Sustainable Shorelines: Working with Nature

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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

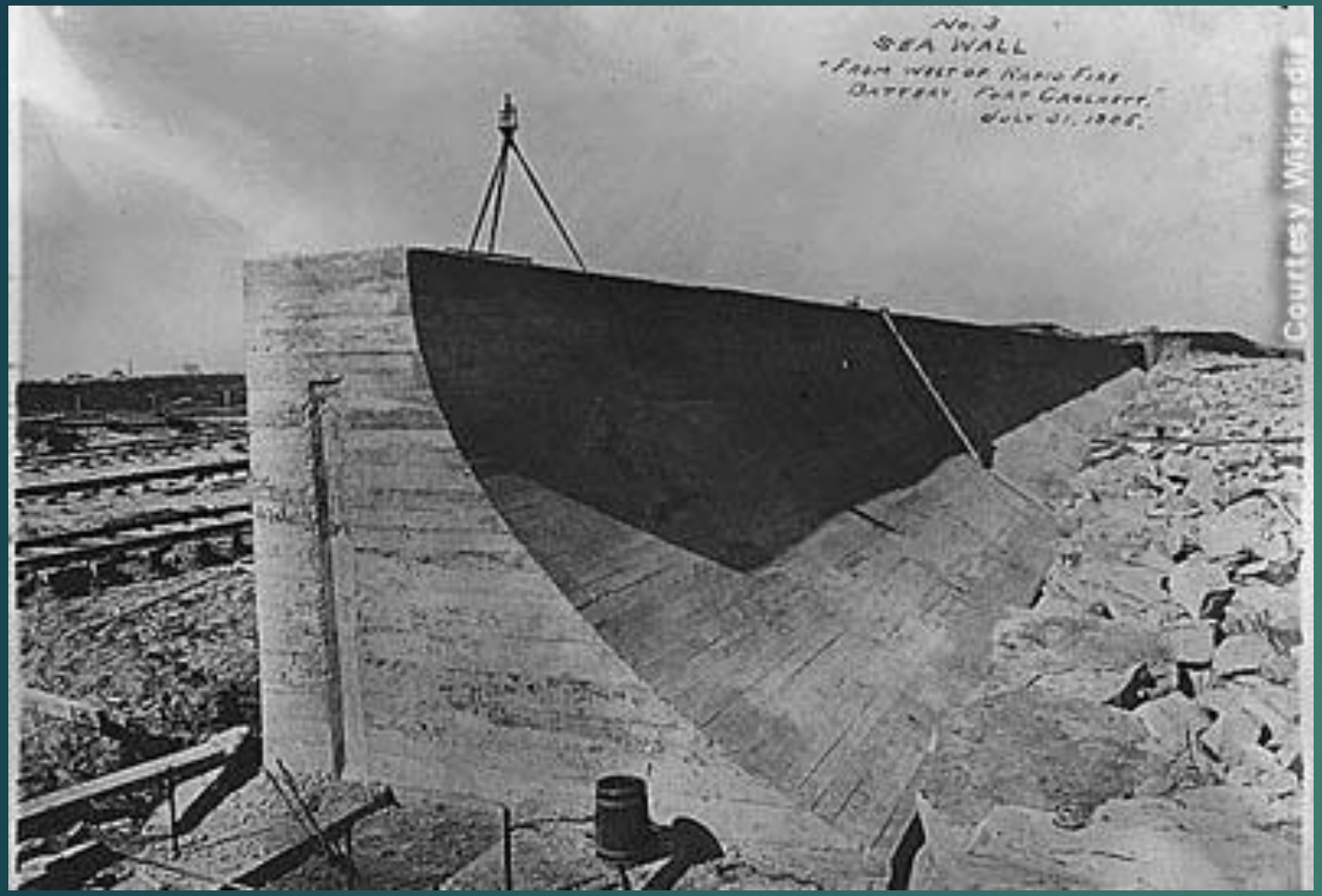
Landscape Architect

Scientist/Biologist

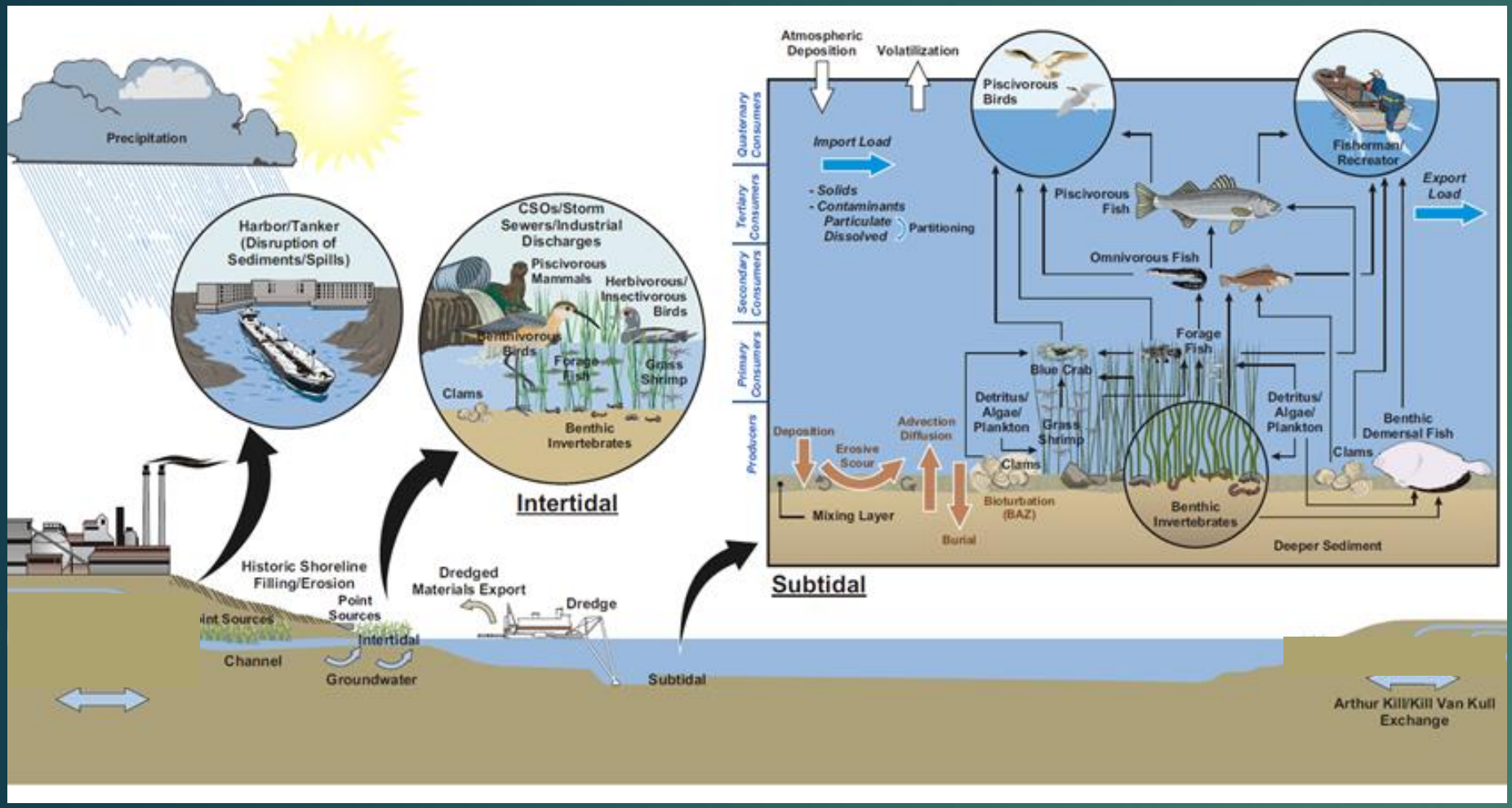
Dredging & Beach Nourishment

A Historical Perspective: When Weather Changed History

Galveston Seawall and Grade Raising Project



Shore Zone: A Dynamic Environment



Shore Zone: Ecotone

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

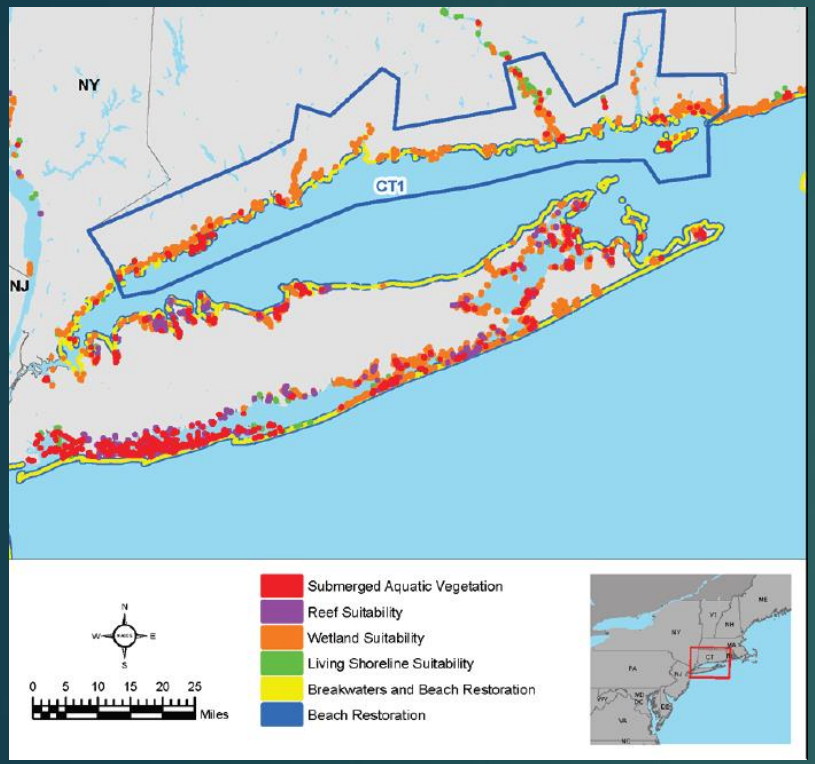
