Use of headcount surveys to estimate the relative abundance of diamondback terrapins (*Malaclemys terrapin centrata*) at Masonboro Island, North Carolina

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ABSTRACT

Diamondback terrapins (*Malaclemys terrapin centrata*) are declining in portions of their range due to coastal development, mortality associated with crab pots, and human consumption. Although long-term population data is lacking in many geographical areas, it is estimated that diamondback terrapins are declining throughout their entire range. Diamondback terrapin populations are currently unknown at Masonboro Island, North Carolina. Masonboro Island is the largest undisturbed barrier island in southern North Carolina and is protected under the North Carolina Coastal Reserve (NCCR) and the North Carolina National Estuarine Research Reserve System (NCNERR). A visual encounter survey was conducted in creeks at Masonboro Island, North Carolina to determine the relative abundance of diamondback terrapins. Headcounts were performed weekly along an established route that consisted of the intracoastal waterway, channels, small creeks, and one large bay. For analysis purposes, the route was separated into five areas: Channel A, Massacre Creek, Byrons Creek, Channel B, & Terrapin Bay. Byrons Creek (1.25) and Terrapin Bay (1.20) had the highest relative abundances. Channel A had the lowest relative abundance (0.13) perhaps due to the morphology of the channel. These results are an indication that the highest population density of terrapins in the study area occurs in Byrons Creek and Terrapin Bay. Long-term population data is needed to analyze the survival rate of Masonboro Island terrapins. This data, once accumulated can be used to evaluate the effects of environmental stressors such as blue crab pots and habitat degradation on local terrapin populations.

INTRODUCTION

Diamondback terrapins are the only North American turtles that are specifically adapted to survive in salt marsh and estuarine habitats (Hart and Lee 2006). Their home range extends as far north as Massachusetts and as far south as Texas (Ernst and Barbour 1989). Terrapins have a life span of at least twenty years, with some researchers expecting that they can live beyond forty years. They exhibit sexual dimorphism with females weighing three to four times more than males. Females also have larger heads and smaller more narrow tails. Females also reach sexual maturity at a later age than males (Breenessel 2006; Hart and Lee 2006). Nesting occurs from April through July and females may lay two clutches per season with varying clutch sizes (Ernst and Barbour 1989).

There are a variety of factors that have led to the decline of diamondback terrapins. Throughout colonial America, terrapins were a major protein source for the Continental Army and for slaves in tidewater plantations. In the late 1800's, terrapin soup became very popular among economically privileged individuals. This led to the creation of mass harvesting operations and by the beginning of the twentieth century some local populations were extinct. Prohibition significantly reduced consumer demand for terrapins because the liquors used to prepare the meat were no longer available (Hart and Lee 2006). Habitat degradation has also reduced diamondback terrapin populations. Coastal development has increased dramatically in urbanized areas along the mid-Atlantic coast which in turn has encroached into terrapin territory. Female terrapins are now forced to travel longer distances, often across dangerous roads, in search of a suitable area to nest (Wood and Herlands 1997). Terrapin populations have also declined due to mortality associated with recreational and commercial crab pots. Terrapins and blue crabs (*Callinectus sapidus*) share the same range (NCDENR/DMF 2004)). Terrapins enter crab pots for food or to follow other terrapins and are unable to exit. Crab pots must be monitored frequently to prevent terrapins from drowning. Ghost crab pots (i.e. abandoned crab pots) are the most detrimental to terrapins because they are never monitored and therefore have a high mortality rate (Dorcas et al. 2007; Wood and Herlands 1997). A mark/recapture study conducted in South Carolina concluded that crab pots alter the sex ratio of diamondback terrapins by catching mostly juveniles and males (Dorcas et al. 2007).

There are seven subspecies of diamondback terrapins characterized by dissimilarities in carapace morphology and body coloration. Diamondback terrapin subspecies, Carolina terrapin also known as Southern Diamond (*Malaclemys terrapin centrata*) ranges from Cape Hatteras N. C. to Northern Florida. The Carolina terrapin is easily identified because it contains no knobs or median keel and its posterior margins are curled upward (Ernest and Barbour 1989; Brennessel 2006; Hart and Lee 2006). In North Carolina the Carolina terrapin is listed as a species of special concern (NCDENR/DMF 2004) because long-term population data is lacking in many areas of the state.

In order to assess Carolina terrapin population trends, multiple years of mark/recapture data is needed (Hart and Lee 2006). Crab pots (Hoyle and Gibbons 2000), seines, trammel nets (Lovich and Gibbons 1990; Dorcas et al. 2007), and dip nets (Harden et al. 2009), are typical sampling techniques utilized to capture terrapins. Sampling techniques used in one study area may not be appropriate for other sites because of creek morphology, semi-diurnal tidal fluxes, and navigation issues. These techniques are both labor intensive and time consuming; therefore, not applicable to all research situations.

