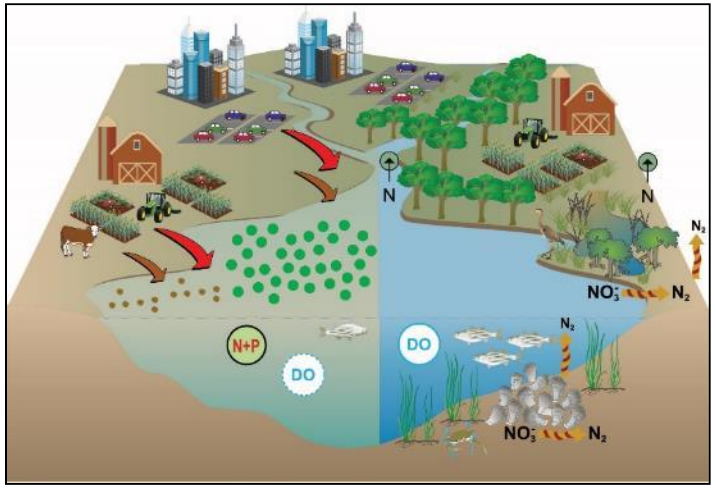
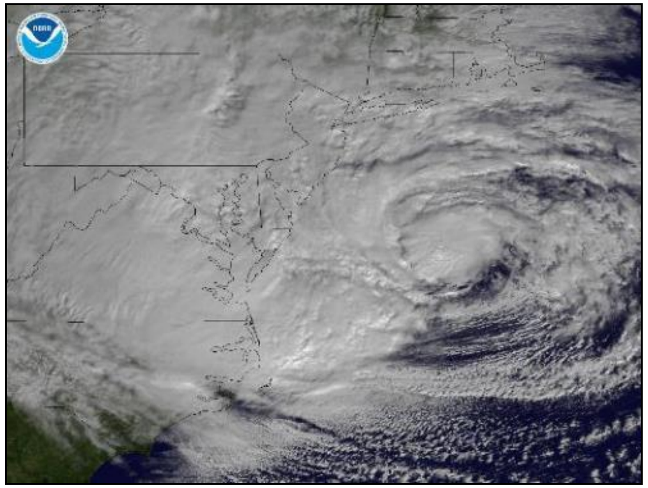
Building Resiliency through Restoration





Nicole Carlozo

Chesapeake & Coastal Service

Maryland Department of Natural Resources

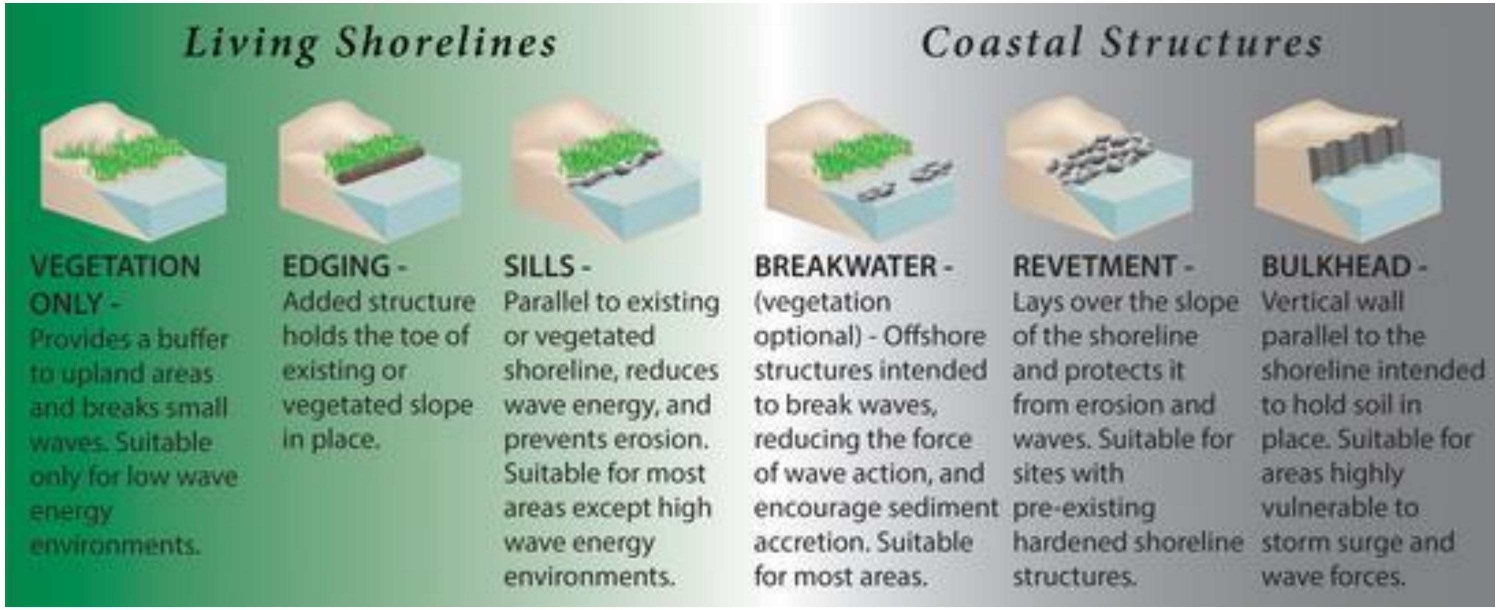
Natural and Nature-Based Features

- ***Natural Features*** are created and evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature.

- ***Nature-Based Features*** mimic characteristics of natural features, but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction.

