Potential Ecological effects of Living Shorelines

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Chesapeake Bay Trust
Eroding Shorelines

One third of all Chesapeake Bay shorelines are (naturally?) actively eroding.

- 1300 of 4360 miles in MD
- Rates up to several feet per year
One third of all Chesapeake Bay shorelines are (naturally?) actively eroding.

We’re hardening our shorelines to protect against erosion.
Hardening of Shorelines

One third of all Chesapeake Bay shorelines are (naturally?) actively eroding.

We’re hardening our shorelines to protect against erosion
  - But armor doesn’t always work
  - We hypothesize that armor has fewer ecologic benefits
The First Living Shorelines

- 1972 – Ed Garbisch, Environmental Concern

Control of upland bank erosion through tidal marsh construction on restored shores: Application in the Maryland portion of Chesapeake Bay

Hambleton Island restoration: Environmental Concern's first wetland creation project.
History of “Living Shorelines”

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- 2003   North Carolina passes Living Shoreline Law (HB 1028)
- Early 2000s Delaware puts “no bulkhead” policy in place
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<td>2010</td>
<td>President Obama’s Ches. Bay Exec Order includes LS goal</td>
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<td>2010</td>
<td>Rhode Island and NJ begin living shoreline effort</td>
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<td>2013</td>
<td>Second Chesapeake Living Shoreline Summit</td>
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<td>2013-4</td>
<td>Bay Program Expert Panel to grant NPS credit for LS projects</td>
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Priorities – 2006 Chesapeake LS Summit

Chesapeake Living Shoreline Summit and Follow-Up Recommendations

1) Increase research on design, ecological impact, and sea level rise
2) Produce design criteria
3) Create (and use) regional management plans
4) Investigate social marketing
5) Promote local government planning
6) Create financial incentives
Existing Research

• Research on armor versus natural habitat
  - Campbell Foundation and Trust funded VIMS work
  - Trust and NOAA studies
  - NOAA-funded SERC work 2010-2015
  - Work from Europe on seawalls and rocky shores

• Research on conversion of armor to living shoreline
Ecological: Armor vs. Natural Marsh
Ecological: Armor vs. Natural Marsh

Bulkhead sites – Deeper than fringe marshes by 35cm; No habitat < 30 cm
Ecological: Armor vs. Natural Marsh
Most species more abundant in marsh than armor

Mummichog (*F. heteroclitus*)
- Density (#/m²)
- Control Marsh: West River, College Creek, Miles River, Beards Creek
- Bulkhead: West River, College Creek, Miles River, Beards Creek
- Comparison: p=0.020

Grass shrimp (*P. pugio*)
- Density (#/m²)
- Control Marsh: West River, College Creek, Miles River, Beards Creek
- Bulkhead: West River, College Creek, Miles River, Beards Creek
- Comparison: p=0.016

Other species:
- Chain pickerel
- Stickleback
- Spot
Ecological: Armor vs. Natural Marsh
Bulkhead lower values of diversity, density
(Bilkovic and Roggero 2008)
Ecological: Armor vs. Natural Marsh

Seawalls - lower values of spp richness

(Brauns et al. 2005; German lakes)

Fig. 2. Median species richness (+ max) of natural and developed shorelines (beach, retaining wall, riprap) within the (a) eulittoral and (b) infralittoral zones. Significant differences (Mann–Whitney U-test) between natural and each type of developed shorelines are indicated by asterisks (**P < 0.01, *P < 0.05).
Less research exists on armor versus living shorelines.
Ecological: Change in Spp. Diversity and Density hypothesized to be higher at LS sites than control sites

After-Before (change in density; #/sq m)

bulkheads to living shorelines  eroding fringe marsh to living shoreline

living shoreline  control
Nekton: species diversity increased

After-Before (change in density; #/sq m)

-0.01
-0.005
0
0.005
0.01
0.015
0.02

bulkhead to LS

n = 6 sites

living shoreline

control

eroding to LS

n = 2 sites

n = 6 sites

20
Nekton: density of individuals increased

After-Before
(change in density; 
#/sq m)

bulkhead to LS
eroding to LS

living shoreline
control
Ecological: several nekton species increased at LS; none decreased

After-Before (change in density; #/sq m)

Blue Crab

Striped Bass

Grass Shrimp
Ecological: LS similar infauna and plant density to other shoreline types (Bilkovic and Mitchell 2013)
Physical/Erosion: Sill/Living shoreline sites have higher accretion than natural sites (Currin et al., 2010; NC)

<table>
<thead>
<tr>
<th>Marsh type</th>
<th>Marsh edge location</th>
<th>Net sediment accretion (mm y^(-1))</th>
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<tr>
<td>Natural</td>
<td>Lower</td>
<td>-6.92 A</td>
<td>4</td>
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<tr>
<td>Sill</td>
<td>Lower</td>
<td>5.36 B</td>
<td>4</td>
</tr>
<tr>
<td>Natural</td>
<td>Upper</td>
<td>1.18 A</td>
<td>4</td>
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<tr>
<td>Sill</td>
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Using “natural habitats” in armor in other systems (rocky intertidal):
It’s not all about wetlands (Bulleri and Chapman, 2010; Italy)

Fig. 2. The number of species of macro-algae and sessile animals living on the façade of the seawall (black bars) and the number of additional species found in the ‘rock-pools’ (clear bars) at three different shore levels (high, mid and low); data summed across all sites (see Designing “rock pools’ into seawalls
Research Priorities – 2013 Chesapeake LS Summit

% of votes from each sector

efficacy (ecology, physical, water quality)
most effective types and locations
habitat tradeoffs (riparian buffer, subtidal)
cost benefit analysis and life cycle costs
methods to measure success (physical, ecological)
how to build marshes to adapt to sea level rise
prioritizing shoreline project sites basin-wide
monitoring protocol
situations where shorelines should not be protected from erosion
lessons learned - what worked, what didn't and why
social marketing tools for various stakeholders
gap
Top Research Priorities

For scientists

1. Efficacy of LS (WQ, hab, erosion)
2. Monitoring protocol development
3. Efficacy of types of LS and location
4. Adaptation to SL rise
5. Debate about where shorelines should not be protected from erosion
Top Research Priorities

For scientists

1. Efficacy of LS (WQ, habitat, erosion)
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For regulators

1. Tradeoffs (subtidal, riparian buffer)
2. Efficacy of LS (WQ, habitat, erosion)
3. Cost benefit analysis and life cycle costs
4. How do we actually measure success
5. How do we prioritize LS sites basin-wide
Next Steps/Needs: Test Design Effectiveness for Erosion Protection and Habitat

1. LS #1 continuous sill with windows
2. LS #2 segmented sill (offshore breakwaters)
3. LS #3 groins
4. revetment
Future Research

- Optimum designs to maximize ecological function \textit{and} erosion control function?