Location dependent egg viability of the Atlantic horseshoe crab, *Limulus polyphemus*: A comparison between salt marsh and Delaware Bayshore spawning sites

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The Atlantic horseshoe crab, *Limulus polyphemus*, is an ecologically, economically, and biomedically significant species of marine arthropod which inhabits the eastern shore of the United States and Mexico. The Delaware Bayshore is home to the largest horseshoe crab spawning events in the world, and their reproductive success here has been the subject of many investigations. However, horseshoe crabs also spawn in small patches of habitat found on Atlantic-side back bay marshes. Spawning here has been poorly documented, but success is assumed to be low. In 2014, a beach-nesting bird habitat was constructed from dredged sandy material on Ring Island, a salt marsh island. This habitat features a grain size smaller than the bayshore beach. To compare the reproductive success of horseshoe crabs spawning at the sites, I dug 104 randomly placed pits on beach sections at the constructed habitat and the bayshore from late June through July and classified the development of found egg clusters. The proportion of eggs showing development was found to be lower on the constructed habitat than on the bayshore ($\chi 2=32.23$, $p<0.01$), while eggs from the habitat had a higher proportion of development than those from the bayshore when kept in controlled conditions in tanks ($F=4.81$, $p=0.04$). My findings confirm that spawning is occurring on marsh habitats and show that eggs laid here are fertilized and viable. However, something, perhaps low oxygen availability, is preventing these eggs from developing as well as those laid on the bayshore.

Interspecific interactions between American Oystercatchers, *Haematopus palliatus*, and colonial nesting birds at Stone Harbor Point

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On Stone Harbor Point, New Jersey American Oystercatchers share beach nesting habitat with colonial nesting Black Skimmers (*Rynchops niger*), Least Terns (*Sternula antillarum*) and Common Terns (*Sterna hirundo*). Oystercatcher nests may or may not occur near colonial birds. In contrast to the pair-based defense strategies of oystercatchers, colonial birds defend territories as a group against disturbances such as predatory gulls and raptors. I hypothesized oystercatchers should show higher reproductive success and decreased response to disturbances when nests are located near tern colonies than those without colonial birds nearby due to the colonial defense strategy. I conducted 40 30-min behavioral observation surveys on oystercatcher pairs at sites with and without colonial nesting birds to compare the level of antipredator response, time to return to neutral behavior, and reproductive success. After 20 surveys at each site, I found no significant difference in the number of disturbances at sites with ($N=33$) or without ($N=23$) colonies. Behavioral responses to all disturbances did not differ regardless of the presence of a colony ($t\text{-critical} = 2.02$, $p = 0.23$). Hatching success at each site was assessed to evaluate reproductive success. No significant difference in hatching success was observed for pairs nesting in sites with (82%, $N=17$) or without (75%, $N=8$) colonial birds ($\chi^2 =0.07$, $p=0.79$). My results suggest that nesting near bird colonies did not have a significant effect on oystercatcher fitness and antipredator behavior.

Diamondback terrapin (*Malaclemys terrapin*) and predator activity at artificial nesting sites or "terrapin gardens"

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Coastal development is threatening the nesting habitat of diamondback terrapins. One approach to restore this lost habitat is the construction of "terrapin gardens," areas of sand preferred by nesting terrapins. Although terrapins have been found to nest in terrapin gardens, research has also suggested that nests in terrapin gardens may attract more predators than those in other nesting areas. To evaluate the costs and benefits of terrapin gardens, I used trap cameras and in-person observations to monitor two gardens in Sea Isle City, New Jersey. I compared terrapin and predator activity in the gardens to that in control plots in nearby grassy lawns. I also used the cameras to evaluate the effectiveness of Predator Guard, a predator deterrent that mimics predators' nighttime eyeshine. The camera footage indicated that both terrapin and predator activity was higher in the gardens than in the grassy lawns. Most terrapins nested in the less vegetated garden ($Z = 2.5$, $P = 0.01$), while predators visited both gardens more frequently than the grass plots (all $P < 0.03$). These results suggest that gardens could benefit the terrapin population, but only if paired with an effective predator deterrent. Moreover, Predator Guard did not significantly decrease predator activity ($Z = -0.35$, $P = 0.73$); although Predator Guard seemed initially effective, the predators appeared to acclimate to the presence of the deterrent over time. Consequently, further research into different predator deterrents would help to determine how to make terrapin gardens more beneficial to local terrapin populations.