Living Shorelines

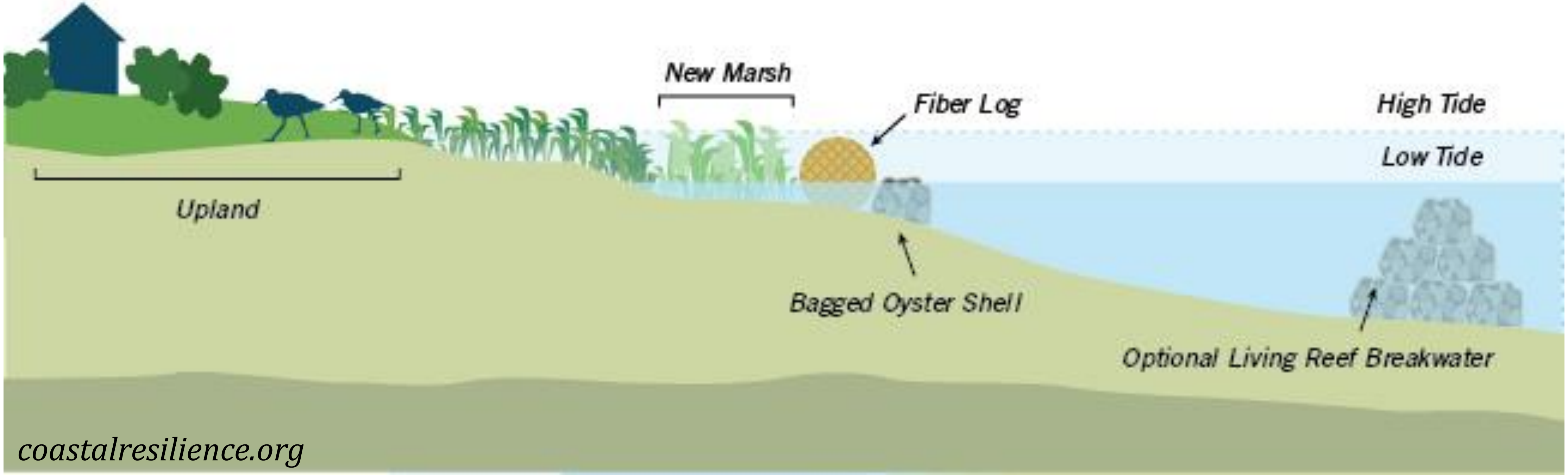
- *"An erosion control measure that is dominated by tidal wetland vegetation and is designed to preserve the natural shoreline, minimize erosion, and establish aquatic habitat."* (Living Shorelines Protection Act of 2008)
- *"Maintain continuity of the natural land–water interface and reduce erosion while providing habitat value and enhancing coastal resilience."* (NOAA, Guidance for Considering the Use of Living Shorelines, 2015)



Nature-Based Living Shoreline

Nature-Based Living Shoreline

Nature-based living shorelines are best in low-energy areas. "Biological enhancements," like biodegradable fiber logs (which also provide habitat for ribbed mussels) or Christmas trees, are placed along the tidal marsh edge to provide a contained area for sediment to accumulate and marsh vegetation to grow. In more moderate energy areas, it might be possible to use a hybrid approach that pairs nature-based living shorelines with living reef breakwaters.



coastalresilience.org

Beyond Shoreline Stabilization

- Water quality
- Fish and wildlife habitat
- Food webs
- Biodiversity
- Recreation
- Aesthetic Value
- Coastal and community resilience
  - Storm and wave attenuation and absorption

Not only do Living Shorelines defend land against destructive waves, but they also provide crucial habitat for fish and wildlife.

Estuaries and Coasts
DOI 10.1007/s12237-017-0213-6

Linking the Abundance of Estuarine Fish and Crustaceans in Nearshore Waters to Shoreline Hardening and Land Cover

Matthew S. Kornis[1,2] • Denise Breitburg[1] • Richard Balouskus[3] • Donna M. Bilkovic[4] • Lori A. Davias[1] • Steve Giordano[5] • Keira Heggie[1] • Anson H. Hines[1] • John M. Jacobs[6] • Thomas E. Jordan[1] • Ryan S. King[7] • Christopher J. Patrick[1] • Rochelle D. Seitz[4] • Heather Soulen[1] • Timothy E. Targett[3] • Donald E. Weller[1] • Dennis F. Whigham[1] • Jim Uphoff Jr[8]

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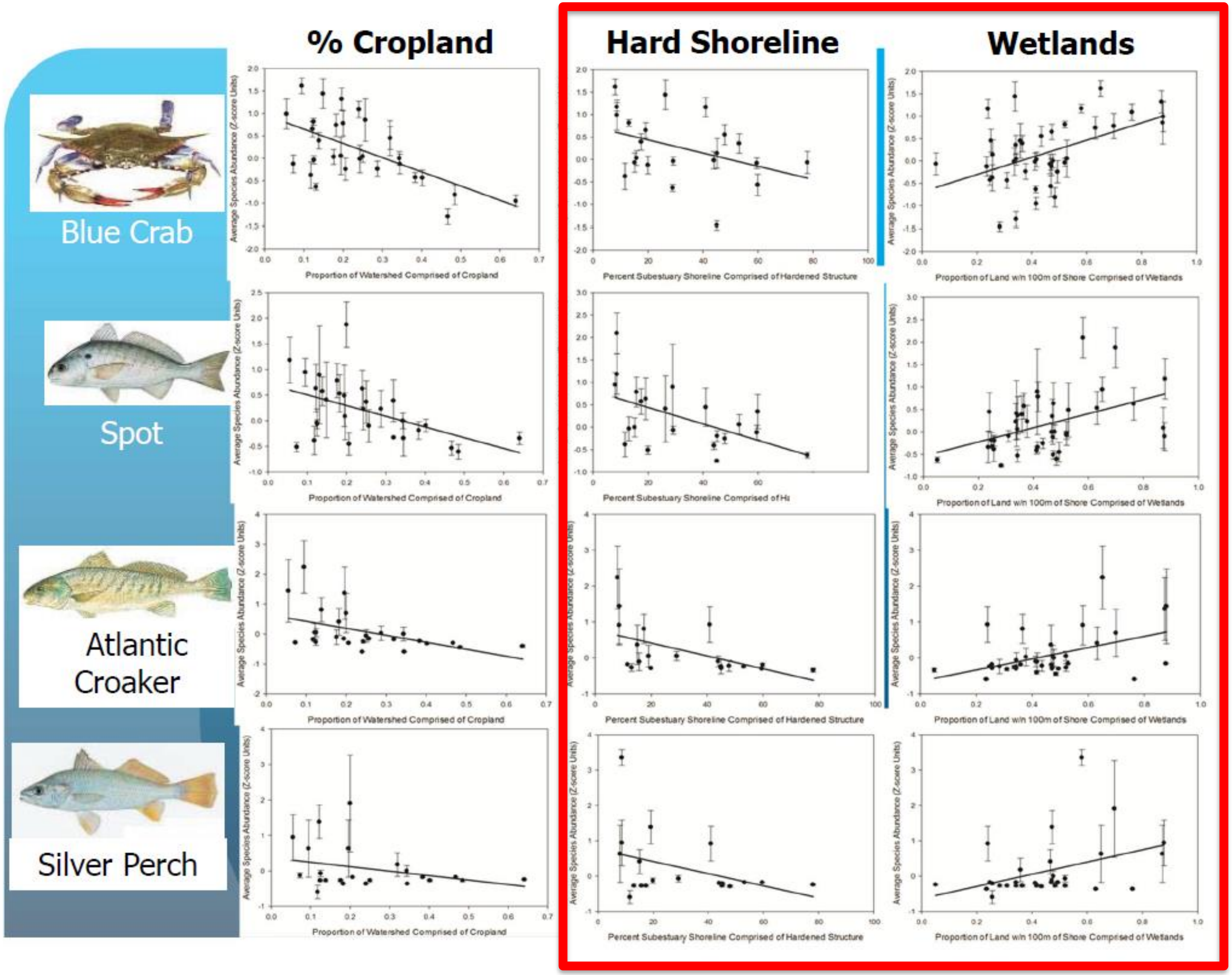
Abstract Human alteration of land cover (e.g., urban and agricultural land use) and shoreline hardening (e.g., bulkheading and rip rap revetment) are intensifying due to increasing human populations and sea level rise. Fishes and crustaceans that are ecologically and economically valuable to coastal systems may be affected by these changes, but direct links between these stressors and faunal populations have been elusive at large spatial scales. We examined nearshore abundance patterns of 15 common taxa across gradients of urban and agricultural land cover as well as wetland and