Structural "Grey" Infrastructure

- 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

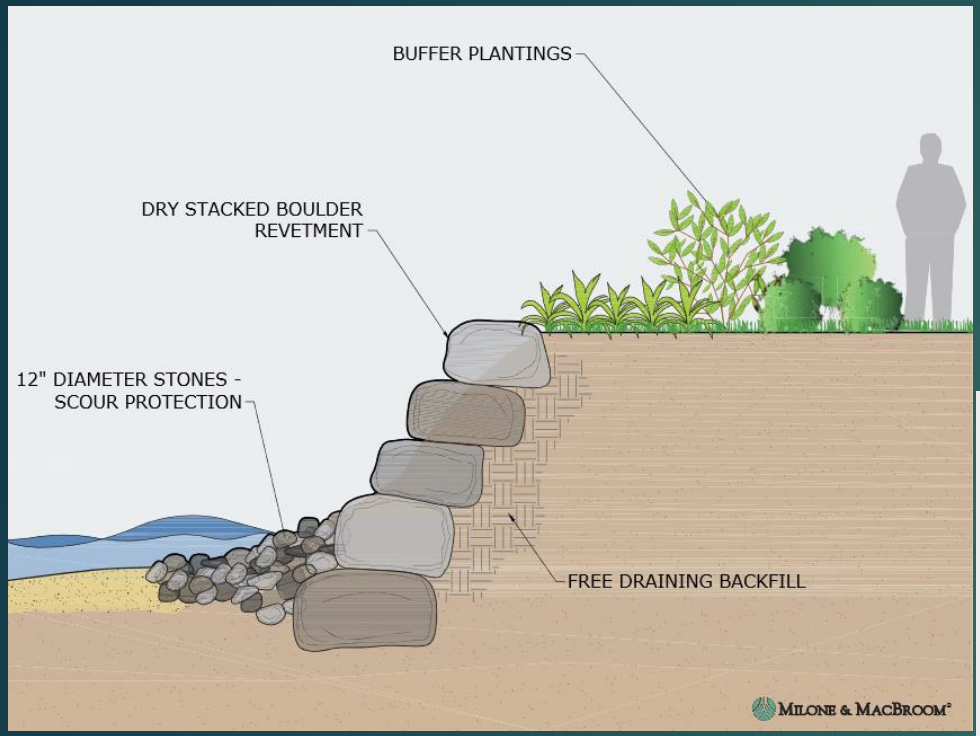
Shoreline Stabilization Measures

- Structural
- Bioengineering
- Biotechnical

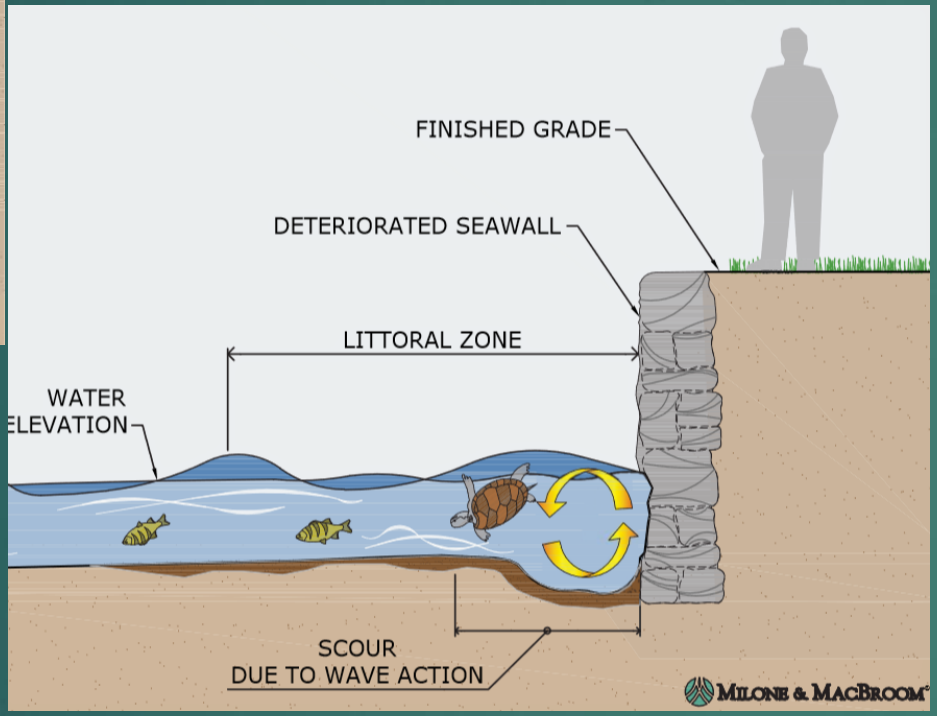
General Considerations for Bank Stabilization

- 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

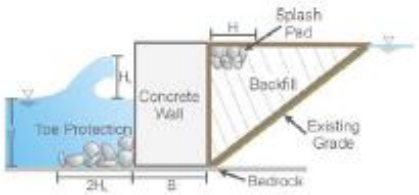
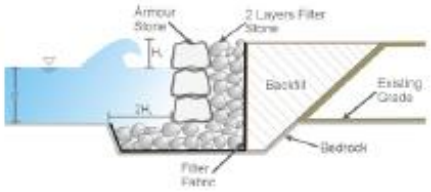
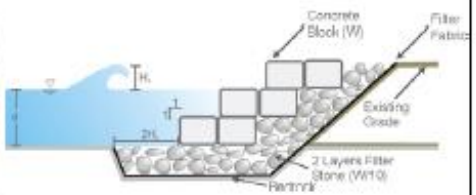
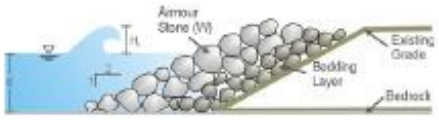


- Groundwater and ice factors
- 20 – 25 year lifespan



- Most expensive
- Wave and scour impacts

Structural Shoreline Stabilization Measures

Structure	Breakdown[a]	Example Photograph	Conceptual Sketch	Design Assumptions	Design for base-case DWL (+1.71 m CD)
Concrete Wall	38%			• Gravity-type seawall [b] on bedrock. • Base width, B = 1.3 x 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%			• Stacked armor stone retaining wall [b]. • Base width, B = 0.8 x 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: Hb = 0.78 d.	• Armour 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%			• Concrete blocks [b] (two deep), sloped 1V:1H. • Block size from Hudson's formula [c] for modified cube (Factor of Safety = 1.0 on block weight). • Riprap underlayer with filter fabric and toe protection. • Design wave depth limited: Hb = 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%			• Two-layer armor stone revetment, slope 1V:2H. • Stone size from Hudson's formula [c] (Factor of Safety = 2 on stone weight). • Riprap bedding layer. • No filter fabric or toe protection. • Design wave depth limited: Hb = 0.78 d.	• Armour 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.