Visual encounter surveys can be used as an alternative method to mark/recapture studies. This particular methodology can determine relative abundances of terrapins and estimate population densities over time. Visual encounter surveys are appropriate for terrapin monitoring because terrapins surface frequently to breathe and bask in the sun (Harden et al. 2009). A visual encounter survey was conducted at Masonboro Island, North Carolina to determine the relative abundance of diamondback terrapins in area water bodies. The salt marshes and tidal creeks of Masonboro Island provide ideal habitat for diamondback terrapins. They are known to inhabit the area, yet their population size is unknown. The purpose of this study is to provide sound data to the North Carolina National Estuarine Research Reserve (NCNERR) on the relative abundances of diamondback terrapins at the Masonboro Island Research Reserve component. This data will not only infer where the highest population densities of terrapins are located, but also will examine tidal fluxes to determine the most ideal tides to conduct visual encounter surveys.

METHODS

Masonboro Island, located five miles southeast of Wilmington, is the largest undisturbed barrier island in southern North Carolina (Fig. 1). Masonboro Island is protected under the North Carolina Coastal Reserve (NCCR) and the North Carolina National Estuarine Research Reserve (NCNERR). Masonboro Island is only accessible

Fig 1 – Map of Masonboro Island Research Reserve; Courtesy of NC Coastal Reserve

by boat and is utilized for both recreational and research purposes. The island is approximately 8.4 miles long and entails a variety of ecosystems, such as, tidal flats, salt marshes, shrub thickets, maritime forests, grasslands, ocean beaches, and sand dunes (Fear 2008). Intertidal salt marsh is the predominate ecosystem at Masonboro Island encompassing over 1500 acres (based on 2004 statistics) which is 58% of the total reserve (Fear 2008). Carolina terrapins utilize salt marshes for foraging of crustaceans and polychaete worms. Juveniles also use the salt marsh to burrow under cordgrass (*Spartina alterniflora*) to prevent predation (Brennessel 2006). The second largest habitat at Masonboro Island is the sand dunes, which cover 202 acres or 7.8% of the reserve component. Another important habitat at Masonboro Island for terrapins is the ocean beach, which is 133 acres or 5.2% of the island (Fear 2008). Carolina terrapins use sand dunes and ocean beaches for nesting because of the sandy loose soil.

Fig. 2 – Map of Masonboro Island Study Area. The red line indicates the headcount route.

A visual encounter survey, also known as a headcount survey, was conducted at Masonboro Island, North Carolina from June through September 2009. Headcounts were performed at least weekly; sometimes more frequent, along an established route (Fig. 2) that consisted of the intracoastal waterway, channels, creeks, and one large bay. Terrapin Bay was not included in every headcount survey because of weather conditions and navigation issues. Headcount surveys began after departure from the Center for Marine

Sciences (CMS) dock on the intracoastal waterway. Next, the route headed north, down the intracoastal waterway to a nearby channel (Channel A). The route eventually meanders to the south through large channels and smaller creeks and eventually returns to the CMS dock.

Headcount surveys typically involved two people in their own individual kayaks. These surveys consisted of gathering GPS coordinates of the location of every terrapin that surfaces, time, tide, morphological characteristics, and duration (the number of times resurfacing occurred).

For analysis purposes the study area was separated into five locations: Channel A, Massacre Creek, Byrons Creek, Channel B, and Terrapin Bay. The GPS coordinates obtained in the field were used to map the exact location of diamondback terrapins in the study area. This data was also utilized to determine the relative abundances of diamondback terrapins at the five locations. The GPS coordinates of each terrapin and corresponding tide will be examined to decide the ideal tide for performing headcount surveys.

RESULTS

Sixty-eight terrapin observations occurred during headcount surveys from June through September 2009. Byrons Creek (n=30) had the highest number of terrapin observations. Terrapin Bay (n=12) had the second highest number of terrapin observations (Fig. 3). Relative abundances were determined for all five locations. Relative abundance was defined as the number of terrapin observations per number of sampling days (Graeter et al. 2008). Byrons Creek (1.25) and Terrapin Bay (1.20) had the highest relative abundances (Fig. 4). Channel A had the lowest relative abundance (0.13).

The highest number of terrapin observations were on ¼ ebb tide (n=25) and ½ ebb tide (n=22) (Fig. 5). The least number of terrapin observations were on ¼ flood tide (n=0) and ¾ flood tide (n=2). The number of terrapin observations in each creek per tide was also examined. At ¼ ebb tide terrapin observations occurred in all locations (Fig. 6). ½ ebb was the second highest tide to observe terrapins in all locations except Channel A.

