Abundance and Distribution of Juvenile Green Sea Turtles (*Chelonia mydas*) and Sharks around South Eleuthera

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Introduction

Green sea turtles *(Chelonia mydas)* are a global migratory species that use a variety of terrestrial and marine habitats throughout their life history (Bjorndal *et al.,* 2005). Most population estimates on sea turtles are based on nesting females, the most accessible and concentrated life stage. Because of this focus, there has been a lack of information collected on juvenile turtles' threats, abundance, and distribution (Pilcher *et al.,* 2010*,* Bjorndal *et al.,* 2005). Juvenile green sea turtles can be found in shallow tidal creeks and bays throughout the Caribbean.

Factors that have been shown to affect the abundance of juvenile turtles include predation, food availability, overexploitation, climate change, pollution, and bycatch (Seminoff *et al.,* 2003*)*. Since the ban on the harvesting of sea turtles in The Bahamas in 2009, South Eleuthera has become a safer and largely undeveloped environment for turtles. With reduced anthropogenic effects, predation and food availability become the main drivers of abundance, specifically sharks and seagrass (Heithaus *et al.,* 2007). In a healthy ecosystem, the sea turtle populations are controlled by shark abundance, while sea turtles function as grazers, increasing productivity of seagrass and species richness in their ecosystem (Wilson *et al.*).

Currently, green sea turtles are classified as globally endangered by the IUCN. If they go extinct, they will leave an irreplaceable gap in healthy marine ecosystems (Wilson *et al.*). Researching factors that affect green sea turtle abundance will help build the knowledge of a less understood life stage, protect turtles and their ecosystems from extinction, and focus conservation efforts on critical environments and vulnerable life stages. The purpose of this study was to determine the size and relative abundance of turtles in study sites around south Eleuthera as well as to determine the relative abundance of shark populations and their affect on green sea turtle distribution.

Study Site

Figure 1: Nine study sites used around South Eleuthera. Half Sound, Starved Creek, Poison Creek, Broad Creek, Kemps Creek, Rollins Creek, Deep Creek, and Plum Creek were all surveyed for turtle and shark abundance and tagging, while Winding Bay was only used for tagging data.

Methods

Abundance Surveys

Abundance surveys begin with collecting environmental conditions and a starting GPS point. The boat follows a transect for thirty minutes at a constant speed. Turtles are spotted and their location is recorded along with a final GPS point of the transect.

Figure 2. Spotting turtles from a boat.

Rodeo

The rodeo method begins with spotting and chasing a turtle from a boat. Once the turtle slows down, a swimmer is deployed from the boat to catch the turtle. After capture, the turtle is tagged, and individual measurements are collected, including the maximum curved carapace length (CCL). Turtles are then returned to their original location, and a GPS point is taken.

Figure 3. Turtle captured using the rodeo technique.

BRUVS

Baited Remote Underwater Video Surveys (BRUVS) are placed in the mouth of a creek bottom on an outgoing tide. Frozen, ground bonita tuna is secured in the bait cage, and releases a scent plume as it melts. The bait cage is filmed for 90-120 minutes to observe predators attracted from the area. Surveys are reviewed and predators typed to species.

Figure 4: BRUV image of a nurse shark.

Results

This study analyzed data collected from nine study sites around South Eleuthera. The study utilized abundance data collected from 2014-2016 totaling 126.22 hours. Shark abundance data has been collected in 2015-2016 using Baited Remote Underwater Video Surveys (BRUVS) totaling 407 hours. The tagging data included measurements on 558 captured turtles since 2011.

Abundance of Green Sea Turtles

The abundance surveys showed that there was a significant difference in the number of turtles observed in each of the eight sites (Kruskal-Wallis chi-squared $_{df = 7}$, p-value < 0.05). Half Sound had the greatest mean abundance (42 turtles/hour), more than twice the amount of any other creek, with the lowest mean abundance in Broad and Kemps Creek (<1 turtle/hour) (Figure 5).

When creeks are grouped according to coastline, there is a significant difference between their abundance. The Atlantic coastline has the highest abundance of turtles; the Exumas Sound coastline has the second highest abundance whereas the lowest abundance of turtles is found on the Bahama Banks coastline.