Study of nearshore macrofauna in the Chesapeake Bay.

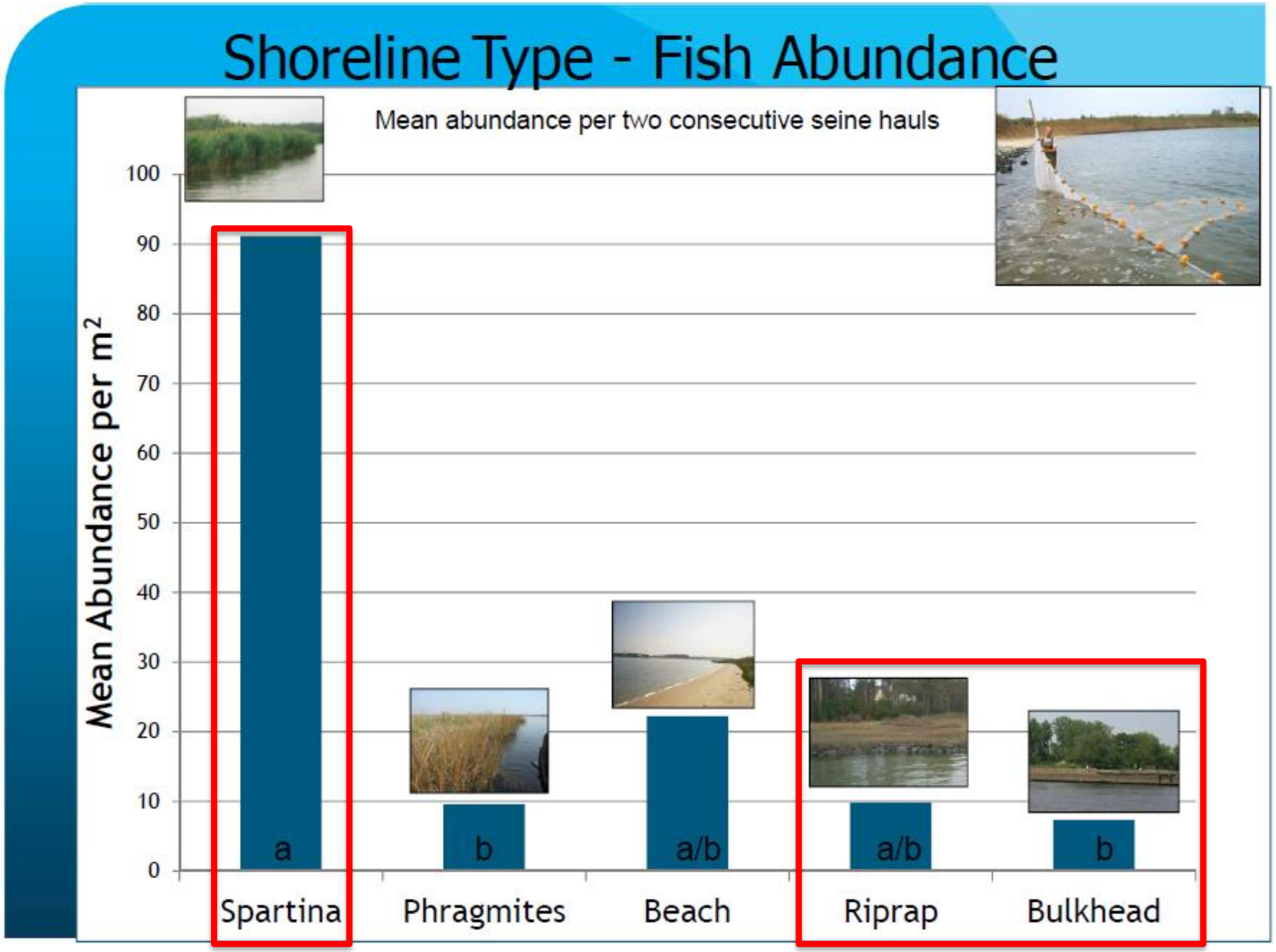
Upland development and shoreline hardening negatively impact estuarine benthos, fish, and waterbirds

PIs Rochelle Seitz (VIMS), Denise Breitburg (SERC), Tim Targett (UDE), and Diann Prosser (USGS)

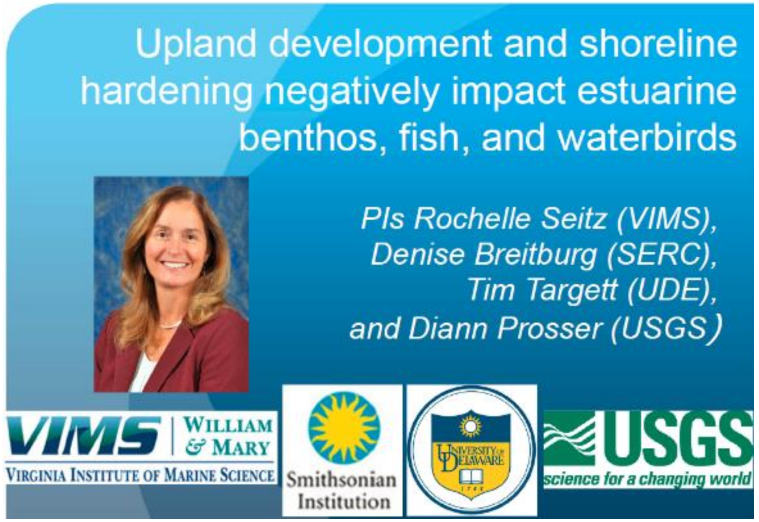
VIMS William & Mary Virginia Institute of Marine Science

Smithsonian Institution

USGS science for a changing world



Study of nearshore macrofauna in the Delaware Coastal Bays.




