# Evaluating nature-based approaches to storm wave attenuation

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## Introduction

Growing concern over the negative impacts of traditional shoreline protection methods (seawalls or bulkheads) has increased interest in nature-based solutions, called "living shorelines," that use natural marsh vegetation and constructed oyster reefs to control erosion while maintaining ecosystem functions.

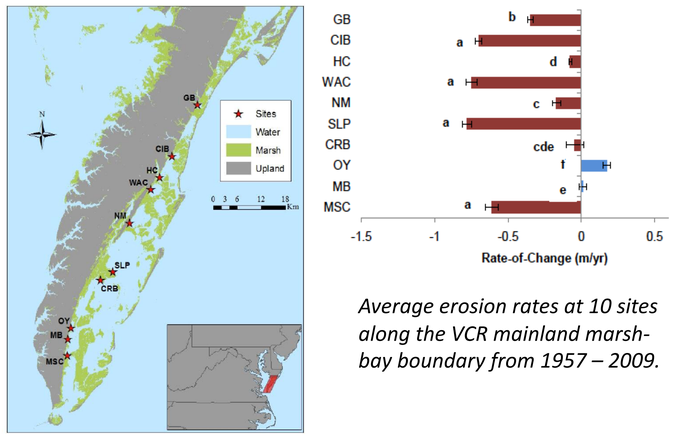
Researchers at UVA have been investigating the effects of marsh vegetation and constructed oyster reefs on attenuation of storm waves, which are the main driver of marsh shoreline erosion in the Virginia Coast Reserve (VCR) – the set of coastal bays along Virginia's Eastern Shore.

*Living shoreline treatment constructed by TNC with Oyster Castles at Man and Boy marsh, VA*

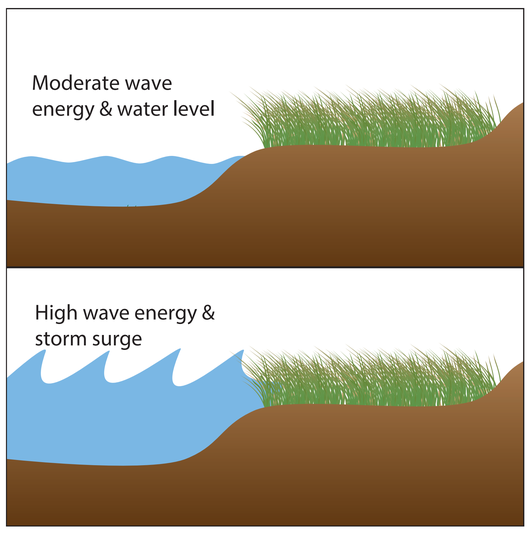
## Marsh shoreline erosion

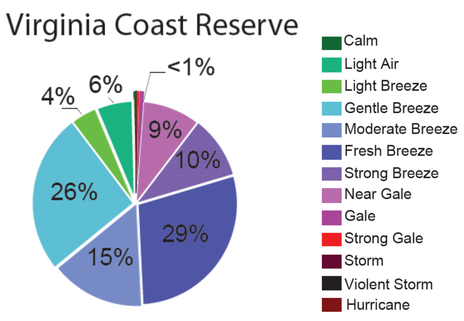
Marsh shorelines in the Virginia coastal bays are mostly erosional, with rates of erosion on the order of 1 m/yr in many locations. [*right*]

Waves are the primary driver of marsh shoreline erosion. The most effective waves are moderate waves that attack the marsh when water levels are at the same elevation at the marsh surface. [*top panel below*]




*Average erosion rates at 10 sites along the VCR mainland marsh-bay boundary from 1957 – 2009.*



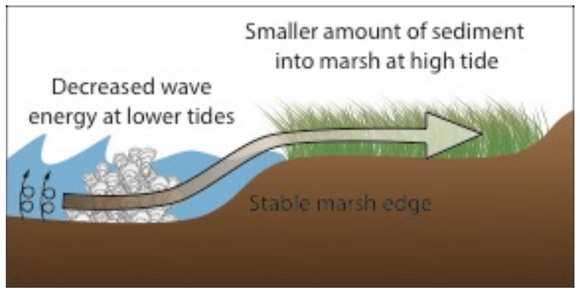




*Percent marsh erosion in the VCR for various wind classes (Leonardi et al. 2016)*

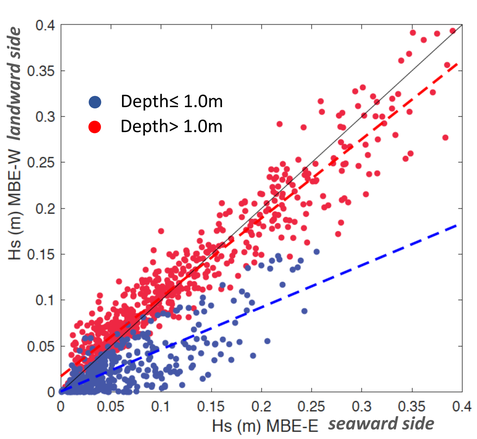
High winds are associated with high waves and storm surge. Storm surge carries wave energy across the marsh shoreline where it is dissipated by marsh vegetation. [*left*]

## Wave attenuation by oyster reefs

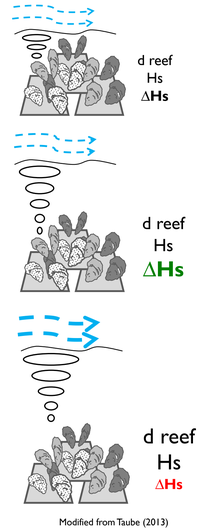
Oyster reefs have the potential to attenuate the wave energy that drives shoreline erosion, in addition to providing habitat. [*right*]




We measured waves across 4 intertidal oyster reefs that differed in composition and position relative to the shoreline, but had reef crest elevations 0.3 - 0.5 m below mean sea level and were not in contact with a marsh.




*Comparison of measured wave heights on seaward side (MBE-E) and landward side (MBE-W) of Man & Boy Marsh.*

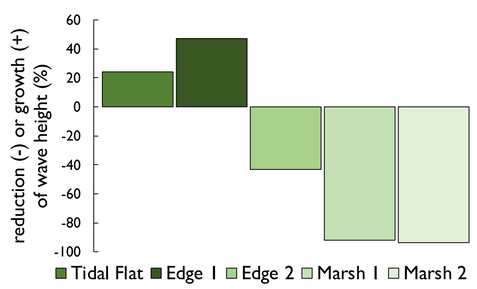



Modified from Taube (2013)

The reefs we studied reduced wave heights by an average of 40% for water depths for which the reef crest was exposed or barely submerged (water depths ≤ 1.0m). In contrast, wave height reduction was < 10% when water depths were high enough that the top of the reef was at least 10s of cm below the water surface (depths > 1.0m). [*far left*] The difference is due to reduced interaction of wave orbital motion and the reef crest as water depths increase [*near left*].

## Wave attenuation by marsh vegetation

Waves that propagated across the marsh edge and into the marsh during deep water conditions (high tides, storm surge) were effectively attenuated by marsh vegetation. [*below*]


*Measured wave height on a tidal flat and adjacent marsh at Fowling Point show that marsh vegetation dampened waves by 91% over a 20-meter transect at high water levels.*

## Conclusion

Restored oyster reefs in combination with marsh can be an effective buffer against storm wave energy. Marshes with surface elevations near mean sea level are most likely to benefit from reef-associated wave attenuation. Marsh vegetation buffers provide greater attenuation, particularly during storm surge conditions.