What is a Living Shoreline?
Living Shoreline Fundamentals

Karen Duhring
Virginia Institute of Marine Science
College of William & Mary

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Living Shoreline Fundamentals

• Origins of Living Shoreline Initiative

• Main Guiding Principles

• How to get started – first considerations
ORIGINS OF LIVING SHORELINE INITIATIVE
Shoreline Hardening

The installation of multiple bulkheads and revetments along the shoreline that “hardens” previously natural shoreline conditions.

Each individual project may seem insignificant by itself but the combined miles of many hard structures across time & space has cumulative impacts on entire estuary.
Research on Cumulative Impacts of Shoreline Hardening mid 1990’s - present complex connections between habitats & landscape level effects of hardening on living resources even where shoreline hardening is absent
Cumulative Impacts of Shoreline Hardening

- Habitat loss & fragmentation
  - Decreased habitat diversity
- Sediment supply & transport altered
  - Increased scour & turbidity
- Increase in invasive species
- Decrease in fish & benthos # & diversity
- Decrease in marsh bird diversity
- Habitat migration interrupted
- Evidence of low thresholds
  - Some adverse effects noticed @ 5% hardening
  - Even more when hardening reaches >15%

For More Information

Mitigating Shore Erosion Along Sheltered Coasts
National Research Council, 2007
Delaware Shoreline Inventory

Completed in 3 phases to map shoreline conditions in select watersheds 2005 - 2007 - 2012

http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/delaware/delaware_disclaimer.html
Defended Shorelines by River System
Delaware Coastal Bays

Indian River Watershed
Defended Shoreline
Miles Defended Shoreline: 24.69

- Bulkhead
- Debris
- Dilapidated Bulkhead
- Groin Field
- Jetty
- Riprap
- Breakwater

Rehoboth Bay
Defended Shoreline
Miles Defended Shoreline: 25.04

- Bulkhead
- Debris
- Dilapidated Bulkhead
- Groin Field
- Jetty
- Riprap
- Breakwater
- Unconventional
- Marsh Toe

2006 data
23 miles bulkhead + riprap
120 miles surveyed
19% hardened shoreline

2012 data
23 miles bulkhead + riprap
148 miles surveyed
15.5% hardened shoreline
Origin of “Living Shorelines”

• Not New - ‘Vegetative Stabilization’ developed in 1970’s

• Always been preferred alternative for low energy, minor erosion problem solving
  – but not widely practiced when appropriate

• 2004 new initiative started in Maryland & Virginia
  – to re-invigorate interest in low impact stabilization

• Fueled by data from cumulative impact analyses & scientific research of hardened shorelines
  – Annual miles of shoreline hardening
  – Net tidal wetland loss compared to mitigation acres

Re-Branding with ‘Living Shorelines’
Coastal States with Living Shoreline Programs due to concerns for shoreline hardening trend

- Northeast
  - Connecticut
  - Rhode Island
  - New York
  - New Jersey
  - Delaware
- Mid-Atlantic & Southeast
  - Maryland
  - Virginia
  - North Carolina
  - Florida
- Gulf Coast
  - Alabama
  - Mississippi
  - Texas
- West & Northwest
  - California
  - Oregon
  - Washington
- Great Lakes
  - Michigan
  - Ohio
  - New York

Many outreach education resources available for client education & promotion
Living Shorelines

MAIN GUIDING PRINCIPLES
What are Living Shorelines for Erosion Protection?

Alternatives for bulkheads & revetments
Where erosion cannot be tolerated & some type of shoreline management is necessary

Nature-Based Features
Mimic &/or protect existing local habitats

Upland

Wetland

Shallow Water

Riparian Buffers

Tidal Marshes Sand Beaches

Shellfish Reefs Submerged Aquatic Vegetation SAV
Common Shoreline Terms

- **Upland Slope**: Level ground to storm tides
- **Shoreline Slope**: Storm tides to mean low water
- **Bank Height**: Varies
- **High Marsh**
- **Low Marsh**
- **Irregularly Flooded**
- **Regularly Flooded**
- **Tidal Marsh**
- **Extremely High Tides & Storms**
- **Mean High Tide**
- **Mean Low Tide**
- **SAV**
- **Intertidal Wetlands & Beaches**
- **Shallow Water**

Graphic courtesy Burke Environmental Associates
Upland Bank Erosion

Erosion area above intertidal zone
Living Shorelines for **Upland Bank Erosion**

Create more gradual slopes
Create distance that waves must cross before striking shoreline

Sand Fill + Planted Marsh
+ Marsh Edge Protection

**Graphic Source: Chesapeake Bay Foundation**
Marsh Edge Erosion

Erosion area within intertidal zone
Living Shorelines for **Marsh Edge Erosion**

Help stabilize erosion & increase vertical sediment accretion
## What’s the Difference?

