NOAA FISHERIES

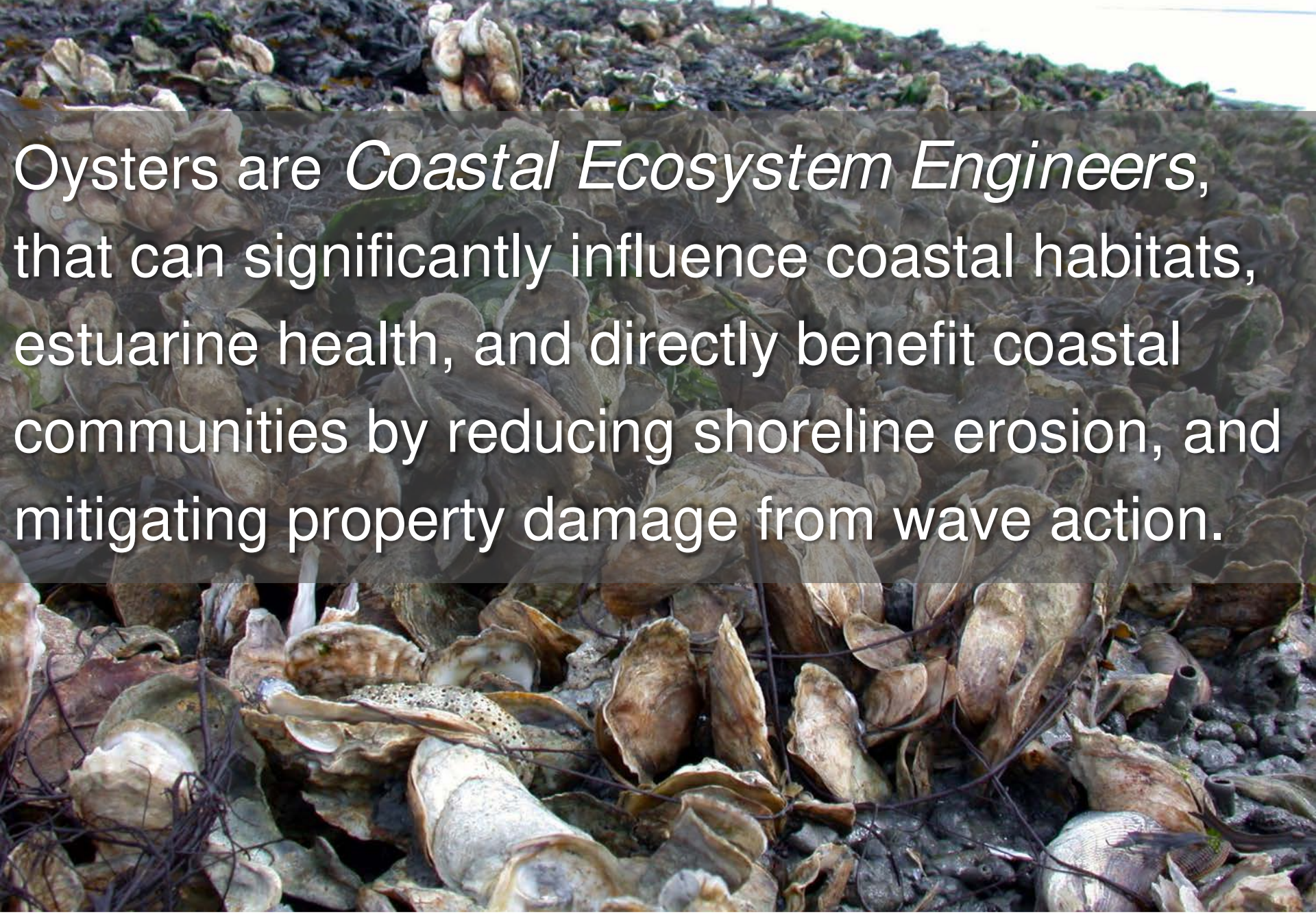
Headquarters

Oysters – Employing Nature's Coastal Engineers for Coastal Ecosystem and Community Resilience

Engineering With Nature for Sustainable Estuaries

9th National Summit on Coastal and Estuarine Restoration and Management

December 13, 2018



Oysters are *Coastal Ecosystem Engineers*, that can significantly influence coastal habitats, estuarine health, and directly benefit coastal communities by reducing shoreline erosion, and mitigating property damage from wave action.

