growth rate of different size classes of prey in a closed system (Werner and Gilliam, 1983). Our aim was to conduct a similar study involving juvenile lemon sharks in an open system. We examined the effect that potential predators exhibit on the growth rates of three size classes of juvenile lemon sharks by analyzing recapture data. Our model utilizes shallow mangrove creek systems, which are an essential habitat during development of juvenile lemon sharks. Lemon sharks spend their first 3-6 years of life within these mangrove systems (Chapman et al, 2009), which act as a physical refuge from predation. These nursery systems are home to populations of juvenile lemon sharks that exhibit natal site fidelity, further highlighting the importance of preserving these sites.

Through direct observation and research on habitat preferences and threats facing juvenile lemon sharks, our findings have high potential to direct the focus of successful conservation efforts. Our conclusions highlight the importance of mangrove creek nurseries to the health and survival of future shark populations.

Fig. 1- Mangrove creek system, nursery for juvenile lemon sharks.

Fig. 2- Collecting data from juvenile lemon shark after seining.

Methods

Our samples were collected by two field methods at 9 different creek locations (Fig. 4). Juvenile lemon sharks were captured in mangrove systems with seine nets, while predators were captured outside of the creeks on baited drum lines.

Seine nets are long nets that act as a physical barrier with a set of floats on top and lead weights on the bottom. They serve to block the mouth of the creek so that juvenile lemon sharks and potential prey can be contained for data collection. When seining, juvenile lemon sharks and potential prey species were driven from the back of the creek towards the net located at the mouth. As the targeted catch moved into the net, the ends of the seine were closed off creating a circular containment area. Each juvenile shark was captured, counted, measured, weighed, and then tagged. DNA and RNA samples were collected by a small dorsal fin biopsy, which are sent for molecular analysis. All animals are handled in as stress-free a manner as possible and released back into the nursery.

Drum lines were used to capture predators at three distances from the mouth of the creek (0 meters, 250 meters, 500 meters). This system consists of a anchor, which holds a buoy in place with an additional 5.5m horizontal float line at the surface. This float line was tied to another float, which had a 1.5m gangion with a 16/0 circle hook attached. The float line on the surface was attached to a swivel, which allowed any catch to circle the anchor point of the drum line (Fig. 3). These systems were set for a total of 4 hours, with a bait check occurring at the 2-hour mark. When a predator is captured, it is measured, tagged, tissue sampled and released unharmed.

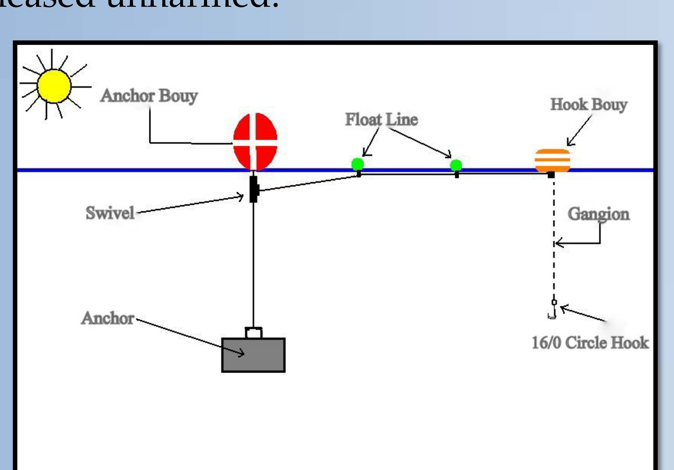

Fig. 3- Drum Line diagram with anchor and float systems.

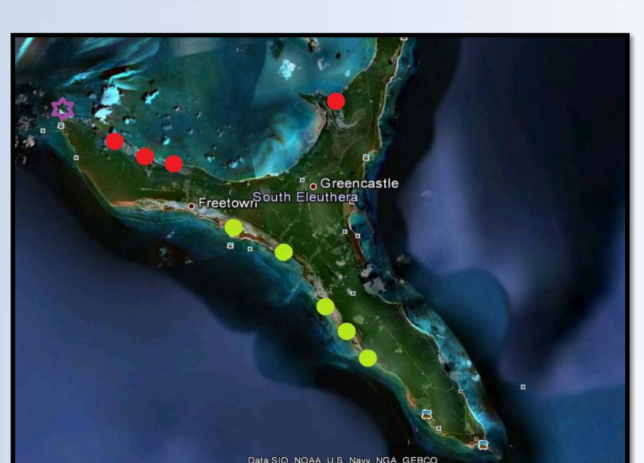

Fig. 4- Site map of South Eleuthera.

