Re-engineering Living Shorelines for High-Energy Coastal Environments

Project Location

Northeast Florida

Project Duration

January 2016 to September 2019

Project Lead

Christine Angelini
University of Florida
c.angelini@ufl.edu

Project Type

Collaborative research – Generating science that informs decisions

Products

- Training manual for use of gabion-breaks from planning to monitoring
- Training video with instructions to build and install gabion-breaks
- Fact sheets comparing shoreline breakwall design and challenges of managing dynamic shorelines
- Several journal articles about boat wakes and the ecological and physical effects of living shorelines

Project Partners

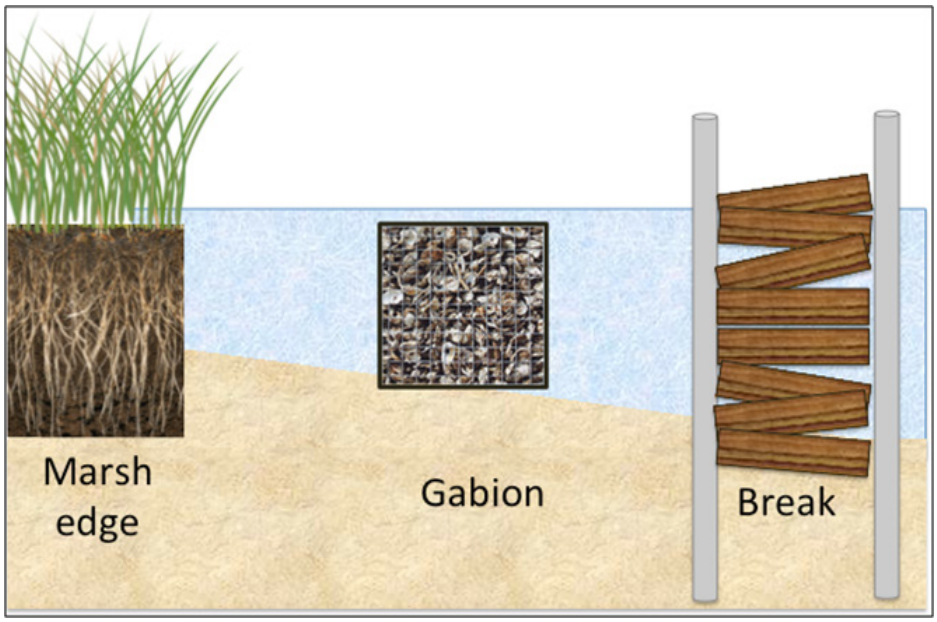
- Guana Tolomato Matanzas National Estuarine Research Reserve
- NIOZ Royal Netherlands Institute for Sea Research
- Northeast Florida Aquatic Preserves
- Radboud University Nijmegen
- University of Florida
- University of Groningen
- University of New Hampshire

Project Webpage

Overview

Worldwide, estuaries face an alarming loss of salt marsh and oyster reef habitats, especially along high-energy shorelines where there is significant boat wake and wave action. Living shorelines, a form of natural bank stabilization, offer coastal managers a promising approach to dampening boat wake and wave stress, mitigating erosion, and restoring habitats. However, typical living shoreline designs have been largely unsuccessful under high-energy conditions.

This project tested a new hybrid method that uses ecological and engineering approaches and has been used successfully in the Netherlands. The project's "gabion-break" design uses two lines of defense to reduce erosion along the marsh edge—porous wooden breakwalls placed in front of structures that foster oyster growth.



An in-depth study monitored boat wake and wave energy, oyster reef development, and salt marsh edge movement to evaluate the effectiveness of the gabion-breaks in protecting and enhancing coastal habitat in areas with high boat traffic. The project team incorporated findings into training activities for restoration practitioners and coastal managers and interpretive exhibits for reserve visitors.

Project Approach

The project team designed and installed an experimental living shoreline treatment and conducted an in-depth study of its suitability for moderate- to high-energy wave and wake conditions along the Atlantic Intracoastal Waterway within the Guana Tolomato Matanzas Reserve in northeast Florida. This area is popular among boaters and is characteristic of the salt marsh and fringing oyster reefs found in estuaries across the U.S. Eastern Seaboard.

