Herring and Great Black-backed Gull Nest Site Selection and American Oystercatcher Nesting Response within Historic Placement Areas

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In salt marshes, rising sea levels are becoming an increasing problem for ground-nesting birds. Nests are more prone to flooding during extreme high tide events, and these events are happening with increased frequency. Limited suitable nesting habitat can lead to interspecific competition between species with similar nest site preferences, such as the focal species for this project: American Oystercatcher (*Haematopus palliates*), Herring Gull (*Larus argentatus*), and Great Black-backed Gull (*Larus marinus)*. To better understand species habitat preferences within proximity to historic dredged material placement areas on Gull and Sturgeon Island, I marked gull nests within study areas during peak incubation (mid-June) and mapped habitat boundaries. I also examined data from oystercatcher nests monitored between 2019-2022. For each nest, I determined elevation, dominant vegetation classification and distance from previously established nesting habitat. Results indicated differences in nest site selection of gulls (t_{82}=-1.8, P=0.03), with Herring Gulls primarily nesting in areas dominated by *Iva frutescens* and Great Black-backed Gulls nesting in areas dominated by *Distichlis spicata*. The distance of oystercatcher nests from preferred nest habitat significantly increased (X^2_1=5.9, P=0.015) after the gull nesting season commenced (May 15). This suggests that gulls are affecting oystercatcher nest site selection, either directly or indirectly. Results from this study can help inform conservation practices or restoration plans in the future to protect valuable nesting sites and enhance nesting areas. This is particularly important for local oystercatcher populations, which are often impacted by nest flooding and predation.

Behavioral Response of Nest-seeking Female Diamondback Terrapins (*Malaclemys terrapin*) to Animex Wildlife Fencing, with Notes on Fence Effectiveness

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The Diamondback Terrapin is the only turtle species in the U.S. that can permanently inhabit brackish water ecosystems. Due to the development of coastal land for human use, terrapins have become more susceptible to anthropogenic impacts, especially road mortality. Over the past few decades, The Wetlands Institute (TWI) has implemented a variety of fencing types along Stone Harbor Boulevard to mitigate terrapin road mortalities. Recently, TWI installed a section of Animex wildlife fencing, which is designed specifically to keep wildlife off roadways and reduce road mortalities in a high-risk area. There has been no prior testing of how terrapins interact with Animex fencing. I documented terrapins' behavioral response to fencing to assess the overall effectiveness of the Animex. Over five weeks, I routinely walked a transect along the Animex and recorded terrapin behavior related to nesting and movements. I quantified observations from 33 terrapins by creating an ethogram based on the proportion of time spent on each behavior across every encounter. Terrapins spent significantly more time walking alongside the fence (towards/away from TWI) and nesting as compared to climbing and jump-out attempts (X^2_8=29.2, P<0.001), although they used jump-outs successfully. Weekly terrapin encounters along the Animex transect on Stone Harbor Boulevard were found to vary by year (X^2_3=12.7, p=0.012). When comparing 2019 to 2022, there was a significant difference in number of encounters per week (X^2_3=10.0, P=0.002). These results suggest a decline in encounters, however, additional years of data are needed to determine the effectiveness of Animex fencing.

Investigating Diamondback Terrapin (*Malaclemys terrapin*) Nesting Activity and Predation on Elevated Nesting Habitats in Salt Marshes

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Diamondback terrapins are a keystone species within the Atlantic coastal wetland ecosystem. Both natural and anthropogenic pressures have resulted in notable population decreases over the past century. With habitat loss deemed a leading issue in salt marshes, the construction of elevated nesting habitats (ENHs) for wildlife has been a key conservation feature in southern New Jersey. Terrapins have been observed on ENHs, but the extent to which they nest on these habitats is unknown. To investigate, I conducted a four-week study using trail cameras in 10x15m study plots on Ring Island ENH, my focal site proximate to The Wetlands Institute (TWI), and Great Flats ENH, a secondary site included for comparison. Using images captured at 5 minute intervals over 24 hours, I quantified terrapin nesting activity and analyzed predator presence along with weather and nesting activity from TWI property for comparative purposes. Ring Island ENH is a popular location for terrapins, with patterns of nesting activity similar to those observed on TWI property. Fish Crow (*Corvus ossifragus)* presence at Ring Island ENH increased with terrapin activity ($F=10.3$, $P=0.03$). Terrapin presence was determined to be influenced by time of day ($X^2_4=23.3$, $P<0.001$), but was not significantly influenced by weather ($X^2_3=1.7$, $P=0.63$). While avian predation remains a significant threat on ENHs and is likely to impact nest and hatchling survival rates, ENHs provide nesting habitat with reduced risk to nesting adults from road crossings.