<table>
<thead>
<tr>
<th>Habitat Restoration</th>
<th>Living Shorelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wetland Mitigation</strong></td>
<td><strong>Main purpose is usually to solve a problem for people</strong></td>
</tr>
<tr>
<td>Main purpose is to create &amp; replace lost natural habitat for its intrinsic value</td>
<td>Erosion</td>
</tr>
<tr>
<td></td>
<td>Sediment contamination</td>
</tr>
<tr>
<td></td>
<td>Beneficial use of dredged material</td>
</tr>
<tr>
<td>Human presence minimal if not absent</td>
<td><strong>Manipulated, engineered designs</strong></td>
</tr>
<tr>
<td></td>
<td>Human presence normal</td>
</tr>
<tr>
<td></td>
<td><strong>Mimic but may not match natural community ecology</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Focus on changing physical forces, ecology evolves over time</strong></td>
</tr>
</tbody>
</table>
Common Elements in Living Shoreline Definitions

- **Erosion risk reduction** – unacceptable erosion risk is present and some type of shoreline management action is necessary

- **Wave attenuation** – rough surfaces to reduce wave height and energy of approaching waves

- **Habitat heterogeneity** – Diverse habitats similar to natural shorelines in local area; habitats are largest features

- **Habitat continuum** – unimpeded migration of fish and wildlife along the shoreline and between aquatic and terrestrial habitats, flow of energy, organic matter, & food between habitats

- **Habitat dynamics & migration** – habitat features can shift in response to sea level rise, vertical sediment accretion

*Source: Bilkovic, Mitchell, Mason & Duhring, 2016*
Achieve **Ecological Uplift** – Net Benefits

Reduce erosion but also....

- **Do No Harm** to ecologically valuable habitats
- Connect animals to critical nursery areas
- Net increase number & types of fish and wildlife
- Less constraints, dynamic sand & soil movement

Habitat tradeoffs are one focus of permitting process
Living Shoreline Project Types

Non-Structural Bio-Based
Vegetative Stabilization
Sand Fill
Gradual Slopes

Hybrid
Engineered structures required to support living habitat components & achieve desired level of protection
Non-Structural Approaches

Riparian Buffer Planting

Grade Bank & Restore Riparian Buffer

Planted Marshes & Fiber Logs

Beach Nourishment & Planted Dunes
Hybrid Approaches

• Low-Profile Rock Structures
  – Marsh sills, marsh toe revetments, breakwaters

• Shellfish Reef Structures
  – Oyster Castles, Reef Balls, Ready Reef, Reef Blok (& others)

• Wave Attenuation Devices (WAD)
Marsh Sill

A low-profile revetment backfilled with sand to create & support planted tidal marsh
Shellfish Reef Structures or Biogenic Reefs

Mimic vegetation – shellfish association that occurs naturally

Bagged Shell

‘Reef Balls’

‘Oyster Castles’

‘Ready Reef’
Hybrid Project Example at Mispillion Harbor

Fiber Log Reinforcement with Oyster Castles & Oyster Shell Bags
Support Vegetative Stabilization
How do plants provide erosion protection?

Stem density & height

+ Interconnected roots & rhizomes

Increases friction

Intercept & dampen waves & runoff

Sediment trapping & accretion maintain vertical & horizontal position
Storm Performance - Realistic Expectations

Living shorelines are usually submerged during storm events.

When water depth exceeds plant height, marsh impact on waves is much less.

Virginia living shoreline project during Veterans Day Nor’Easter 2009
Living Shoreline Resilience

Post-storm recovery is expected after multiple events

Same planted marsh the day after another storm event in 2011
Shoreline Erosion vs. Tidal Flooding

Erosion protection structures typically do not reduce flooding risk

Different adaptations to reduce recurrent flood risk

Elevating houses - roads - utilities

Fill material to raise elevations

Retreat from shoreline
Other Limiting Situations
Living Shorelines are Not Appropriate or Feasible Everywhere

• No need for risk reduction
• Overwhelming need for risk reduction
  – more substantial level of protection required

• Significant or critical resources would be harmed
• Nature-based features cannot be self-sustaining
  – Costly & frequent inputs needed to persist

• Overwhelming construction access challenges
  – Necessary equipment cannot gain access
Site-Specific Design Required

• Every site has unique set of circumstances
  – Physical & Biological
  – Human risk situation & perceptions
  – Potential use conflicts
    
    *Navigation, recreation access*
    
    – Potential changes to adjacent shorelines
      
      *Sediment transport, reflected wave energy*
Living Shorelines Main Guiding Principles

Review

• Risk reduction problem solving should be necessary

• Achieve net ecological uplift
  – *Guided by local native habitats & vegetation communities*

