Green or Grey Solutions? Why not both? Lessons from the Mid-Atlantic on Hybrid Living Shorelines

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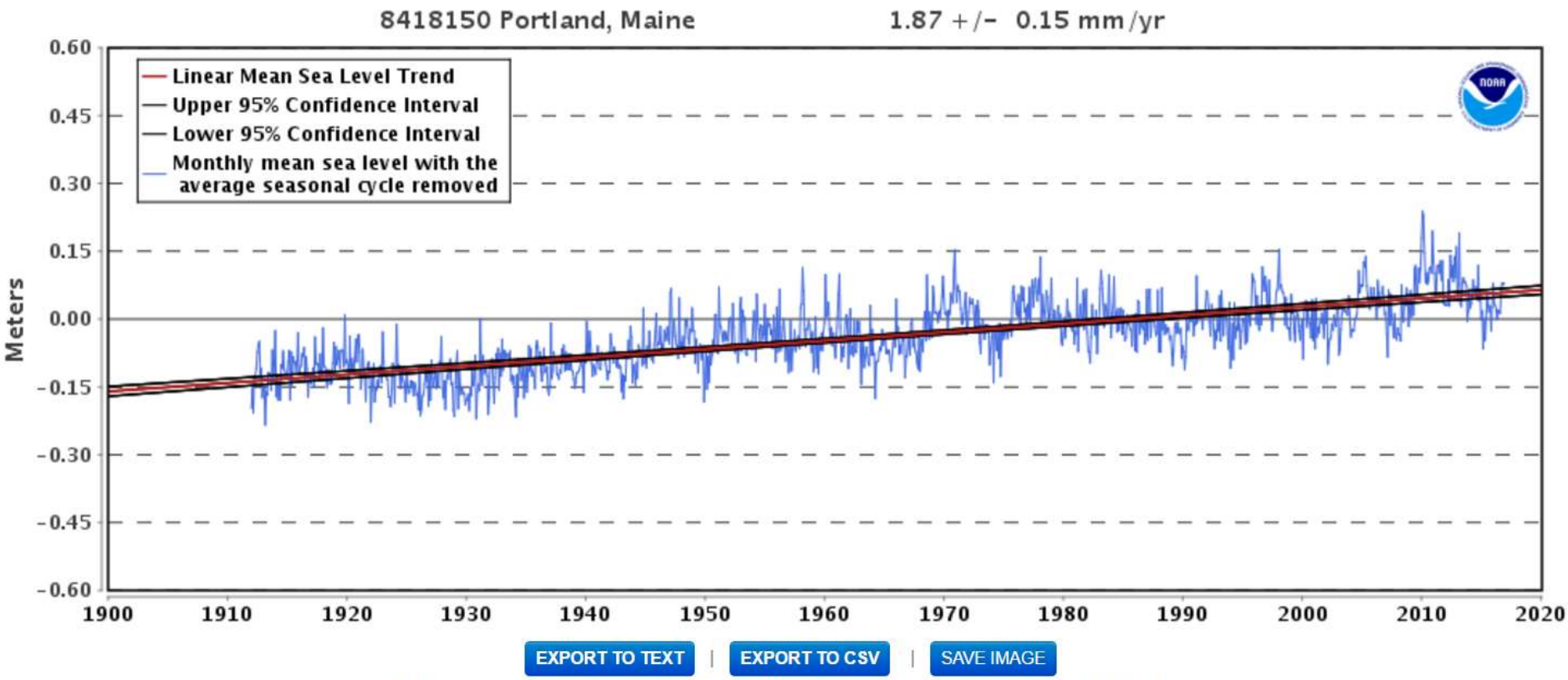
Sea-Level Rise in Maine

Mean Sea Level Trend
8418150 Portland, Maine



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The mean sea level trend is 1.87 millimeters/year with a 95% confidence interval of +/- 0.15 mm/yr based on monthly mean sea level data from 1912 to 2015 which is equivalent to a change of 0.61 feet in 100 years.

As Sea-Level Rises, Shorelines Erode

Grey Solutions: Bulkheads

Grey Solutions: Seawalls

Grey Solutions: Advantages and Disadvantages

Advantages

- This is pretty stable!
- Historically easier to permit

Disadvantages

- Loss of natural riparian edge
- Lost filtering capacity of vegetation
- Benthic habitat impacts from wave energy

Green Solutions: Marsh Restoration

Green Solutions:
Coir Logs - Marsh Toe Protection

Green Solutions:
Bank Grading and Vegetation

Green Solutions: Advantages & Disadvantages

Advantages

- Established vegetated edge
- Bank stability
- Habitat enhancement
- Filtration of upland runoff

Disadvantages

- Limited application
- Protected shorelines / rivers
- Limited fetch (<0.5 nm)
- Shorter project life
- Coir degrades

Combining Green and Grey: Hybrid Living Shorelines

Why must we choose one or the other?