Hypothesis:

H_0: **The growth rate of the small, medium, and large size classes of juvenile lemon sharks will not differ in response to increased predation.**

H_A: **The growth rate of the small, medium, and large size classes of juvenile lemon sharks will differ in response to increased predation.**

Results

Small Size Class

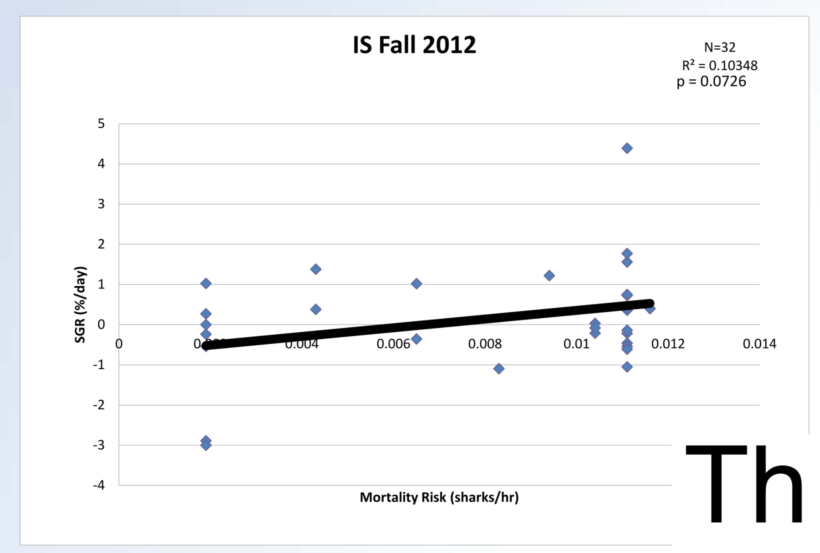

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Fig. 5a- The small size class of juvenile lemon sharks increased in growth rate as mortality risk increased.

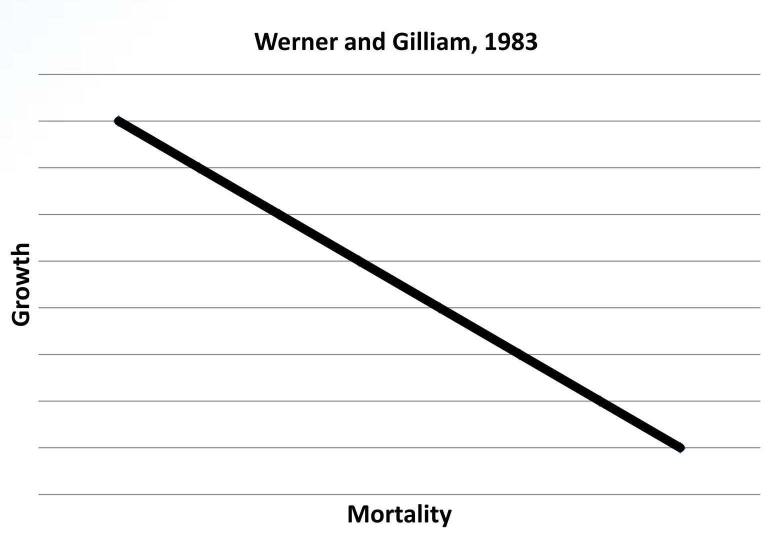

Fig. 7a- The small size class decreased in growth rate as Mortality risk increased.