• Choose least impacting yet effective approach

• Will not prevent storm surge flooding, but can be resilient with post-storm recovery

• Not appropriate or feasible everywhere

• Site-specific design considerations required
  – *No standard recipes or one size fits all site designs*
Living Shorelines

HOW TO GET STARTED
Site Evaluation Process

Each shoreline professional has a method for conducting site evaluations

Not all parameters have equal weight, professional judgment necessary

This workshop has data collection suggestions and tools for basic site evaluations for initial suitability determinations

More complex data collection may be necessary to develop concept design & permit application package
General Location Considerations

- Delaware River
- Delaware Bay
- Inland Bays
- Atlantic Ocean coast

Each region has its own character & influences

Tidal tributaries within each region are varied
Where are living shoreline methods suitable?

**MOST SUITABLE**
Upper reaches of narrow creeks

**MAYBE**
Lower reaches, wider creeks

**LEAST SUITABLE**
Bayfront & main tributaries, Ocean coast
Risk Reduction Considerations

Is shoreline management necessary?
Is there a risk problem that needs to be addressed?
Erosion? Tidal Flooding? Both?

Extra scrutiny for all currently undefended, natural shorelines

Especially those with valuable living resources:
- riparian forest
- tidal marsh
- oysters
- SAV
Project Type Considerations

- Upland bank erosion
- Marsh edge erosion
- Protecting human infrastructure
- Protecting significant natural resources
- Natural undisturbed shoreline
- Disturbed, degraded, existing shoreline hardening
## Living Shoreline Suitability
### Anthropogenic Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property owner</td>
<td>Willing</td>
<td>Not interested</td>
</tr>
<tr>
<td>Parcel size</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Upland improvements</td>
<td>At risk</td>
<td>Not threatened</td>
</tr>
<tr>
<td>Accessory structures</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Adjacent parcels</td>
<td>Same</td>
<td>Different</td>
</tr>
<tr>
<td>Recreation uses</td>
<td>Passive</td>
<td>Active</td>
</tr>
<tr>
<td>Cultural resources</td>
<td>Absent</td>
<td>Present</td>
</tr>
</tbody>
</table>
## Living Shoreline Suitability

### Environmental Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riparian buffer</td>
<td>Open</td>
<td>Developed</td>
</tr>
<tr>
<td>Natural marsh</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Amount of sunlight</td>
<td>Full sun</td>
<td>Shaded</td>
</tr>
<tr>
<td>Wind wave action</td>
<td>Minor</td>
<td>Heavy</td>
</tr>
<tr>
<td>Boat wakes</td>
<td>Rare</td>
<td>Frequent</td>
</tr>
<tr>
<td>Nearshore</td>
<td>Shallow</td>
<td>Deep</td>
</tr>
<tr>
<td>Bottom substrate</td>
<td>Hard sand</td>
<td>Soft mud</td>
</tr>
<tr>
<td>SAV</td>
<td>Absent</td>
<td>Present</td>
</tr>
</tbody>
</table>
Basic Do No Harm Considerations for Delaware Estuary & Coastal Bays

• Existing Riparian Buffers & Wetlands
  – avoid completely OR is temporary disturbance feasible

• Oyster Reefs

• Anadromous Fish – time of year restrictions

• Horseshoe Crabs – resting & spawning areas

• Migratory Shorebirds

• Beach Nesting Birds

Source: PDE, 2012
Constructability must be determined EARLY in planning process

- Construction access from land or water? Stockpile areas?
- Any forest or marsh crossings required?
- Machine size? Own or rental required?
  - Excavator reach long or short
  - Small equipment needs
  - Hand placement needs
Early Logistics & Economic Considerations

• Construction sequence & timeframes
  – Patience typically required for living habitats to become established
  – Seasonal preferences for vegetation planting

• Labor requirements
  – Paid professional services
  – Volunteer opportunities

• Permitting process
  – Pre-application consultation encouraged

• $$$$  
  – Private funds
  – Public grant or loan support available?
Living Shoreline Fundamentals

Summary

• **Nationwide Living Shoreline Initiative**
  – Re-invigorate interest in low impact shoreline stabilization
  – Bring attention to growing evidence of harm caused by shoreline hardening

• **Main guiding principles** include:
  – Solve problems for people with realistic goals & expectations
  – Mimic dynamic natural habitats in local area
  – Achieve ecological uplift
  – Identify potential use conflicts, impacts to adjacent shorelines

• **How to Get Started First Considerations**
  – Local area setting & situations
  – Match property owner goals to possible alternatives
  – Basic logistics, permitting & economic requirements
Questions About the Fundamentals?

Contact Information
Karen Duhring  karend@vims.edu  804-684-7159