LIVING SHORELINES SUPPORT RESILIENT COMMUNITIES
Living shorelines use plants or other natural elements—sometimes in combination with harder shoreline structures—to stabilize estuarine coasts, bays, and tributaries.
One square mile of salt marsh stores the carbon equivalent of **76,000 gal of gas** annually.
Marshes trap sediments from tidal waters, allowing them to **grow in elevation** as sea level rises.
Living shorelines improve **water quality**, provide fisheries **habitat**, increase **biodiversity**, and promote **recreation**.
Marshes and oyster reefs act as natural **barriers** to waves. **15 ft** of marsh can **absorb 50%** of incoming wave energy.
Living shorelines are **more resilient** against storms than bulkheads.
33% of shorelines in the U.S. will be **hardened** by **2100**, decreasing fisheries habitat and biodiversity.
Hard shoreline structures like **bulkheads** prevent natural marsh migration and may create seaward **erosion**.
The National Centers for Coastal Ocean Science | coastalscience.noaa.gov

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Marshes with and without sills protect estuarine shorelines from erosion better than bulkheads during a Category 1 hurricane

Rachel K. Gittman [a,*], Alyssa M. Popowich [a,1], John F. Bruno [b], Charles H. Peterson [a,b]

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ABSTRACT

Acting on the perception that they perform better for longer, most property owners in the United States choose hard engineered structures, such as bulkheads or riprap revetments, to protect estuarine shorelines from erosion. Less intrusive alternatives, specifically marsh plantings with and without sills, have the potential to better sustain marsh habitat and support its ecosystem services, yet their shoreline protection capabilities during storms have not been evaluated. In this study, the performances of alternative shoreline protection approaches during Hurricane Irene (Category 1 storm) were compared by 1) classifying resultant damage to shorelines with different types of shoreline protection in three NC coastal regions after Irene; and 2) quantifying shoreline erosion at marshes with and without sills in one NC region by using repeated measurements of marsh surface elevation and marsh vegetation stem density before and after Irene. In the central Outer Banks, NC, where the strongest sustained winds blew across the longest fetch; Irene damaged 76% of bulkheads surveyed, while no damage to other shoreline protection options was detected. Across marsh sites within 25 km of its landfall, Hurricane Irene had no effect on marsh surface elevations behind sills or along marsh shorelines without sills. Although Irene temporarily reduced marsh vegetation density at sites with and without sills, vegetation recovered to pre-hurricane levels within a year. Storm responses suggest that marshes with and without sills are more durable and may protect shorelines from erosion better than the bulkheads in a Category 1 storm. This study is the first to provide data on the shoreline protection capabilities of marshes with and without sills relative to bulkheads during a substantial storm event, and to articulate a research framework to assist in the development of comprehensive policies for climate change adaptation and sustainable management of estuarine shorelines and resources in U.S. and globally.

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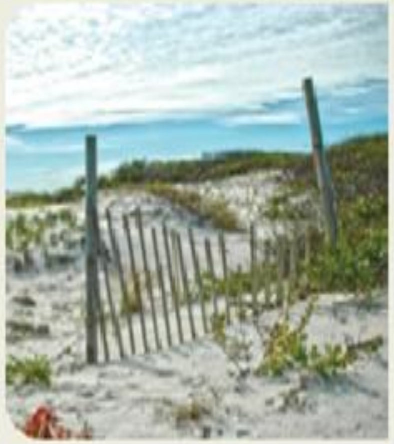
Enhancing Resiliency with Natural Features

MARYLAND DEPARTMENT OF NATURAL RESOURCES





Dunes and Beaches	Vegetated Features (e.g., Marshes)	Oyster and Coral Reefs	Barrier Islands	Maritime Forests/Shrub Communities
Benefits/Processes	**Benefits/Processes**	**Benefits/Processes**	**Benefits/Processes**	**Benefits/Processes**
Breaking of offshore waves	Breaking of offshore waves	Breaking of offshore waves	Wave attenuation and/or dissipation	Wave attenuation and/or dissipation
Attenuation of wave energy	Attenuation of wave energy	Attenuation of wave energy	Sediment stabilization	Shoreline erosion stabilization
Slow inland water transfer	Slow inland water transfer	Slow inland water transfer		Soil retention
	Increased infiltration			

US Army Corps 2015, *Use of NNBF for Coastal Resilience*

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

"Coastal wetlands prevented more than $625 Million (US) in direct property damages during Hurricane Sandy"

THE VALUE OF COASTAL WETLANDS FOR REDUCING PROPERTY DAMAGE

COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

Using Risk Industry-based Models
to Assess Natural Defenses in the Northeastern USA

October 2016

UNIVERSITY OF CALIFORNIA SANTA CRUZ
The Nature Conservancy
Wildlife Conservation Society
LLOYD'S TERCENTENARY RESEARCH FOUNDATION

In Maryland, wetlands reduced damages to private property by 29% during Hurricane Sandy.

Journal of Environmental Management 183 (2016) 1088–1098

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Review

The role of nature-based infrastructure (NBI) in coastal resiliency planning: A literature review

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ABSTRACT

The use of nature-based infrastructure (NBI) has attracted increasing attention in the context of protection against coastal flooding. This review is focused on NBI approaches to improve coastal resilience in the face of extreme storm events, including hurricanes. We not only consider the role of NBI as a measure to protect people and property but also in the context of other ecological goods and services provided by tidal wetlands including production of fish and shellfish. Although the results of many studies suggest that populated areas protected by coastal marshes were less likely to experience damage when exposed to the full force of storm surge, it was absolutely critical to place the role of coastal wetlands into perspective by noting that while tidal marshes can reduce wave energy from low-to-moderate-energy storms, their capacity to substantially reduce storm surge remains poorly quantified. Moreover, although tidal marshes can reduce storm surge from fast moving storms, very large expanses of habitat are needed to be most effective, and for most urban settings, there is insufficient space to rely on nature-based risk reduction strategies alone. The success of a given NBI method is also context dependent on local conditions, with potentially confounding influences from substrate characteristics, topography, near shore bathymetry, distance from the shore and other physical factors and human drivers such as development patterns. Furthermore, it is important to better understand the strengths and weaknesses of newly developed NBI projects through rigorous evaluations and characterize the local specificities of the particular built and natural environments surrounding these coastal areas. In order for the relevant science to better inform policy, and assist in land-use challenges, scientists must clearly state the likelihood of success in a particular circumstance and set of conditions. We conclude that "caution is advised" before selecting a particular NBI method as there is no "one size fits all" solution to address site-

Climate-Resilient Practices

- Maintain natural coastal processes (i.e. sediment dynamics)
- Regenerative
- Thrive under dynamic conditions / Adapt to changing conditions
- Recover and readjust following natural disturbance
- Increase community resiliency (human and ecological)

RESILIENCY THROUGH RESTORATION:

Design and Implementation of Resilient Practices


Pocomoke River restoration site. Photo credit: Maryland Department of Natural Resources.


