Recovery of the juvenile bull shark nursery in the Shark River Estuary after the 2010 cold snap

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Introduction:
The frequency of extreme environmental events is predicted to increase, and understanding their impacts will provide insight into the spatial and temporal scales at which acute disturbances may persist within and across ecosystems. From January 2-13, 2010 south Florida experienced a drastic and extended drop in air temperature (mean low air temperature = 6.1°C ± 0.2 SE; NOAA 2010), that led to an extreme mortality event on a scale not recorded in Everglades National Park for more than 50 years (Rehage et al. 2010). Data collected before, during, and after the cold snap showed that juvenile bull sharks were considerably impacted by the cold snap: 57% of acoustically tagged sharks left the estuary during or immediately after the event, and the other 43% of sharks apparently succumbed to the cold temperatures (Matich & Heithaus 2012). Few individuals returned to the system after the event (<9%), and the estuary is currently recovering, with the relative abundance, size-range, and trophic niche width of sharks increasing over the last two years. Our research suggests that the nursery is still recovering, and it will take several more years to resemble its structure prior to the cold event and fill a similar ecological niche.

Methods:
Sharks were sampled using bottom-set longlines year-round. Total length of all sharks was measured. Blood samples were collected and separated with a centrifuge to extract plasma for stable isotope analysis.

Results:
The proportion of sharks in each size-class varied with sampling year. In 2010, most individuals were <81 cm TL, and in 2011 most individuals were 81-100 cm TL, suggesting individuals present after the cold snap were born in 2010 or 2011.

Occurrence (presence/absence of sharks on longline), concentration (number of sharks caught/longline when present), and catch per unit effort (CPUE; sharks caught/longline) all suggest that the relative abundance of sharks decreased in 2010 as a result of the cold snap, but increased in 2011 to values similar to those prior to the cold snap (2008-2009).

Isotopic niche width decreased by 85% in 2010 after the cold snap, and increased by 85% from 2010 to 2011. However, the isotopic niche width of sharks caught in 2011 was still 63% smaller than 2008-2009 based on standard ellipse areas (Jackson et al. 2011).

Discussion:
Extreme environmental events are predicted to increase, and their impacts on ecosystems can lead to changes in population size and structure. These changes in population dynamics may cause changes in the ecological niches species fill, and affect the trophic dynamics of ecosystems. After the cold snap in 2010, the relative abundance and size-range of juvenile bull sharks within the Shark River Estuary decreased considerably (>50%), and the isotopic niche width of the nursery decreased by 85%. In 2011, the relative abundance of sharks resembled years prior to the cold snap, but the size-structure of the nursery was still significantly different from 2008-2009, and the isotopic niche width was still 63% smaller, suggesting it was still recovering from the event during 2011. If the nursery continues to recover at a rate similar to 2010-2011, it should resemble its structure prior to the cold snap in 2-4 years (2013-2015). Higher survival rates of smaller sharks in 2011 compared to 2008-2009 could modify the intensity and spatial pattern of intraspecific competition during this recovery period than previously experienced in 2008-2009, which may cause sharks to forage in areas not used prior to the cold snap, while avoiding others. Such shifts could affect community interactions.

Continued sampling will increase our understanding of the long-term effects the cold snap will have on the nursery and community dynamics. As the frequency of extreme events increases, data that enable management agencies to better predict the recovery time and behavior of individuals during recovery may provide information to better regulate recreational and commercial harvests and other anthropogenic impacts.

NOAA. 2010. Summary of historic cold episode of January 2010. Coldest 12-day period since at least 1940, NOAA, Miami, FL.

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The Shark River Estuary is located in Everglades National Park, Florida, USA, and serves as a nursery for bull sharks year-round.

Study area

The Shark River Estuary