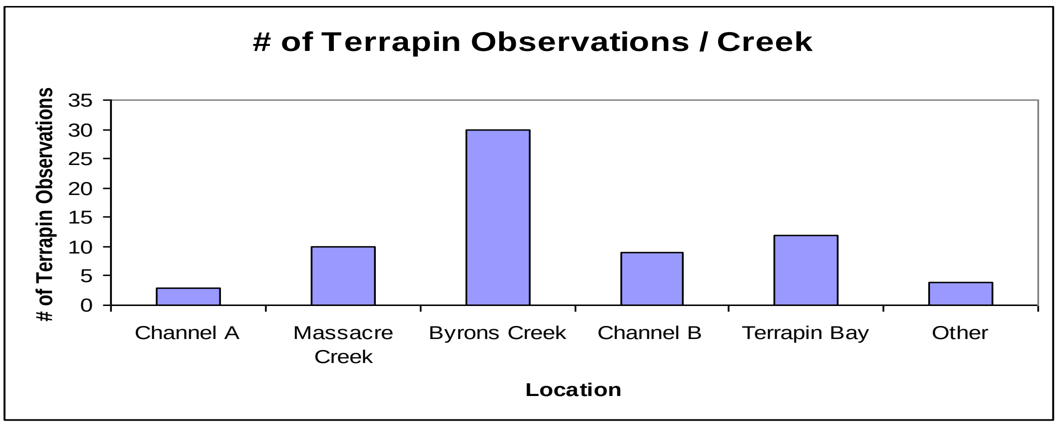

Fig. 3 - Number of terrapin observations per creek at Masonboro Island, North Carolina. Headcount surveys were conducted from June – September 2009.

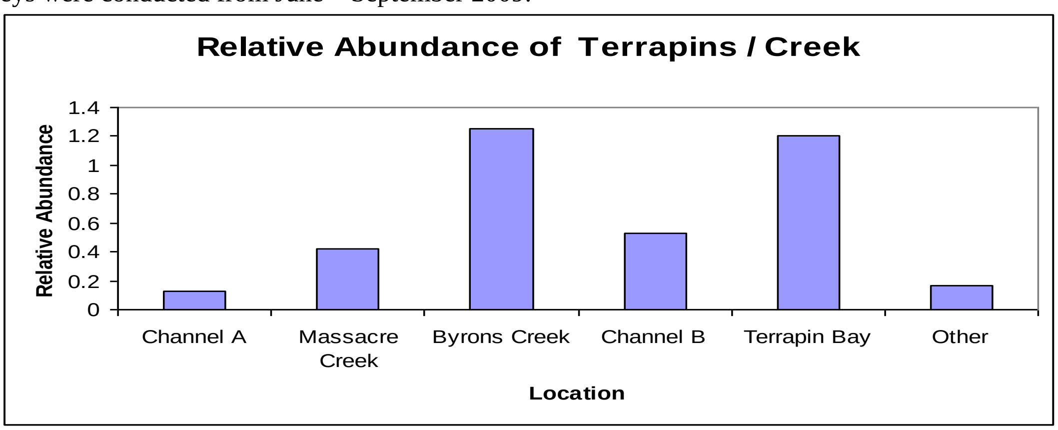

Fig. 4 - The relative abundance of terrapins per creek at Masonboro Island, North Carolina. Relative abundance for this study is defined as the number of terrapin observations per number of sampling days.

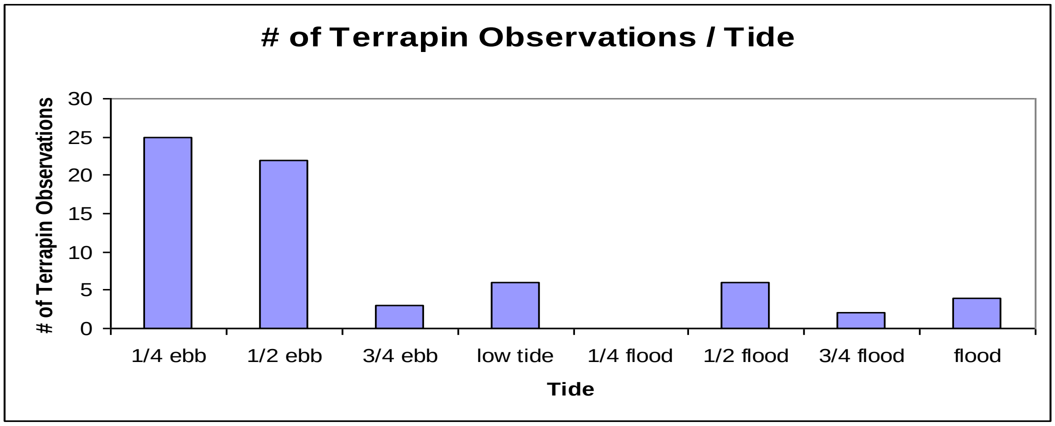

Fig. 5 - This graph shows the number of terrapin observations per tide. ¼ ebb & ½ ebb have the highest number of terrapin observations, whereas ¼ flood had zero terrapin observations.

