

Impacts of Beach Nourishment and Development on *Emerita talpoida* in Southeastern North Carolina

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Introduction

Beach nourishment can be defined as placing sand on an eroding shoreline to restore, re-form, or maintain a beach¹¹. In the US, the first beach nourishment project occurred at Coney Island, New York (USA) in 1921⁴. Over the past 80 years, 333 projects have been completed along the East Coast, placing 517 million cubic yards of sand on the beaches⁹. Since 1950, \$2.5 billion has been spent to nourish these beaches. Beach nourishment can lead to increased water turbidity, burial of invertebrates, changes in nutrient cycling, and sorting out of shell fragments².

Wrightsville Beach, North Carolina (USA) has been nourished since 1938¹². To date, 11 million cubic yards of sand have been placed on the beach. Currently, sand is placed on the center of the beach (erosion is fastest here) every four years. Rock jetties on the south end of Wrightsville Beach and the north end of Masonboro Island are used to hold open the inlet, preventing sand from moving from Wrightsville Beach to Masonboro Island. Because of this, the north end of Masonboro Island is nourished at the same time as Wrightsville Beach.

In North Carolina, The Coastal Resource Commission has few restrictions regarding beach nourishment⁸. Sand placed on the beach as part of the nourishment project must be compatible with existing grain size and type, determined by sediment cores. This excludes sediment placed on the beach from regular dredging to maintain a navigation channel. In addition, beach nourishment projects must be completed by May 1 to minimize the impact on sea turtles.

Emerita talpoida, the mole crab, is found in the intertidal surf zone from Massachusetts to Mexico⁶, and serves as an important food source for shore birds⁷, and surf zone fish¹³. This burrowing crustacean typically moves up and down the beach following the tide, and is most active 1-2 hours after high tide⁶. *Emerita* typically inhabit dissipative beaches, or beaches characterized as being wide with fine grained sands and a flat slope^{2, 3, 5}. *E. talpoida* are most frequently found in sand ranging from 0.25 mm to 0.89 mm and prefer a beach slope angle between 4.0 and 9.0 degrees².

Few studies have been conducted to test the effects of beach nourishment on mole crabs. It has been found that *E. talpoida* use the long shore current to move down the beach away from the point of discharge during the nourishment project⁷. Another study found that mole crabs display reduced population abundance on nourished beaches the first two months following the project, but recover after that, reaching annual highs by the end of the season¹¹.

Objectives

While some studies have been done to test the effects of beach nourishment on intertidal organisms, few have studied *E. talpoida*, and none have examined the long-term effects of beach nourishment on *Emerita*. This study aims to assess the long-term, combined impacts of beach nourishment and development on *E. talpoida* by comparing mole crab abundance, size, and female reproductive status at beach locations in Southeastern North Carolina.

Shoreline slope, sand compaction, salinity, dissolved oxygen, water temperature, turbidity, and sediment grain size will be measured at each site to examine possible underlying causes of differences in mole crab distribution between all beaches. All data will be synthesized

to create a policy recommendation for future beach nourishment projects regarding impacts to *Emerita talpoida*.

Justification

Currently, few policies are in place regarding beach nourishment. Little research has been done to examine the long-term impacts of beach nourishment on the animals that live on the beach, especially those who live in the intertidal zone. With more and more beaches being nourished, it is vital to understand the impacts beach nourishment has on the intertidal community to create effective policies to help preserve the beaches for future generations.

Materials and Methods

A total of fifteen beach sites will be sampled, six on Wrightsville Beach, six on Masonboro Island, and three on Hutaff Island. Three sites on Wrightsville Beach are in the nourished and developed section of the beach and three sites are in the un-nourished but developed section of the beach. Three sites on Masonboro Island are located within the nourished but undeveloped section of the beach, and three sites are located within the un-nourished and un-developed section of the beach. All three sites on Hutaff Island are un-developed and un-nourished. Sites on Masonboro Island and Hutaff Island will be located 300 meters apart.

All sites will be sampled once a month from May thru September of 2009. Test order will be randomized by group and beach, with three sites being tested each trip. Sampling will be done an hour after high tide to match the peak activity of mole crabs⁶. On Wrightsville beach, sampling will be done in the morning or evening to minimize the impact of people on

the beach. During each trip, three replicate stations 100 m apart will be sampled at each site to ensure independence².

Emerita will be collected using a Large Sand Flea Rake purchased from Bass Pro Shops. The rake measures 15" wide with a handle of 54" and ½" mesh. The rake will be deployed on the wave up-rush when the wave is ankle deep. Each sample will consist of five rake replicates at each site. All crabs collected will be placed in buckets with ambient seawater until counted and measured. Ten gravid females from each group (developed and nourished, un-developed and nourished, developed and un-nourished, un-developed and un-nourished) will be placed in alcohol and taken back to the lab where the egg mass will be removed and weighed.

At each test site sediment type and size, beach slope, sand compaction, water temperature, salinity, dissolved oxygen, turbidity, wind speed, and wave height will also be measured. Sediment type and size will be measured once at each site using a 225 cm² core to a depth of 15 cm. Samples will be taken back to the lab and dried at 60 °C. The dried sample will then be passed through a series of brass sieves ranging from 4 mm to 0.16 mm. Material on each sieve will be collected, weighed, and grain size distribution will be calculated for each site. Beach slope will be measured between mean high water to mean low water using an Abney Level. Degree of sand compaction will be replicated three times at each site using a cone penetrometer. Salinity, dissolved oxygen, and water temperature will be measured once at each site using a YSI model 85. To measure turbidity, a water sample will be collected from each site and returned to the lab for analysis using a portable turbidimeter. Wave height and wind speed will be obtained each day from the National Weather Service. Sites will only be tested on days with a maximum wave height of three feet or less².

To measure female egg mass, each crab will be placed in a weigh boat, weighed, and its mass recorded (± 0.001 g). The legs, antennae, and telson will then be removed and set aside. Using forceps the egg mass will be removed from the carapace and placed in the weigh boat and measured (± 0.001 g).

Data Analysis

Hypothesis 1 predicts that nourishment and development will both have an effect on *Emerita talpoida*, and the greatest impact will be seen in sites where both of these variables are present. To analyze this hypothesis, a 2-way ANOVA will be conducted to assess whether mean CPUE of *Emerita* is affected significantly ($P < 0.05$) by nourishment and development.

Hypothesis 2 predicts that while some variation may be seen at each site from month to month, this will be consistent across all sites. A second ANOVA will be conducted to assess any significant differences ($P < 0.05$) found within sites between months, and whether this pattern holds true for all sites tested during the month. Hypothesis 3 predicts that higher beach slopes will negatively influence *Emerita* abundance. Hypothesis 4 predicts that *Emerita* abundance will be negatively correlated with increasing sediment size. Hypothesis 5 predicts that *Emerita* abundance will be negatively impacted from increased sand compaction. To test hypotheses 3, 4, and 5 a correlation analysis will be conducted to study the effects of beach slope, sediment size, and sand compaction on *Emerita* abundance. Hypothesis 6 predicts that *Emerita* in unnourished and undeveloped beach locations will be healthier. To assess this hypothesis a female *Emerita* gonadosomatic index will be calculated using overall female weight versus egg mass.

Description of the Project: A scientific report

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