Background

Sea level rise, increased storminess, and human population growth amplify coastal erosion problems, pressuring landowners to implement shoreline protection measures. Growing concern over the negative impacts of traditional shoreline protection methods (seawalls or bulkheads) has increased interest in nature-based solutions, called “living shorelines.” Studies offer encouraging findings that living shorelines use natural marsh vegetation and constructed oyster reefs can control erosion while maintaining ecosystem functions. This project explores the factors influencing erosion along salt marshes and the suitability of individual shorelines for nature-based protection techniques. Field study in Virginia’s coastal bays investigated the effects of marsh vegetation and constructed oyster reefs on damping waves, the main driver of shoreline erosion. Using geospatial information, a Marsh Vulnerability Index (MVI) was developed that relates disparate factors related to shoreline erosion and serves as the foundation for living shoreline design and placement recommendations.

Objectives

- **Measure** the ability of marsh vegetation and artificial oyster reefs to dampen waves in order to provide evidence-based mitigation metrics.
- **Develop** a Marsh Vulnerability Index (MVI) in order to characterize variables that contribute to marsh erosion potential.
- **Design** a site suitability model in order to determine appropriate nature-based shoreline protection techniques given site-specific characteristics.
- **Share** data with the public through a free, online mapping portal – coastalresilience.org.

Study area

- **A. Chincoteague Reef**
- **B. Tom’s Cove Reef**
- **C. Fowling Point Marsh**
- **D. Idaho Marsh**
- **E. Man and Boy Marsh and Reef**

Field methods

The wave-dampening effects of marsh vegetation and oyster reefs were investigated through field study in Virginia’s coastal bays. Wave measurements were collected at all five sites.

**Field results**

Results suggest that combining marsh vegetation with constructed oyster reefs may offer effective and sustainable long-term coastal protection.

- **Constructed oyster reefs** are effective at dampening waves at low to moderate water levels.
- **Marsh vegetation** dampened waves by 91% over a 20-meter transect at high water levels.

![Image of wave gauges placed along a transect](image)

**Geospatial methods**

A Geographic Information System (GIS) was used to relate and manipulate spatial data collected at different scales and units to develop a Marsh Vulnerability Index (MVI).

- The MVI incorporates high resolution spatial datasets on eight salt marsh erosion variables.
- Erosion variables are assigned a risk value in the range of 1 to 5 in order of increasing vulnerability and combined via a simple geospatial computation to reveal erosion potential.

![Image of geospatial analysis](image)

**Geospatial results**

- MVI output shows generally good agreement with historical shoreline erosion rates.

![Image of MVI output and shoreline erosion rates](image)

**Future work**

Resultant data will be available to the public through The Nature Conservancy’s Coastal Resilience online decision-support tool, where it can be used with other spatial data to find cost-effective, nature-based solutions to coastal erosion problems.

**References**


Kremer, M. 2016. Wave dissipation over constructed oyster reefs in the Virginia Coast Reserve. Undergraduate thesis. UVA.


Notes:

- All data and methods developed for this project were in the design of a tool that would be accessible to the public. This includes the development of a site suitability model that could be used to identify areas of high potential for shoreline protection. The tool was developed using a combination of geographic information system (GIS) and geostatistical analysis techniques to predict shoreline erosion rates.

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