The Need for Oyster Reef Restoration

- Oyster populations have been impacted by:
  - Over-fishing
  - Water quality degradation
  - Shoreline erosion due to storms and boat wakes
  - Coastal development and dredging
  - Toxic algae blooms
  - Protozoan disease vectors carrying MSX or Dermo
  - Pests (boring sponge)
- Globally, ~ **85% of shellfish reefs have been lost**- more than other critically important habitats such as corals, mangroves, and seagrasses[1].
- In the **Chesapeake Bay, oyster populations are at one percent of historic levels**, and ecosystem services are similarly reduced[2]

[1]Brumbaugh, R.D., M.W. Beck, L. D. Coen, L.Craig and P. Hicks. 2006. A Practitioners' Guide to the Design and Monitoring of Shellfish Restoration Projects: An Ecosystem Services Approach. The Nature Conservancy, Arlington, VA.

[2]Roger I. E. Newell, Ecological Changes in the Chesapeake Bay: Are They The Result of Overharvesting the American Oyster, Crassostrea virginica Chesapeake Research Consortium, Baltimore, Maryland, 1988.

NOAA's Role in Oyster Reef Restoration

- NOAA's Restoration Center has implemented over 200 shellfish restoration projects; oyster projects have included:
    - Placement of enhanced substrate materials
    - Juvenile oyster releases
    - Monitoring, and outreach
- NOAA's Damage Assessment Remediation and Restoration Program (DARRP) has also resulted in numerous oyster restoration projects, which compensate for injury to habitat or species.

Ecological Benefits

Broadening Benefits

Increasing the value provided by projects to include social, environmental, and economic benefits

Ecological Benefits of Oyster Reefs

- Oysters are a *Keystone Species* in our estuaries.
- NOAA-managed and commercially-important species that use oyster reef habitat as nursery or forage habitat include:
  - Bay anchovy, herring, and menhaden; blue crab, stone crab, and penaeid shrimp; red drum, Atlantic croaker, spotted and silver seatrout, spot, silver perch, black drum, summer and southern flounder, Spanish mackerel, striped bass, and spadefish.
- Oysters also provide habitat for a variety of birds, such as the American oystercatcher (pictured).

Social & SocioEconomic Benefits

Broadening Benefits

Increasing the value provided by projects to include social, environmental, and economic benefits

Social / Cultural Benefits

- Oyster roasts, oyster beds, & oyster shells are part of the cultural identity of many places like the Carolinas.
  - The risk of losing access to oysters (wild harvesting, aquaculture) is not only to the environment and fisheries, but to the **social, aesthetic, and economic character** of the region.

SocioEconomic Benefits

- Ecosystem services provided by oyster reefs include:
  - Nitrogen removal and sequestration
  - Water filtration
  - Habitat for many species of fish and crabs, including forage fish and commercially-important species such as blue crab and striped bass
- Research[1] shows that restored oyster populations in Harris Creek (350 acres):
  - Remove one million pounds of nitrogen over a decade, and
  - In summer months filters the entire water volume of the Creek every 10 days.
- Other studies[2] project blue crab harvest (the Chesapeake's most valuable fishery) will increase considerably from Choptank Complex oyster restoration.

1. Virginia Institute of Marine Science and University of Maryland
2. Morgan State University

SocioEconomic Benefits

- American Reinvestment and Recovery Act projects supported ~15 jobs per million dollars spent.
  - Labor-intensive restoration like building oyster reefs may support ~30 jobs per million.

Coastal habitat restoration projects require the employment of people with diverse sets of skills.

For example, marine debris removal requires, among other job types, boat operators and heavy equipment managers, while oyster and coral reef restoration may require divers, barge operators, fishermen, and scientists in addition to the aforementioned.

Perceived Value and Effectiveness Oyster Reefs (Alabama)

- (DeQuattro, J. 2012, Scyphers, S.B., J.S. Picou, S.P. Powers. 2012)
  - 70% of respondents recognized the overall ecological importance of oysters - providing a regulating service by filtering bay water
  - 80% of respondents recognized the value for protecting shoreline marsh habitats.
  - A majority would pay additional taxes to protect oyster reefs.

Breakwater reefs created along two stretches of shoreline in AL protect almost 30 acres of habitat for submerged aquatic vegetation and create almost 3 acres of oyster reef.