The Influence of Nesting Success on the Habitat Selection of the American Oystercatcher *Haematopus palliates*

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Since 2004, New Jersey biologists have banded American Oystercatchers (AMOY) to track their populations. Approximately 130 banded AMOYs annually migrate to Stone Harbor Point (SHPT) beach in Cape May County. However, a significant number are first observed post-breeding season with their breeding habitats unknown. I hypothesized that some are nesting in the less-monitored surrounding marsh, due to isolation from humans and mammalian predators. I determined the number relocating from beach to marsh mid-breeding season using field data and the AMOY Working Group banding database. The number of beach-banded birds returning to breed in that habitat (N = 9 in 2013 & 2014, 11 in 2015, 10 in 2016) was significantly lower ($p=0.01$) than those not observed (N = 21 in 2013 & 2014, 21 in 2015, 26 in 2016) or observed in the marsh over multiple years (N = 1 in 2013, 2014, & 2015, 5 in 2016). I also calculated the success rate of banded AMOYs both nesting at SHPT from 2013 to 2016 and all nearby marsh nesting birds during 2016 only. In 2016, 33% of all pairs successfully nested in the marsh, falling within the range of success observed for beach habitats (31% in 2013, 18% in 2014, 57% in 2015, 83% in 2016). Although these results oppose the hypothesis, a lack of data from the marsh in previous years makes these rates difficult to compare. However, the significant numbers of undetected individuals during the breeding season indicate the need for increased observation of the salt marsh.

Estimating Hatchling Sex Ratios in Diamondback Terrapins (*Malaclemys terrapin*) from Nest Cavity Temperature

Wolfgang Trumbauer, Widener University

Diamondback terrapins undergo temperature dependent sex determination. We can infer the sex of a particular clutch of eggs from incubation temperature during a critical period of embryonic development. In terrapins, males are produced below 28°C, whereas female development is triggered at temperatures around or above 30°C. Furthermore, incubation temperature can be influenced by plant cover, shade, proximity to roadways, and substrate type. Using this information, I measured the temperature and relative humidity of a stratified sample of naturally occurring terrapin nests (N=13) with iButton temperature loggers at shallow and deep depths. Paired control buttons were also measured (N=7). I planted these loggers inside the nest cavity for a seven day period (starting day 8-11) to capture the temperature sensitive period. I predicted the predominant sex of hatchlings in each nest by evaluating the measures of central tendency for upper and lower cavity temperatures. A chi-squared analysis determined no significant difference from the expected 1:1 ratio ($X2=1.92$, $df=1$). Furthermore, the average incubation temperature in nest cavities remains relatively constant despite fluctuations in ambient highs and lows. Additionally, I found significant differences in temperature amongst some of the substrate types for both the upper and lower nest cavity ($P<0.01$). Lastly, the relative humidity in the lower nest cavity was significantly lower than in paired plots ~25cm away from the nest cavity at comparable depth ($P<0.01$). Further investigation is needed, but my results have improved understanding of terrapin nesting activities at The Wetlands Institute.

Evaluating the population characteristics of Diamondback Terrapins (*Malaclemys terrapin*) within saltmarsh tidal creeks of Southern New Jersey.

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Knowledge of diamondback terrapin population characteristics in salt marsh tidal creeks can allow impacts from road mortality, habitat loss and drowning in crab traps to be understood. Unfortunately limited data are available on the population and distribution of terrapins within local saltmarsh creeks. My primary objective was to determine the sex ratio of the terrapin population in Josh and Charles Creeks in Cape May County, New Jersey. Modified commercial crab traps were used to capture terrapins in the same localities surveyed during a 2008 mark-recapture study. Between June 26 -July 22, each creek was surveyed four times with seven baited traps. A total of 71 terrapins were captured (Charles Creek: N = 22, Josh Creek: N = 49), of which three (4.2%) were captured in previous years. Upon capture terrapins were scanned for pit tags, measured, sexed, and microchipped if needed before release. Sex ratios of terrapins in each creek did not differ significantly from 1:1 for 2016 (Josh: $p=0.77$, Charles: $p=0.12$). I compared average carapace length by year for both sexes, using data from 2002-2016. Male carapace length differed by year in both creeks (Charles: $p=0.04$, Josh: $p<0.01$). In Josh Creek, males were significantly larger in 2002 than in subsequent study years. In Charles Creek, males were significantly larger in 2016 than 2003. No significant difference was detected in carapace length by year for females at either site (Charles: $p=0.17$, Josh: $p=0.12$)). Results from this study will help researchers at TWI better understand the population status of diamondback terrapins.