Bishopville restoration project (after). Photo credit: Maryland Department of Natural Resources.


Ferry Point restoration project (after). Photo credit: Maryland Department of Natural Resources.

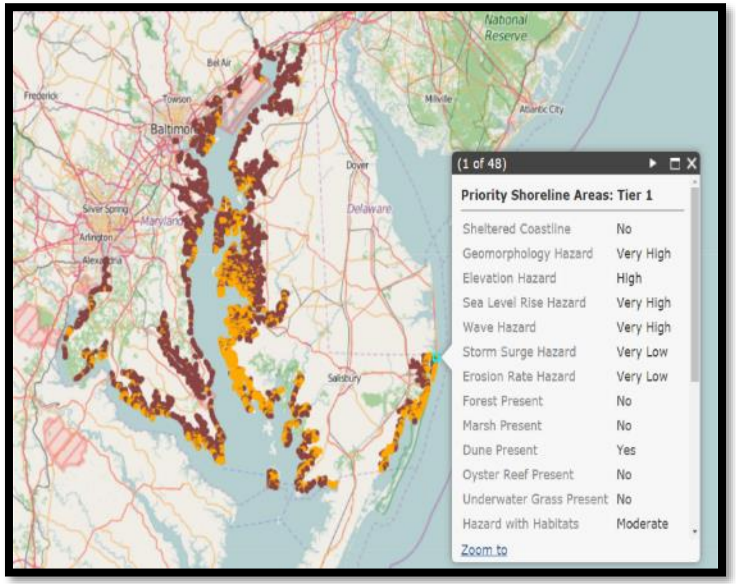

Conquest Beach restoration project (after). Photo credit: Maryland Department of Natural Resources.

DNR's Building Resilience to Climate Change Policy

"It is the policy of the Maryland Department of Natural Resources to make sound investments in <u>land and facilities</u> and to manage its <u>assets and natural resources</u> so as to better understand, mitigate and adapt to climate change."

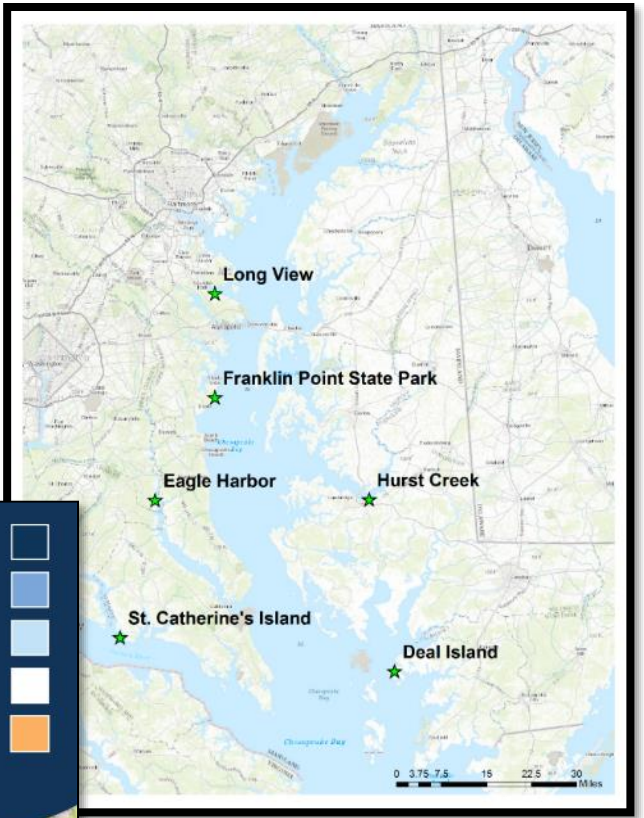
Initiative Components

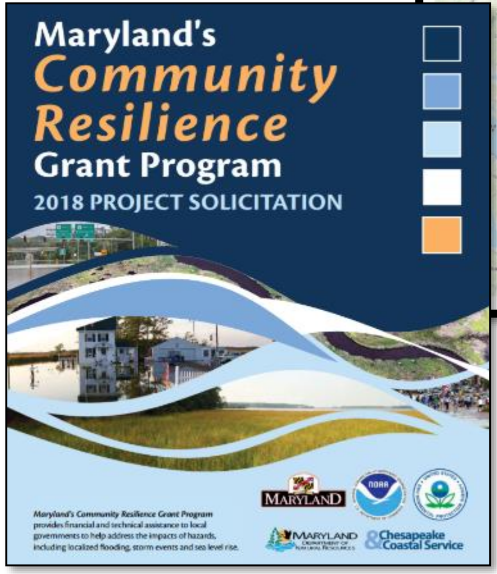
1. **Targeting**
   - Identify vulnerable coastal communities
   - Identify locations where nature can help reduce risk
2. **Coastal Resiliency Grant Program**
   - Technical and financial assistance
   - Protect residents, economies, infrastructure and public resources.
3. **Innovative Climate-Resilient Designs**
   - Tidally influenced sites (SLR, marsh migration, storm surge, etc.)
   - Non-tidal/inland sites (Precipitation, streamwater flow, etc.)
4. **Monitoring for Maintenance & Adaptive Management**
   - Identify physical, chemical and biological metrics
   - Improve design with changing conditions
5. **Outreach, Communication & Education**



Coastal Resiliency Grant Program

- **Eligible Projects:**
  - **Year 1:** Natural and nature-based shoreline stabilization and coastal flood reduction projects.
  - **Year 2:** Expansion to upland/non coastal communities with stormwater and/or floodplain climate impacts
- **Community Resilience Grant Solicitation**
  - Phase 3: Implementation
  - 22 requests (over $1.6 M)
  - Design/permitting
  - Future funding: construction, adaptive management