Medium Size Class

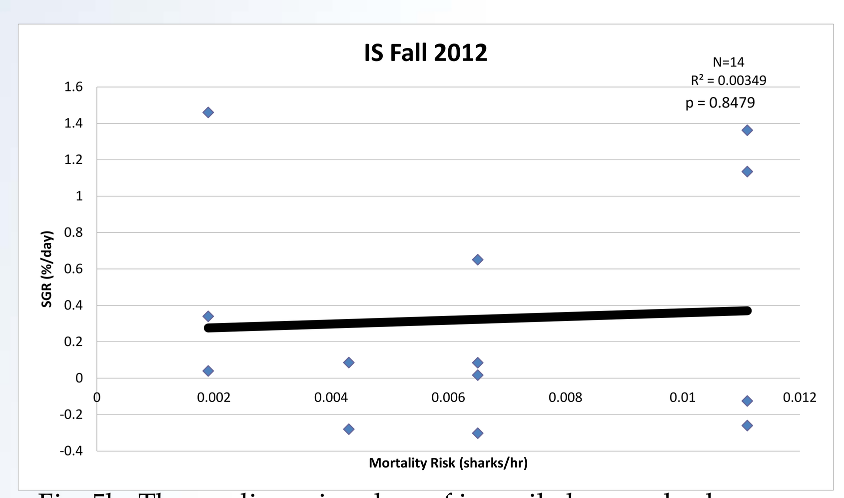

Fig. 5b- The medium size class of juvenile lemon sharks stayed the same in growth rate as mortality risk increased.

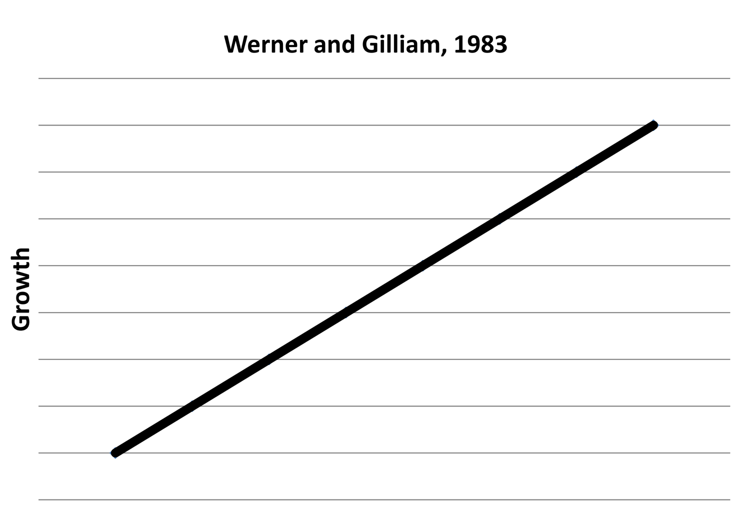

Fig. 7b- The medium size class increased in growth rate as mortality risk increased.

Large Size Class

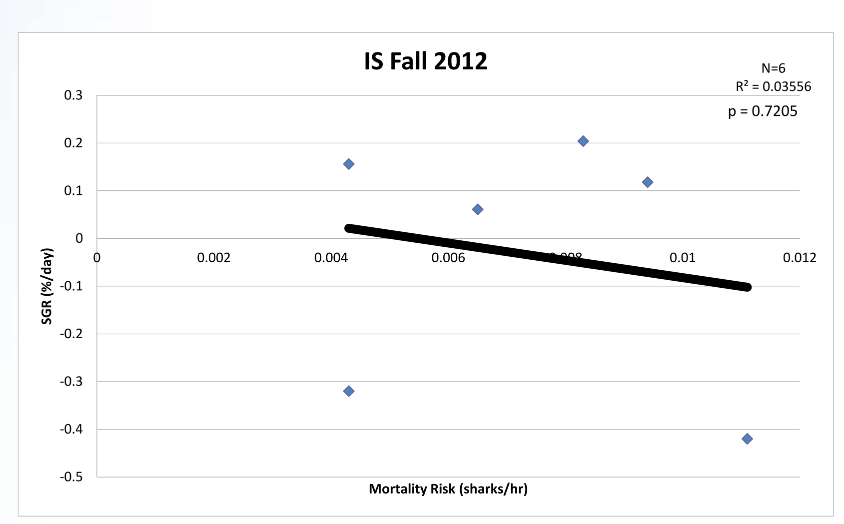

Fig. 5c- The large size class of juvenile lemon sharks decreased in growth rate as mortality risk increased.