We can combine grey elements to provide wave attenuation and toe stability with green elements to provide natural habitat and upland runoff filtration to create a *sustainable natural shoreline*.

Mid-Atlantic states have been using hybrid living shorelines for decades

Hybrid Living Shorelines: Stone Sills & Marsh Plantings

fetch <5 nautical miles

**Hardaway et al*

Low profile stone sill for wave attenuation

Planted marsh in protected wave shadow

"windows" for tidal exchange and habitat access for aquatic species

Hybrid Living Shorelines: Tidally Dependent Design

SILL WITH PLANTINGS

not to scale

North Carolina Coastal Federation

Working Together for a Healthy Coast

illus. Lara Berkley, B+O design studio, PLLC

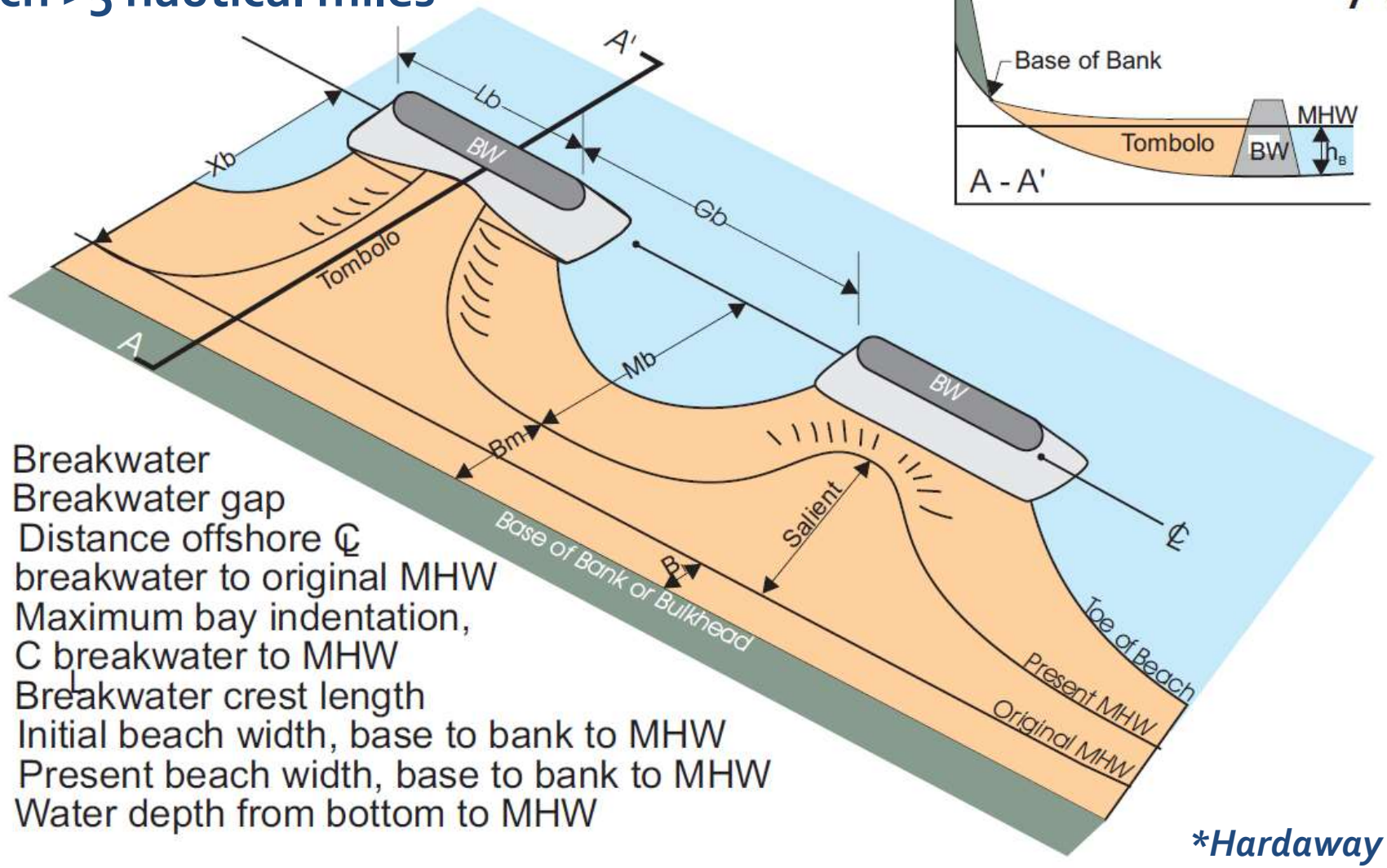
Hybrid Living Shorelines: Stone Sills & Marsh Plantings