The reefs will protect more than a mile of coastal habitat by reflecting erosive wave energy away from the shoreline.

Virginia Seaside Bays Restoration

This American Recovery and Reinvestment project (2009) restored **22 acres of oyster reefs at 12 different sites**, 100 acres of seagrass, and 2.4 million juvenile bay scallops were re-introduced to bays to Virginia's seaside bays from Chincoteague inlet to the Chesapeake Bay, where they have been extinct for 75 years.

Abt Associates, Inc. 2014. Estimating the Change in Ecosystem Service Values from Coastal Restoration. Final Report Prepared for Center for American Progress and Oxfam America. (116 p).

Virginia Seaside Bays Restoration

In a related study[1], the benefits of oyster reefs were examined over a 40-year period. The estimated **total economic values**, including market values for commercial finfish production and non-market values for recreational fishing, **ranged from $49,133 to $112,460 per year.**

1. Abt Associates, Inc. 2014. Estimating the Change in Ecosystem Service Values from Coastal Restoration. Final Report Prepared for Center for American Progress and Oxfam America. (116 p).

Cost effectiveness of natural and artificial flood reduction measures across the Gulf of Mexico

- Wetland and reef restoration can yield benefit-to-cost ratios > 7:1, meaning >$7 in direct flood-reduction benefits for every $1 spent on restoration
  - Many artificial solutions (such as levees and home elevation) have benefit-to-cost ratios near or below 1:1
  - Their benefits can be high, but they are expensive to implement at scale.

Read more at: https://phys.org/news/2018-04-nature-based-solutions-billion-gulf-coast.html#jCp

Credit: The Nature Conservancy

Oyster Reef Restoration as an EWN Technique

Using Natural Processes

Using natural processes to maximize benefit

Oyster Reefs as a EWN Technique

- Unlike built infrastructure, natural ecosystems can adapt and grow with changing environmental conditions, which add to their relative cost effectiveness.
  - Healthy oyster reefs can keep up with sea level rise while built structures cannot self-adapt and would require upgrade planning.

Comparing the cost effectiveness of nature-based and coastal adaptation: A case study from the Gulf Coast of the United States

Reguero BG, Beck MW, Bresch DN, Calil J, Meliane I (2018) Comparing the cost effectiveness of nature-based and coastal adaptation: A case study from the Gulf Coast of the United States. PLOS ONE 13(4): e0192132. https://doi.org/10.1371/journal.pone.0192132

Effectiveness of Oyster Reefs to Attenuate Waves

- One study[1] on established reefs constructed of shell material and oyster castles near marshes indicates that reefs reduced wave heights by an average of up to 17%
  - Reductions were largest at intermediate water depths
  - At low water depths, waves were small regardless of wind speed and were completely interrupted by the emergent reef.
  - At water depths greater than about 0.3 m above the reef, the reefs had significantly less impact on wave heights.
  - The pattern of wave height change as a function of water depth and wind speed was very consistent

1. Wiberg, Patricia & R. Taube, Sara & Ferguson, Amy & R. Kremer, Marnie & A. Reidenbach, Matthew. (2018). Wave Attenuation by Oyster Reefs in Shallow Coastal Bays. Estuaries and Coasts. 10.1007/s12237-018-0463-y.

Effectiveness of Oyster Reefs to Attenuate Waves

- Reid (2013) indicated oyster reefs successfully dissipated wind-wave energy in the Virginia Coast Reserve and can be an effective erosion control method.
  - For significant waves, the mean dissipation of wave power was 49%.
  - Attenuation of wave energy was determined by multiple factors, primarily water depth above the reef and significant wave height.
    - An ideal range of depths at which reefs were most effective was identified, above which, additional increases in water depth diminished the interaction.
    - Strategic installment of reefs based on prominent wind direction and fetch in relationship to marsh shorelines is likely key to greater erosion mitigation.

Project Examples & Techniques

Using Natural Processes

Using natural processes to maximize benefit

MacDill Oyster Reef Shoreline Stabilization

The project aimed to reduce wave energy and erosion along MacDill AFB's southeastern shoreline.

- 910 concrete oyster domes and oyster shell bags were used.
- Reduction of wave energy and subsequent build-up of sediment allowed planting and establishment of salt marsh behind the oyster domes to stabilized the shoreline.
- Within 3 years, salt marsh was fully established behind the oyster reef and the shoreline and erosion was no longer evident.