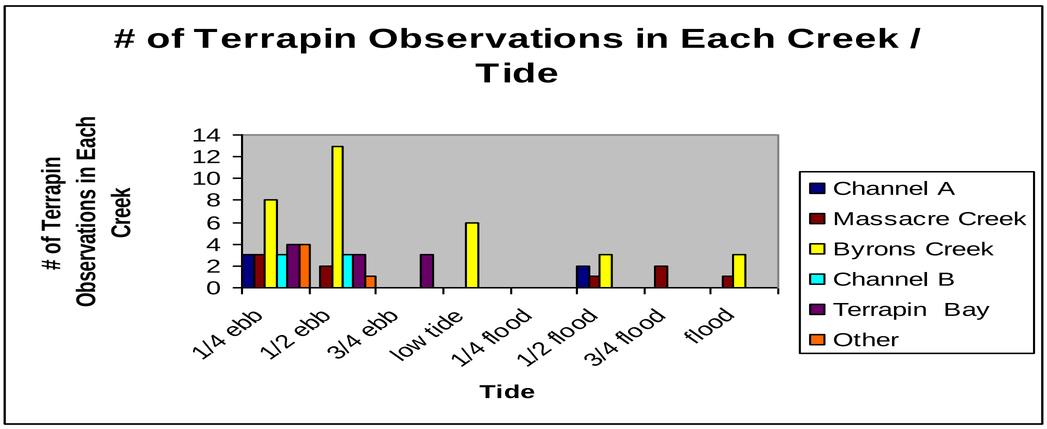

Fig. 6 - The number of terrapin observations in each creek per tide. This graph illustrates that at ¼ ebb tide terrapin observations occurred in all locations. ½ ebb tide was the second most active tide for terrapin observations with the exception of Channel A. No terrapin observations occurred at ¼ flood.

DISCUSSION

Visual encounter surveys require less sampling effort and capital than mark/recapture studies (Harden et al. 2009). Therefore, visual encounter surveys are a more convenient method to analyze population trends over time. Head-count surveys not only estimate relative abundances of terrapins in particular locations but can also evaluate population densities. Typically if relative abundance is utilized on a large scale, an intensive study should be performed to reveal the relationship between relative abundance and population size (Rodda et al. 2005). Harden et al. (2009) conducted a head-count survey from 2005 to 2007, in concurrence with a mark/recapture study on Kiawah Island, South Carolina. They found a positive correlation between number of terrapins observed up and down the creek, combined with the number of terrapins captured (R^2=0.538). A mark/recapture study, similar to the Kiawah Island study, needs to be initiated in the Masonboro Island study area to quantify the relationship between relative abundance and population size.

It was discovered through headcount surveys that Byrons Creek (1.25) and Terrapin Bay (1.20) had the highest relative abundances. Byrons Creek is an ideal habitat for terrapins because it is surrounded by *Spartina alterniflora* and contains one of their favorite foods periwinkle snails (*Littorina irrorata*). In Beaufort, North Carolina, stomach contents of terrapins captured were comprised mainly of periwinkle snails (Brennessel 2006). Channel A had the lowest relative abundance (0.13) perhaps due to the morphology of the channel. Based on the above results one can infer that the highest terrapin population densities are located in Byrons Creek and Terrapin Bay. However, a mark/recapture study needs to be conducted in conjunction with head-count surveys to quantify this hypothesis.

Tidal cycles were also examined to establish the ideal tide to conduct visual encounter surveys. The results depicted that ¼ ebb tide (n=25) and ½ ebb tide (n=22) had the highest number of terrapin observations. These results suggest that the ideal tide to perform head-count surveys is a falling tide. Flood tides are diamondback terrapins prime foraging time and most active tides of the day (Brennessel 2006). Therefore, visual encounter surveys at Masonboro Island should be performed within 3 hours after a flood tide. Harden et al. (2009) discovered from headcount surveys at Kiawah Island, South Carolina that the highest number of terrapins was observed at low tide. In contrast, the majority of the Masonboro Island study area contains minimal water during low tide making navigation impossible. ¼ flood tide (n=0) had the lowest number of terrapin observations due to minimal water in study area creeks.

Visual encounter surveys provide beneficial data on diamondback terrapin locations and densities. A continuation of these surveys for multiple years may reveal long term population trends. A mark/recapture study at Masonboro Island would analyze population densities by determining sex ratios and age distributions of local terrapin populations. Once long-term population data has accumulated, researchers will be able to evaluate the effects of environmental stressors, such as blue crab pots and habitat degradation on local terrapin populations.

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