Research Supports This Approach :

- Wave Attenuation: A 10 m wide fringe marsh can reduce wave heights 50-80%
  - *Shepard, Crain, and Beck (2011)*
- Water Quality: Fringe marshes can remove up to 80% of nitrates from runoff within 5m
  - *Burke, Koch, and Stevenson (2005)*
- SLR: Marsh accretion rates higher behind sills than in native environments
  - *Currin, Delano, and Valdes-Weaver (2008)*
- Biodiversity: Enhancement of invertebrate and fish diversity and abundance compared to armored shorelines
  - *Davis, Takacs, and Schnabel (2006)*
  - *Currin, Delano, and Valdes-Weaver (2008)*
  - *Scyphers et al. 2011*
- Storms: Marshes with stone sills found to be more effective than bulkheads in protecting shorelines from erosion during extreme storm events (hurricanes)
  - *Gittman et al. (2014)*
- Cost: Construction costs competitive with armoring

Hybrid Living Shorelines: Breakwaters/Sand/Plants

fetch >5 nautical miles



BW Breakwater
Gb Breakwater gap
Xb Distance offshore ℄ breakwater to original MHW
Mb Maximum bay indentation, C breakwater to MHW
Lb Breakwater crest length
Bl Initial beach width, base to bank to MHW
Bm Present beach width, base to bank to MHW
hb Water depth from bottom to MHW

**Hardaway et al*

Hybrid Living Shorelines: Breakwaters/Dune/Sand/Plants

Dune Creation

Dune Plantings

Sand Placement

Breakwater

Recreational Beach

Chesapeake Bay

Town of Cape Charles Public Beach

184

Tazewell Ave

Monroe Ave

Harbor Ave

Bay Ave

Pine St

- Cape Charles, Virginia
- 25-30 mile fetch
- $50,000 from Chesapeake Bay Trust Living Shoreline Initiative Program
- Paid for all plantings and a portion of sand placed

Hybrid Living Shorelines: All of the Above

Carteret Community College
Morehead City, NC
Previously Reveted Shoreline
Fetch 0.3-2.0 nautical miles

Stone Sill

Finishing Wetland

Reef Balls

Oyster Bag Sill

Stone Sill

Beach Sand

Eelgrass Plantings

Spartina Plantings

Breakwater

Hybrid Living Shorelines: Storm Resilience

Hurricane Resilience:

- 2007 Hurricane Noel
- 2008 Hurricane Hanna
- 2009 Hurricane Bill
- 2009 Hurricane Ida
- 2010 Hurricane Earl
- 2011 Hurricane Irene
- 2014 Hurricane Arthur
- 2016 Hurricane Mathew

Permitting: Progress & Hurdles

USACE

- *(2016) New Nationwide Permit 54: Living Shorelines!*

Living Shorelines. Structures and work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States for the construction and maintenance of living shorelines to stabilize banks and shores in coastal waters, which includes the Great Lakes, along shores with small fetch and gentle slopes that are subject to low- to mid-energy waves. A living shoreline has a footprint that is made up mostly of native material. It incorporates vegetation or other living, natural "soft" elements alone or in combination with some type of harder shoreline structure (e.g., oyster or mussel reefs or rock sills) for added protection and stability. Living shorelines should maintain the natural continuity of the land-water interface, and retain or enhance shoreline ecological processes. Living shorelines must have a substantial biological component, either tidal or lacustrine fringe wetlands or oyster or mussel reef structures.

- *No more than 500 linear feet without waiver*

Northeastern States

- *(2012) CT requires applicants to consider living shorelines as an alternative to hard structures*
- *(2016) NY DEC releases guidance documents advocating for communities to consider living shorelines*
- *Many State Agencies and Stakeholders still look poorly on ANY fill or stone in intertidal or subtidal areas*

Summary:
Green or Grey? Why Not Both?!

Combine:

Stability and protection of GREY shoreline elements

+

Ecological Benefit of GREEN shoreline elements

=

Sustainable Natural Shorelines

Questions?

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