Figure 1: Before and after photos from Phase I, showing an established marsh after just two and a half years.

Morris Landing Clean Water Preserve (NC)

Goals of the project include:

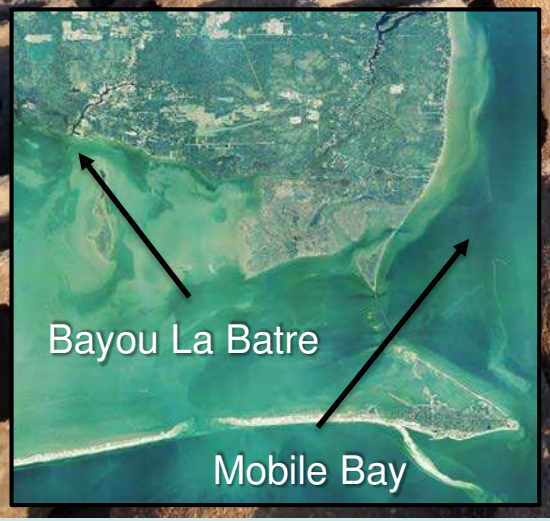
- Protecting Morris Landing
- Restoring salt marsh and oyster habitat
- Enhancing public access and recreation, and
- Expanding shellfish enhancement activities in the area to protect the waters of Stump Sound in Onslow County.

Credit: North Carolina Coastal Federation, Morris Landing Clean Water Preserve

Public-Private Partnership, Mobile County, AL (2009-2011)

Goals:

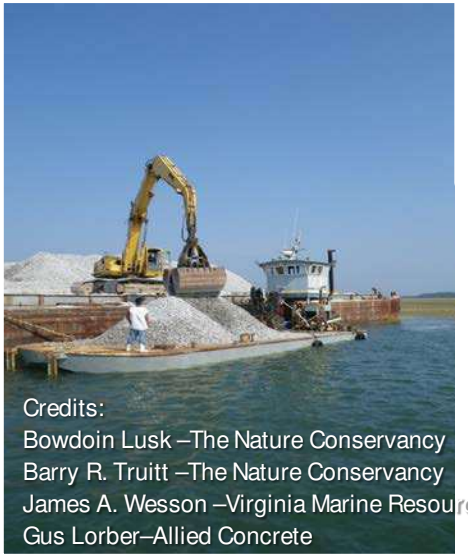
- Create 100 miles of vertical oyster reefs/breakwaters
- Plant and Promote 1,000 acres of marsh/seagrass
- Enhance critical habitat for many species of fish and benthic invertebrates.
- Protect shorelines by slowing, stopping, or reversing erosion.
- Create approximately 35-40 jobs.
- Provide an alternative to bulkheads, riprap, and other hardened shorelines.
- Demonstrate that larger-scale oyster restoration improves environmental/economic resiliency.



October 8, 2010 – Coffee Island

Techniques - Alabama

Techniques - VA Seaside Bays



Credits:
Bowdoin Lusk –The Nature Conservancy
Barry R. Truitt –The Nature Conservancy
James A. Wesson –Virginia Marine Resources Commission
Gus Lorber–Allied Concrete

Challenge - Availability of Substrate

Using Natural Processes

Using natural processes to maximize benefit

Availability of Substrate

- Traditional oyster bottom repletion programs and restoration projects typically rely on oyster shell from either processing houses or fossil shell
- Alternative materials have different uses in oyster restoration:
  - They can provide a base or a bottom type for larval recruitment in the absence of fossil shells; and/or
  - Can be used as a medium to set spat on in a hatchery before being deployed to the natural environment.
- A lack of availability of natural or fossil oyster shell in the Chesapeake Bay necessitated the investigation of alternative materials such as construction rubble, precast concrete structures, coal ash, limestone marl, recycled porcelain, or slag.

Availability of Substrate

- In Harris Creek (Chesapeake Bay), the average oyster density on stone-base reefs was approximately four times higher than on shell-base reefs, and 22 times higher than control reefs.
  - Both the shell-base and the stone-base reefs were planted with hatchery-produced oysters.

NOAA, 2016 Oyster Monitoring Report.
https://chesapeakebay.noaa.gov/images/stories/pdf/2016oysterreefmonitoringreport.pdf

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