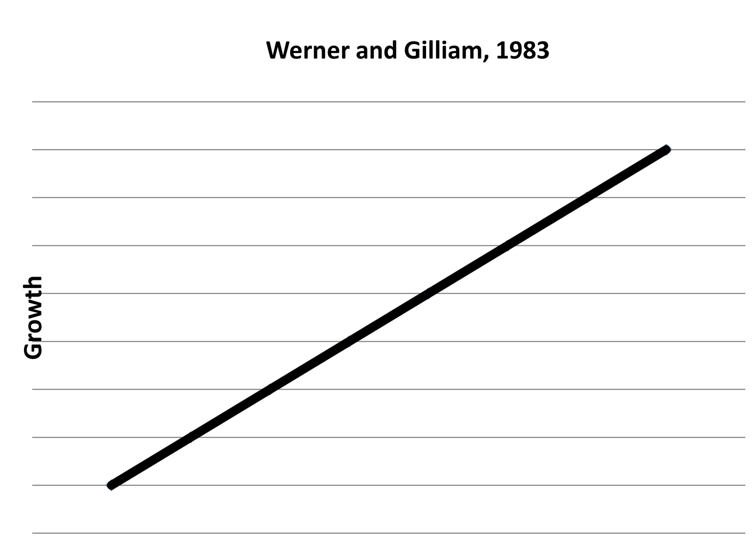

Fig. 7c- The large size class increased in growth rate As mortality risk increased.

Fig. 6- Tiger shark caught on drumline.

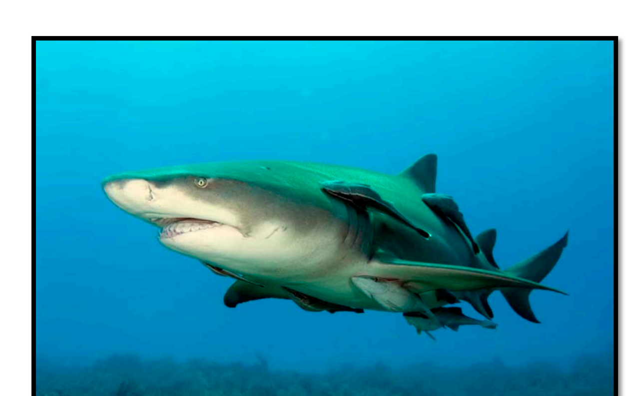

Fig. 8- Adult lemon shark, a local predator.

Results

We observed different trends in growth rates of each size class. Interestingly, the small size class exhibited the highest standard growth rate (SGR) (Pearson's correlation coefficient; p=.0726) (Fig. 5a). The medium size class showed the lowest change in SGR (Pearson's correlation coefficient; p=.8479) (Fig. 5b). The SGR of the large size class decreased (Pearson's correlation coefficient; p=.7205) (Fig. 5c).

Based on these results, there may be a connection between increased mortality risk and a faster growth rate of the small size class of juvenile lemon sharks. The medium size class was under less pressure of mortality risk and may have responded with a weaker growth response. The large size class exhibited a decreasing growth rate as the mortality risk increased. This decrease may occur because predators act as competition for food against this size class of juvenile lemon sharks. Greater competition and less food availability may have affected the growth of large size class juvenile lemon sharks. This data shows how changes in mortality risk can affect the growth of juvenile lemon sharks ranging from small, medium, and large size classes.

Fig. 8- Fall 2012 Lemon Shark Research Team.

Discussion

The observed growth rates of juvenile lemon sharks in this study differed from the findings of Werner and Gilliam on blue-gill sunfish (Werner and Gilliam, 1983). This difference is largely affected by variables present in an open mangrove system that might not be present in a closed system, such as salinity and changing tides. However, the biological significance connecting each study still applies. In both studies, the size classes of the sun-fish and lemon sharks exhibited changes in SGR due to predation. Whether or not this caused an increase or decrease in growth, the responses display how each species utilizes their specific environments. As juvenile lemon sharks act as top predators in the mangrove creek systems, they experience no size disadvantage. However, once the ontogenetic habitat shift occurs, there may be a size disadvantage as they find themselves competing against larger predators for food (DiBatista et al, 2006; Guttridge et al, 2012).

Studying how juvenile lemon sharks respond to mortality risk and utilize their habitats gives insight into methods of conserving key mangrove creek nurseries. Lemon sharks are top oceanic predators who stabilize food webs and maintain the health of the system. Sharks are vital to conserve because they exhibit top-down control of these biological systems and control population size and health. Without this control, the health of entire ecosystems can deteriorate or eventually collapse.

Fig. 9- Lemon Shark Team hard at work.

Fig. 10- Lemon Shark swimming in mangrove.

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Acknowledgements: We would like to thank our advisors Ian Hamilton and Taylor Hoffman, the shark researchers at CEI, and The Island School. We couldn't have done it without you!