Sustainable Shorelines: Working with Nature

MATTHEW BIONDOLILLO
Agenda

➢ Life is a Beach!
➢ Shore Protection: A Historical Perspective
➢ Shore Zone: A Dynamic Environment
➢ What’s a Sustainable Shoreline?
➢ Shoreline Erosion
➢ A New Paradigm
➢ Shoreline Stabilization Measures
➢ Managing Sustainable Shorelines
➢ Game of Stones: Time Permitting
➢ Questions & Answers
The Root Zone
Engineer
Landscape Architect
Scientist/Biologist
Dredging & Beach Nourishment
A Historical Perspective: When Weather Changed History
Galveston Seawall and Grade Raising Project
Shore Zone: A Dynamic Environment
Shore Zone: Ecotone

Milone & MacBroom (2014)
What is a Sustainable Shoreline?

Protect the shore zone’s
- wildlife habitat,
- ecological benefits,
- outdoor recreation,
- community quality of life,
  and
- water-dependent businesses
Shoreline Erosion

- Are large trees falling into the water?
- Is there evidence of undermining?
- Are large portions of bank eroding?
- Is land loss apparent in historical images?
Reasons for Eroding Shoreline

- Waves
  - Wind-driven
  - Boat wakes
- Current
- Runoff
- Ice scour
- Adjacent structures
- Failed or failing structure
A New Paradigm: from Controlling to Integrating Nature

**Structural “Grey” Infrastructure**
- Bulkhead/Seawall
  - Vertical structure
- Stacked Stone/Concrete
  - Vertical/steep
- Rock Revetment
  - Sloping structures
- Groin
- Jetty

**Soft “Green” Infrastructure**
- Living Shorelines
- Engineering with Nature (USACE)
- Ecologically-Engineered Shore Protection
  - Bioengineering
  - Biotechnical
- Natural & Nature-Based Shore Protection
- Ecosystem-based Management
Natural and Nature-based Features

- Riparian buffers
- Dunes/beach complex
- Mudflats
- Salt marshes
- Submerged & emergent aquatic vegetation
- Wetlands, grasslands, shrublands, forests
- Living shorelines
- Engineered beaches and dunes
- Submerged breakwater
- Constructed wetland
- Bioengineered/biotechnical stabilization measures
Shoreline Stabilization Measures

- Structural
- Bioengineering
- Biotechnical
General Considerations for Bank Stabilization

- Topography: degrees of slope and elevation relative to surface water
- Geology & Soil Type
- Hydrology & Groundwater: Interactions
- Vegetation: plant types and stability
- Exposure: Wind, wave and ice exposure
- Adjacent Structures
- Accessibility of the site for construction materials
- Erosion and sediment controls required
- Regulatory permit(s) required to proceed
Structural Shoreline

- Most expensive
- Wave and scour impacts
- Groundwater and ice factors
- 20 – 25 year lifespan
## Structural Shoreline Stabilization Measures

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<th>Structure</th>
<th>Breakdown</th>
<th>Example Photograph</th>
<th>Conceptual Sketch</th>
<th>Design Assumptions</th>
<th>Design for base-case DWL (+1.71 m CD)</th>
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</table>
| Concrete Wall   | 38%       | ![Concrete Wall](image) | ![Concrete Wall Sketch](image) | - Gravity-type seawall \( b \) on bedrock.  
  - Base width, \( B = 1.3 \times \) water depth  
  (for overturning stability from active earth pressures).  
  - Soil saturated to top of wall from overtopping.  
  - Backfill over existing grade to top of wall.  
  - Toe protection and splash pad. | - Base width = 2.2 m (7.2 ft).  
  - Toe stone 80 kg (0.3 m), CAD $55/t.  
  - Typical unit structure cost CAD $4,600/m. |
| Armored Wall    | 32%       | ![Armored Wall](image) | ![Armored Wall Sketch](image) | - Stacked armor stone retaining wall \( b \).  
  - Base width, \( B = 0.8 \times \) water depth  
  (for overturning stability from active earth pressures).  
  - Soil saturated to surge level (wet above).  
  - Riprap underlayer with filter fabric and toe protection.  
  - Design wave depth limited: \( H_b = 0.78 \) d. | - Armours stone 6 t (1.3 m), CAD $83/t.  
  - Filter stone 200 kg (0.4 m), CAD $55/t.  
  - Typical unit structure cost CAD $2,000/m. |
| Block Wall      | 11%       | ![Block Wall](image)  | ![Block Wall Sketch](image) | - Concrete blocks \( b \) (two deep), sloped 1V:1H.  
  - Block size from Hudson’s formula for modified cube (Factor of Safety = 1.0 on block weight).  
  - Riprap underlayer with filter fabric and toe protection.  
  - Design wave depth limited: \( H_b = 0.78 \) d. | - Block dimension 0.5 m.  
  - Filter stone 30 kg (0.2 m), CAD $55/t.  
  - Typical unit structure cost CAD $2,900/m. |
| Dumped Armour   | 6%        | ![Dumped Armour](image) | ![Dumped Armour Sketch](image) | - Two-layer armor stone revetment, slope 1V:2H.  
  - Stone size from Hudson’s formula (Factor of Safety = 2 on stone weight).  
  - Riprap bedding layer.  
  - No filter fabric or toe protection.  
  - Design wave depth limited: \( H_b = 0.78 \) d. | - Armours stone 0.4 t (0.5 m), CAD $55/t.  
  - Bedding layer 30 kg (0.2 m), CAD $55/t.  
  - Typical unit structure cost CAD $1,000/m. |