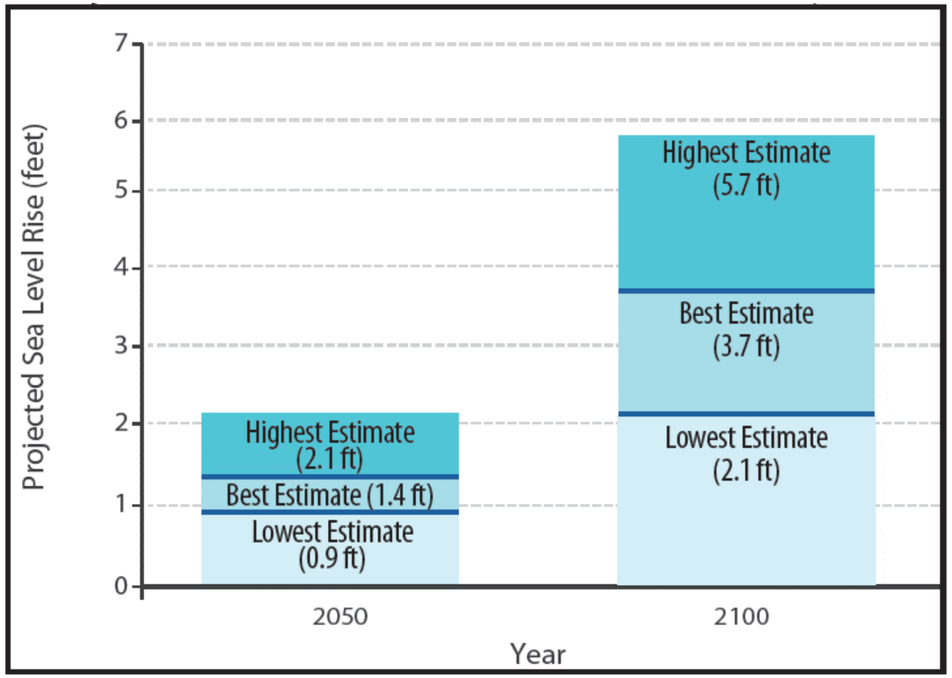




Climate Change in Maryland – 2100 Snapshot

MARYLAND DEPARTMENT OF NATURAL RESOURCES

- ✓ Sea Level Rise: 2- 6 feet
- ✓ Temperature: +2 to > 8 degree C
- ✓ Annual Precipitation: -10% to +20%
- ✓ Spring Runoff: Higher
- ✓ Summer Runoff: Lower
- ✓ More Extreme Events



Source: Boesch et al., 2013

Global Climate Change = Real Consequences for our Coasts

Climate-Resilient Designs

- Address site-specific conditions and climate impacts:
  - Tidally influenced sites (SLR, marsh migration, storm surge, floodplain, fetch, accretion rate, depth, etc.)
  - Non-tidal/inland sites (Precipitation, streamwater flow, upland land use, channel structure)
  - Capacity, inflow and outflow
  - Assess for potential fresh or saltwater intrusion

- Restore hydrologic conditions, facilitate infiltration and select appropriate vegetation:
  - Reconnect Floodplains
  - Maximize wetland area
  - Expand riparian buffers at potential high-flow areas
  - Utilize a diversity of native species and manage invasive species