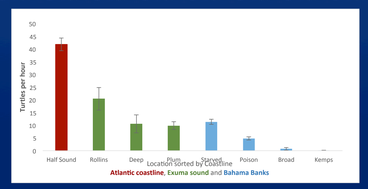

Figure 5: Mean CPUE (catch per unit effort) for turtles by study site in each abundance survey for all years combined.

Turtle Size Distribution

There was a significant difference in the mean size of the turtles between the three coastlines (Kruskal-Wallis chi-squared $_{df = 2}$, p-value< 0.05) (Figure 6). The largest turtles were found on the Bahama Banks shoreline (481mm), the second largest were on the Exumas coastline (371mm), and the smallest were found on the Atlantic coastline (341mm). The mean size was also significantly different between the Atlantic and the Exumas (Kruskal-Wallis chi-squared $_{df = 1}$, p-value< 0.05).

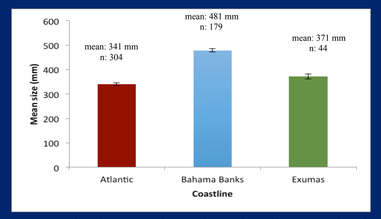

Figure 6. Average size of turtles captured on each coastline all years combined, measured as Maximum Curved Carapace Length (mm).

Tagging data was analyzed to determine the size frequency distribution for Maximum Curved Carapace Length (Figure 7). The mean length was 389mm and standard deviation was 103mm. The smallest turtle was 65mm, and the largest turtle was 746mm. 52% of the turtles were between 250 and 400 mm and 90% of the turtles were between 250 and 550 mm.

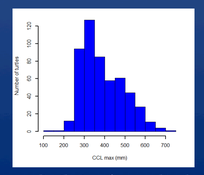

Figure 7. Size frequency distribution of captured turtles according to the Maximum Curved Carapace Length (mm).

Abundance of Sharks

The location had a significant effect on the shark abundance (Kruskal-Wallis chi-squared $_{df = 7}$, p-value < 0.05) (Figure 8*)*. Broad Creek had the greatest relative abundance (0.34 sharks/hour), whereas Kemps creek had the least (0.08 sharks/hour). Half Sound and Deep creek were also low (0.096 and 0.1 sharks/hour respectively).

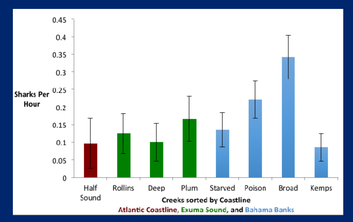

Figure 8. Mean CPUE (catch per unit effort) for sharks according to research site , all years combined.

Shark Species	Max. Number
Caribbean Reef shark	15
Nurse shark	31
Lemon Shark	6
Blacktip Shark	12
Blacknose Shark	4
Hammerhead	1
Total	69

Table 1: Shark species observed in the BRUVS over complete data set.

Discussion

This study revealed significant differences in turtle abundance per creek, shark abundance per creek, and turtle size per coastline. A significant difference in abundance was observed according to coastline, with the greatest abundance on the Atlantic coastline, then on the Exuma Sound, and the least in Bahama Banks. All turtles were within the expected juvenile size range (<780mm) (Bjorndal, 1995) however lowest average size was observed in the Atlantic, whereas the largest was in the Bahama Banks. This could be because smaller juvenile turtles are recruiting first to the Atlantic side research sites after leaving their free floating stage in the Atlantic gyres (Bjorndal *et al.,* 2005). Future research could determine whether turtles are moving from the Atlantic side to the Bahamas side as they grow during their juvenile life stage.

Sharks abundance was greatest in Bahama Banks creeks, then in the Exuma Sound creeks, and least abundant on the Atlantic coastline. Tigers, Bulls, and Lemons are the most likely to prey on turtles (Bjorndal, 1995), but they were seen very rarely in this data set. However, other shark species could still affect the turtle behavior and abundance in these study sites. For example, Broad Creek had the greatest shark abundance, which could explain the low turtle abundance in the creek. Future research could also seek to determine the influence of individual shark species on turtle abundance, through either predation or non-lethal influences, such as changing when or where turtles forage (Heithaus *et al.,* 2007). Together, with a better understanding of food resources, home ranges, and human influences, this research will enable us to understand and protect juvenile green sea turtles.

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