* 13 percent classified as Other: Gabion Wall, or Debris  
* Concrete density assumed 2400 kg/m³, rock 2850 kg/m³  
The Hudson Equation

\[ W_{50} = \frac{W_r H^3}{K_D (Sr - 1)^3} \cot \theta \]

Safety Factor (SF) = 1.5 to 3.0
Bioengineering Shoreline Stabilization

- Least expensive
- Reduces wave and scour impacts
- Use of natural boulders mixed with plantings

Live stake planting on slope
Common Ingredients

- Stone
- Topsoil
- Erosion Control Matting
- Vegetation
  - Grasses
  - Shrubs
  - Trees

Black Willow, Salix Nigra
Digging Deep Reveals the Intrinsic World of Roots
Bioengineering Underway
Restoration in progress
Biotechnical Shoreline Stabilization

- Combination of soft and hard treatments
- Use in moderate wave areas
- Natural boulders, soil, vegetation (trees, shrubs, grasses), erosion control materials
Biotechnical Plan View
Vegetated Buffer Benefits

- Stabilizing shoreline soil and slope
- Protecting and enhancing the water quality of our lakes by collecting, treating, and filtering polluted stormwater runoff into lakes
- Providing food and shelter for fish, reptiles, birds, insects, and other wildlife
- Providing privacy for lakefront residences thus increasing property values
- Reducing maintenance needs and costs on lakefront properties
Managing Sustainable Shoreline

- Be wise about building in the shore zone
- Don’t squeeze the shore zone
- Don’t make it so hard
- Encourage physical & ecological integrity
- Resist tidiness
- Prevent pollution
- Reduce damage from waves, wakes, and currents
- Tread lightly
Be WISE about Building in the Shore Zone

- Understand the power of water and ecological significance of this transition zone
- Use ecosystem-based management or soft structures, where possible
- Promote low impact development for water-dependent uses
Don’t Squeeze the Shore Zone
Don’t Make It So Hard Cont’d!

- Use sloped shore defenses instead of vertical walls, if possible
Use natural materials for shore protection where possible
Don’t Make It So Hard Cont’d!

- Use green infrastructure to reduce runoff
Encourage Physical and Ecological Integrity

- Don’t grade evenly: leave swales, puddles and ridges
Encourage Physical and Ecological Integrity Cont’d

- Make shorelines sinuous or pocketed in bird’s eye view
- When landscaping, use a variety of plant species and types
Encourage Physical and Ecological Integrity Cont’d

- Include as much vegetation as possible, on both land and water side, for multiple benefits
Resist Tidiness

- Don’t mow right to the water’s edge
- Leave brush and shrubs in place (or even plant some)
- Leave dead wood in-place (where you can)
- Leave driftwood and wrack in place (where you can)
Prevent Pollution

- Don’t store harmful substances in the shore zone
- Minimize the use of harmful substances, which can easily runoff into the water
- Manage surface runoff and drainage water so that you don’t start erosion
Reduce Damages from Waves, Wakes, and Currents
Reduce Damages from Waves, Wakes, and Currents

- Consider using rock sills to protect soft shorelines
- Post and enforce no-wake zones
Tread Lightly

• Use paths, plantings, and signs to direct visitors away from sensitive areas
Tread Lightly Cont’d

- Keep livestock out of the shore zone
Benefits of a Sustainable Shore Zone

- Provide erosion control and protect upland land use
- Provide alternative options to hard structures, such as bulkheads and rip rap revetments
- Protect water by capturing polluted runoff
- Increase coastal greenery
- Increase biodiversity of habitats
- Minimize cost over life span of shoreline stabilization
Shoreline Restoration

Before

After
Game of Stones
Detroit Riprap
Layered Stones & Vegetation
Traditional Landscaped Shore Zone
A Precarious Building Lot!
We’re Making Beach Front
We Removed The Trees Along the Shoreline to Enhance the View
Let’s Everyone Do There Own Thing
If I only knew then!
Oh no!
Beautiful House, But......
Ditto
Let the Next Owner Worry About It!

![Image of a house with a sign for sale on the lawn and a beautiful lake view]
Well Done, Can You Help Me?
Shoreline Notes

- One Size Doesn’t Fit All
- Location Matters
- Armoring can Have Unintended Consequences
- Promote Physical & Ecological Integrity
- Attractive Waterfronts add Value
- The Simpler, the Better
Restoration/Resiliency Grant Opportunities

- DOS: Local Waterfront Revitalization Program
- NYSDEC: Water Quality Improvement Project
- NYSDEC: Climate Smart Communities
- NYSDEC/NY Sea Grant: Small Grant Program
- EFC: Green Innovation Grant Program
- EPA: Great Lakes Restoration Initiative
- NFWF: Sustain or Great Lakes
Study nature, love nature, stay close to nature. It will never fail you.

Frank Lloyd Wright
References


MATTHEW J. BIONDOLILLO, PMP®
M: 315.530.5294
MatthewBiondolillo3@gmail.com
Questions & Answers