Building a Toolbox…

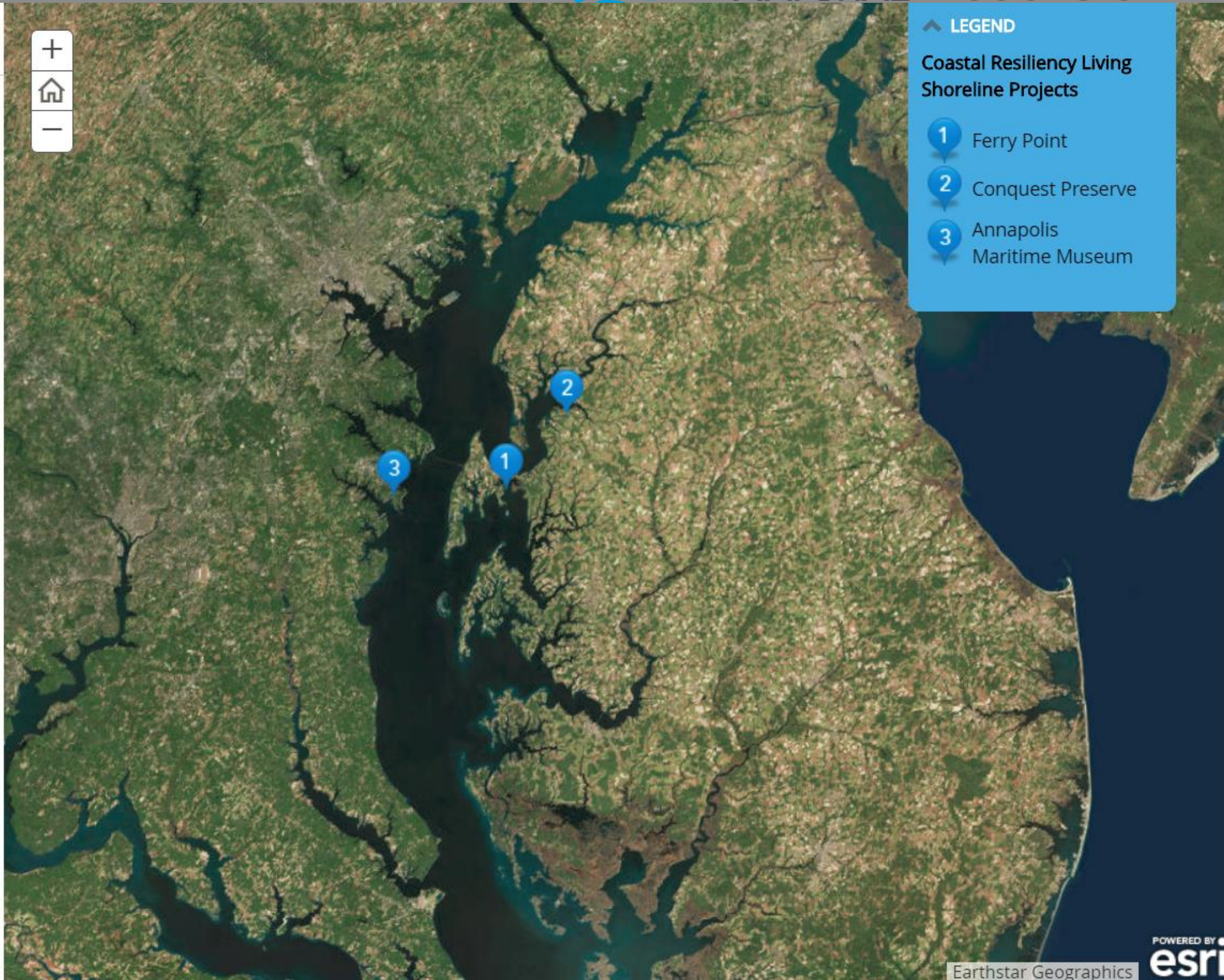
Chesapeake & Coastal Service

Building Resiliency through Restoration

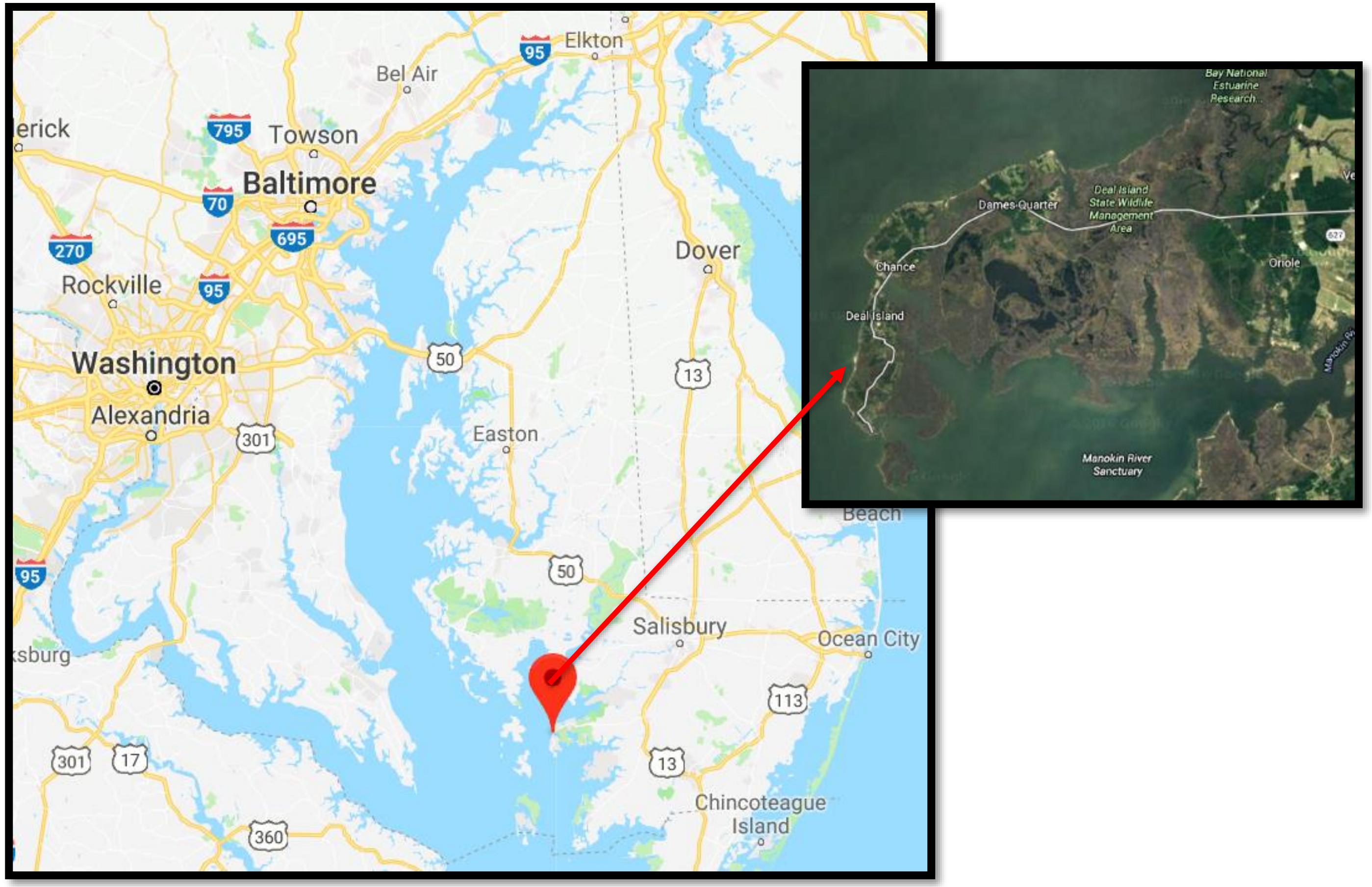
Scroll down to learn about Maryland's innovative coastal resiliency projects and how you can implement a project within your community!

Each year, Maryland's coastal cities and towns experience damage to properties, infrastructure and natural resources due to climate impacts like storm surge, wave action, and sea level rise. These damages put a financial strain on coastal communities and economies. At the same time, Maryland's coastal habitats can help reduce risk in vulnerable areas.

Coastal resources such as wetlands, shorelines, dunes and beaches act as natural defenses to storm surge and other climate impacts. In addition, these habitats provide ecosystem services that boost the economy, improve water quality, and create recreational space. We can heighten these benefits with coastal resiliency projects.