Factors Influencing Nest Site Selection and Reproductive Success in Saltmarsh and Seaside Sparrows

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Saltmarsh Sparrow (*Ammospiza caudacuta*) and Seaside Sparrow (*Ammospiza maritima*) nest in coastal wetlands along the eastern United States. Tidal variation and flooding can have a significantly large impact on their nesting ecology and reproductive success. This is exacerbated by sea level rise causing higher and more frequent tidal extremes. Population trends for the Saltmarsh Sparrow are declining significantly, with an estimated 9% species-wide loss in population per year prompting its consideration for federal listing as an endangered species, while Seaside Sparrow population trends are not well understood. To determine nest site selection, I compiled detections of sparrows from point count and acoustic surveys across study sites. Frequency of detections was related to the number of nests at the site for both point count ($F_{1,28}=89.4$, $P<0.001$) and acoustic surveys ($F_{1,16}=18.0$, $P=0.006$). I located and monitored sparrow nests and collected metrics at nest sites (e.g., nest height, vegetation). Water level data and temperature loggers indicated flooding at monitored nests in 2022. Seaside Sparrow nest success was significantly influenced by highest water level and distance to tidal water edge ($X^2_2=8.2$, $P=0.017$). Of the nests included in this study five fledged, nine failed from flooding, and one is unknown in fate. All nests on Ring Island failed due to flooding while Gull Island had a higher proportion of fledged nests (71%). Creating areas like Gull Island, with elevated habitat and adjacent *Spartina alterniflora* cover could be beneficial in creating sustainable breeding area.

Examining Differences in Vegetation Composition and Succession in Response to Elevation and Salinity on an Enhanced Marsh Nesting Habitat

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Coastal wetlands are among the most productive ecosystems on Earth, providing services that benefit human populations and important habitat for a variety of wildlife species. Restored marsh areas may have increased resistance to erosion and improved resilience to flooding caused by sea level rise. This study investigated differences in vegetation succession in response to salinity and elevation changes over time on an elevated nesting habitat (ENH) established on Ring Island in 2014. I collected vegetation metrics and soil salinity within $1m^2$ monitoring plots along transects spanning an elevation gradient on Ring Island ENH and compared to vegetation data collected within monitoring plots in previous years (2020-present). I investigated elevation changes to further explain changes in vegetation response and found loss of higher elevation sites (> 5.5ft NAVD88) between 2019 and 2022, with an estimated area loss of $240.95m^2$ for this elevation gradient. Species richness was positively correlated to higher elevation (F_1= 8.9, P=0.007), and salinity was negatively correlated with higher elevations (F_1=28.1, P <0.001). For all monitoring plots in this study, Seaside Goldenrod (*Solidago sempervirens*) was the dominant species in 2021 (46% of plots) and 2022 (54% of plots). Species richness within monitoring plots did not change significantly but had a decreasing trend over time (3.04 ± 0.45 in 2020, 2.80 ± 0.45 in 2021, and 2.72 ± 0.45 in 2022). Results from this study can help inform future habitat restoration efforts to target desirable vegetation species for sensitive nesting species and marsh resiliency.

Effects of Water Source and Temperature on Horseshoe Crab (*Limulus polyphemus*) Development in a Captive Setting

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The Delaware Bay has the largest concentration of spawning horseshoe crabs in the world, yet their population faces significant anthropogenic threats, such as harvest for blood and bait, and stranding on beaches. The conservation of this species is crucial as they play a major role in supporting coastal ecosystems. Since 2016, The Wetlands Institute has conducted a horseshoe crab head-starting program, raising horseshoe crab eggs in captivity through their early stages of development to support public education efforts. I sought to identify, among practical locally available options, the water source and water temperature that produce optimal egg development to inform horseshoe crab head-starting efforts at The Wetlands Institute and with its partners. I randomly sorted egg clusters from the Delaware Bayshore into six containers that were filled with approximately two gallons of water sourced directly from the Delaware Bay, made using dechlorinated tap water and Instant Ocean synthetic salt mix, or taken from Scotch Bonnet creek in Stone Harbor, New Jersey. There were two containers for each water source: one at room temperature and one set to 75°F using a water heater. To quantify development, I determined developmental stage for a random sample of eggs from each container twice weekly. Higher temperature accelerated the development of horseshoe crabs (F_1=25.7, P<0.001) and using natural water sources promoted a quicker rate of development than synthetic salt water (F_2=6.3, P<0.012). These results can inform future efforts to raise horseshoe crabs for educational and conservation purposes.