Core elements of the research approach included the following:

1. Understanding the effect of boat wakes through field observations, theoretical approaches, and numerical modeling that profiled wave and wake forces, sediment movement, and marsh erosion rates.
2. Installation and monitoring of six experimental living shoreline sites along the Atlantic Intracoastal Waterway treated with both semi-permeable wooden breakwalls designed to dissipate wake and wave energy and two types of structures designed to facilitate oyster reef recovery—cages filled with oyster shells (gabions) or biodegradable materials.
3. Regular input from stakeholders, end users, coastal engineers, and salt marsh and oyster reef ecologists to refine project goals and gabion-break living shoreline design.
4. A regional workshop, Edges of our Estuaries, to explore current management challenges and innovative approaches for estuaries along the southeastern coast of the U.S.

Results

This project tracked ecological and physical changes along treated and untreated sections of the shoreline to provide guidance for shoreline management in areas where boat wakes are driving coastal erosion. Detailed findings are available in several published and in-development journal articles by the project team.

The team's video surveillance of boat traffic, coupled with hydrodynamic measurements, demonstrated the intensity and impact of different sized boats on the estuary. In many cases, recreational boats are creating an intense and artificial wave climate that accelerates erosion, affecting the bathymetry of waterways and the health of fringing habitats.

The project's gabion-break shoreline treatment was highly effective at dampening boat wake energy. Breakwall porosity and tides determined the rate of wave energy dissipation. Breakwalls built with tightly packed tree branches (moderate- to low-porosity) were most effective. However, over time, shipworms and other invertebrates caused wooden materials to degrade, highlighting the need for additional research to identify other materials less vulnerable to bioerosion.

This study demonstrated that living shorelines can prevent erosion and help habitat recover, even in high-energy conditions. The presence of breakwalls stimulated oyster reef formation and salt marsh recovery along high-energy shorelines, thereby rejuvenating these coastal habitats. Two sites showed recovery of cordgrass and expansion of salt marsh; marsh remained stable at a third site. In comparison, the team documented nearly two meters of erosion along unprotected shoreline. Gabion cages filled with oyster shell supported the development of a healthy oyster reef community. However, few oysters grew on the biodegradable materials.

Benefits

- A new hybrid living shoreline technique was designed and evaluated to provide guidance for managers working to protect habitat along high-energy coastlines.
- Estuarine restoration practitioners were trained in installation, maintenance, and monitoring of gabion-break shoreline treatments. Training resources were developed and made freely available to practitioners within and beyond the reserve network.
- The project has inspired similar living shoreline installations in nearby estuaries. For example, the Florida Wildlife and Conservation Commission replicated the team's shoreline design at North Peninsula State Park and is funding ongoing monitoring at the reserve and this new location.
- The project raised awareness about the significant impacts of boat traffic and helped the coastal management community identify a set of research and management priorities.

What's Next

- The team is continuing to analyze field data sets related to the effect of boat wakes on sediment transport, and the connection between vessel properties (size, speed, draft, etc.) and boat wakes.
- The team's field measurements are being analyzed to directly inform boater education efforts led by the Florida Department of Environmental Protection's Clean Marinas Program. Their findings and outreach materials could be relevant to many regions.
- The project team is collaborating with citizen scientists, the University of Florida Naval Research Laboratory, and the U.S. Geological Survey to develop machine learning techniques for video monitoring to rapidly quantify the speed and type of boats traversing coastal waterways.
- This project has led to an ongoing collaboration with the U.S. Army Corps of Engineers to better understand the effects of vessels on estuaries, including new field experiments that combine video analyses, hydrodynamic assessments, and sediment transport measurements.
- Additionally, project workshops helped identify key areas for future research, including a need to optimize materials and configurations for living shoreline treatments, further explore oyster survival and growth, and study boating behavior and perceptions of restoration choices.

About the Science Collaborative

The National Estuarine Research Reserve System's Science Collaborative supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is managed by the University of Michigan's Water Center through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Funding for the research reserves and this program comes from NOAA. Learn more at nerrssciencecollaborative.org or coast.noaa.gov/nerrs.