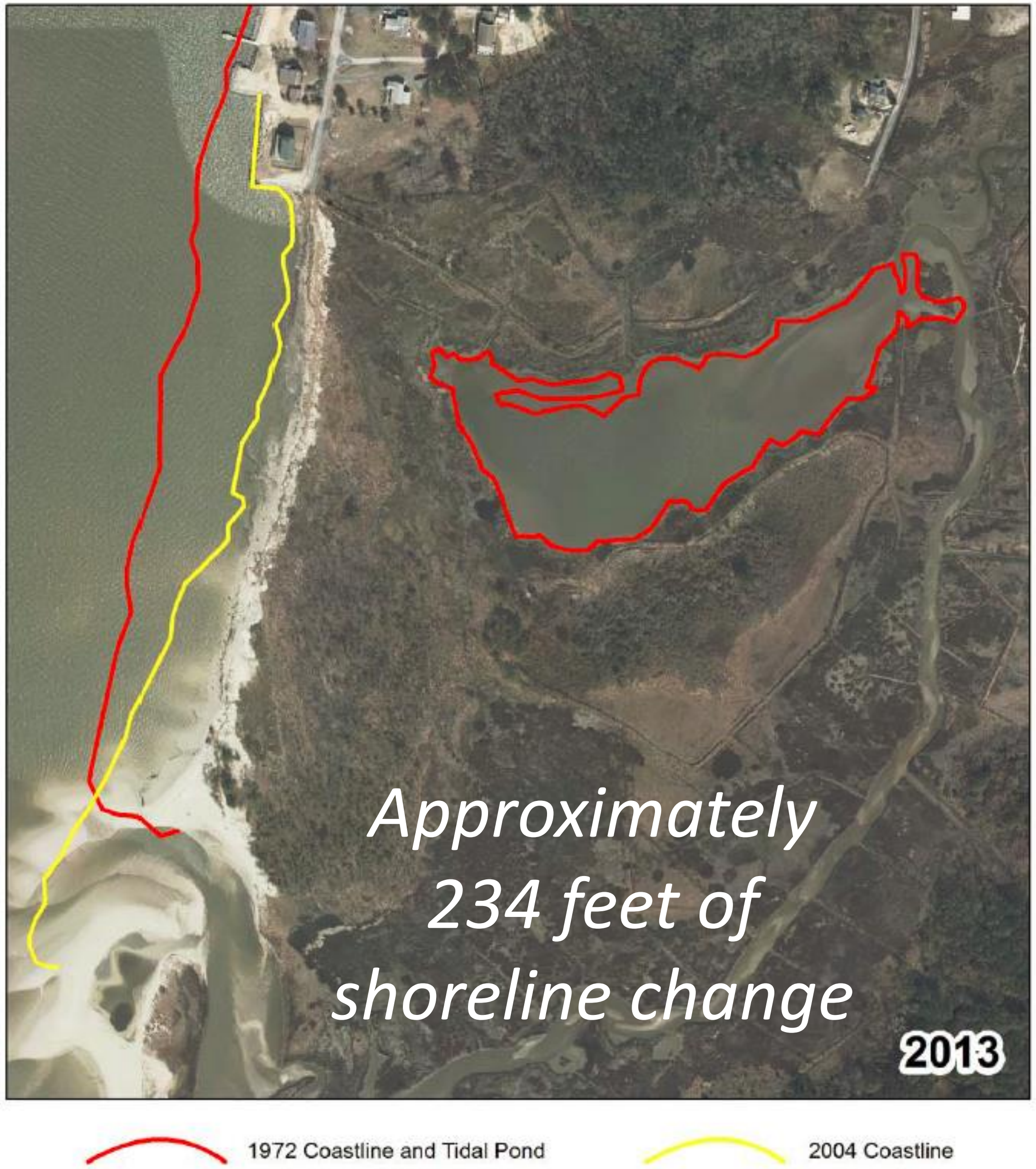


Pilot: Deal Island Shoreline & Marsh Enhancement



Somerset County, Deal Island

Coastline Change 1972-2013
North of Middle Creek, Deal Island, Maryland

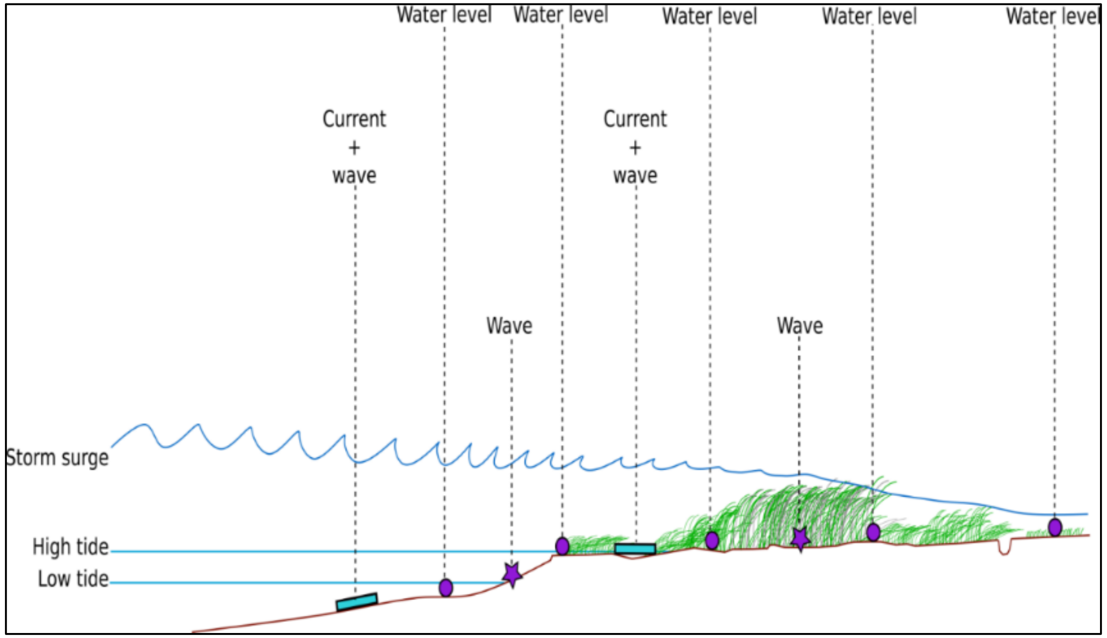


Innovative Designs & Outreach

- Headland breakwater, dune restoration, submerged breakwaters, invasive species removal
- Outreach via Deal Island Peninsula Project **https://www.dealislandpeninsulaproject.org/**

Monitoring for Adaptive Management

- **Chesapeake Bay National Estuarine Research Reserve**
  - Physical, chemical and biological metrics
- **Beneficial Use – Identifying Locations for Dredge**
- **George Mason University / The Nature Conservancy**
  - Water Levels, Currents, Waves
  - Topo/bathymetric surveys
  - Vegetation Surveys
  - Extreme event rapid deployment



Want to Learn More?

Coastal Resiliency Assessment
Training Manual

June 2016

Chesapeake & Coastal Service

For more information:

- **Coastal Atlas / ESRI Story Maps**
  http://dnr.maryland.gov/ccs/coastalatlas/
- **Resiliency through Restoration**
  http://arcg.is/1Gaquy
- **Community Resilience Grants**
  http://dnr.maryland.gov/ccs/Pages/funding/fundingopp.aspx
- **Coastal Resiliency Assessment**
  http://dnr.maryland.gov/ccs/coastalatlas/Pages/CoastalResiliencyAssessment.aspx

Contact: nicole.carlozo@maryland.gov

We created a series of ESRI Story Maps to highlight how the Maryland Department of Natural Resources Chesapeake and Coastal Service uses the best scientific and stakeholder data to inform decisions that are made about Maryland's coastal resources. Explore the Story Maps to better understand how we interpret and respond to risk, challenges, and opportunities throughout the coastal zone.