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MODELING LIVING SHORELINES IN A WAVE TANK: QUANTIFYING WAVE ATTENUATION TO FIND THE MOST EFFECTIVE SHORELINE RESTORATION

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Twelve hundred years of history are eroding away in Mosquito Lagoon from natural and anthropogenic events including storms, high water events, and recreational boat wakes. The Timucuan Native Americans left their mark in Canaveral National Seashore through multiple shell middens, mounds composed of oyster shells, pottery shards and animal remains. The Park wanted to protect their middens with cost-effective stabilization techniques that would maintain the natural habitat while minimizing erosion on the shorelines directly seaward of the mounds. Our goal is to test different forms of "living shorelines," a soft-armoring technique, which uses native flora and fauna for stabilization and that has the ability to adapt to sea level rise.

Two species commonly found on the shorelines of Mosquito Lagoon, the native eastern oyster *Crassostrea virginica,* and smooth cordgrass *Spartina alterniflora,* were tested in a 9-meter wave tank at the Florida Institute of Technology. The oysters and cordgrass were deployed inside the wave tank in four different treatment combinations: control, restoration with only oysters, restoration with only cordgrass, and restoration that combines cordgrass and oysters. A simulated shoreline with a slope of 15:1 was used, and the difference in wave heights was recorded using capacitance wave gauges before and after each stabilization method. Wave energy was calculated using

$$E = \frac{1}{8}\rho g H^2 L \qquad (1)$$

Where ρ, g, and L are kept constant within the tank, and wave height (H^2) is the greatest contributing factor to eq. 1. Therefore measuring wave heights before and after the restoration treatments and comparing them to a control treatment is an efficient way of calculating wave energy.

We found that the wave attenuation associated with different types of restoration varied as the techniques aged in the field. Having time to grow to a higher plant density (*Spartina alterniflora*) and recruiting new oyster larva (*Crassostrea virginica*), each treatment was simulated in the tank at initial deployment (new) and 1-year deployment (old) to evaluate change over time. All treatments were placed in the same 0.75 m^2 area on the shoreline, with oyster mats occupying the space associated with the lower intertidal zone, and marsh grass occupying the middle intertidal zone. Each treatment was run independently 3 times within the tank (block ANOVA) and each block contained 10 subsamples in the form of wave trains. The wave trains were designed to match the wave height, period and length of a boat wake observed in Mosquito Lagoon.

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The wave height, and therefore wave energy was significantly reduced in all treatments, and also the 1-year old treatments significantly reduced wave height and energy compared to the newly deployed treatments. Comparing wave heights behind the restoration techniques to the control (just shoreline) allowed us to evaluate the effectiveness of each technique at attenuating wave energy hitting the shoreward shoreline. For newly deployed restoration (new), the *Spartina alterniflora* with a density of 20 plants per square meter reduced wave energy by 4.02%. Newly deployed mats with 144 disarticulated shells per square meter reduced wave energy by 16.31%. A combination of both *S. alterniflora* and oyster mats at the same density reduced wave energy by 16.59%. For the 1-year old restoration, *S. alterniflora* with a density of 148 plants per square meter reduced energy by 30.16%. Oyster mats with recruited larva and a density of 316 oysters per square meter reduced wave energy by 43.73%, and a combination of plants and mats reduced wave energy by 66.76% as seen in Fig. 1.

These results show a maximum wave energy reduction of 67% after the living shoreline has been established for one year in the field. With decreased wave energy hitting the shoreline, shear stress on sediment decreases therefore limiting the erosion occurring on the shorelines of historical shell middens. On top of reducing erosion, this type of restoration potentially has the ability to creep shoreward as sea level is expected to increase. This information has currently been used to stabilize five separate shell middens located within CANA, and will be used in the future to stabilize other eroded shorelines within the Park.

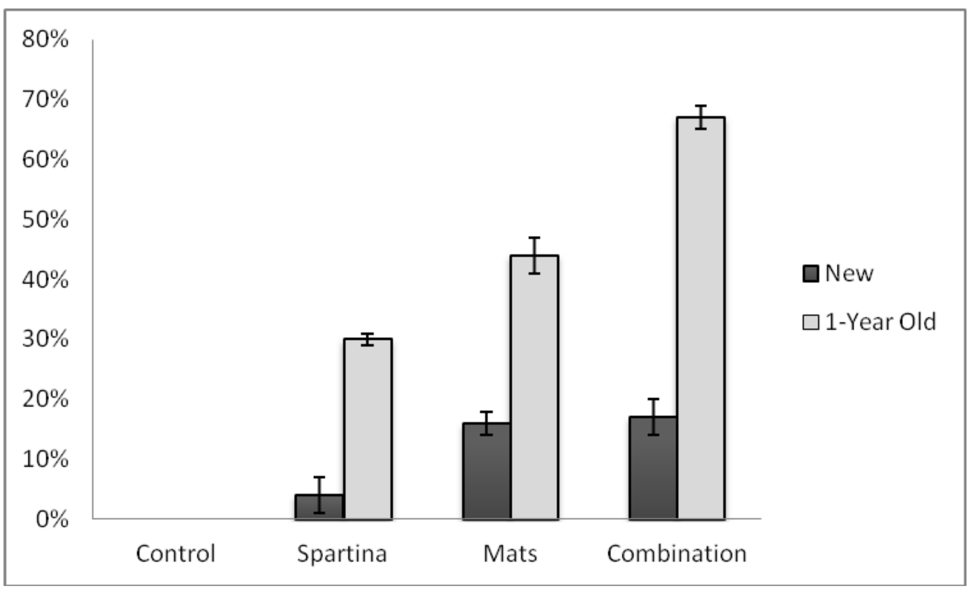

Figure 1 Wave energy reduction from both newly deployed treatments and 1-year old treatments