[a] 13 percent classified as Other, Gabion Wall, or Debris

[b] Concrete density assumed 2400 kg/m³, rock 2650 kg/m³

[c] See U.S.A.C.E (1977), Shore Protection Manual

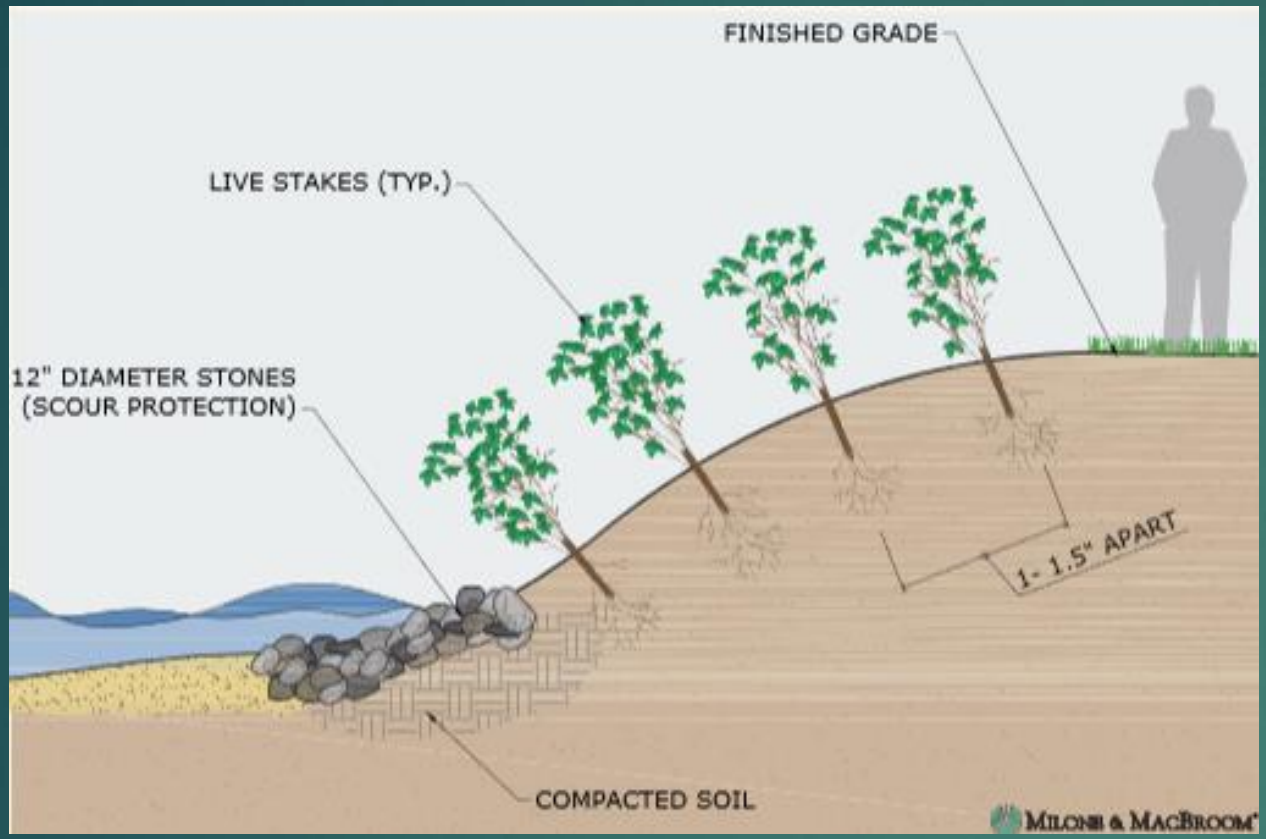
The Hudson Equation

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

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

Black Willow, *Salix Nigra*

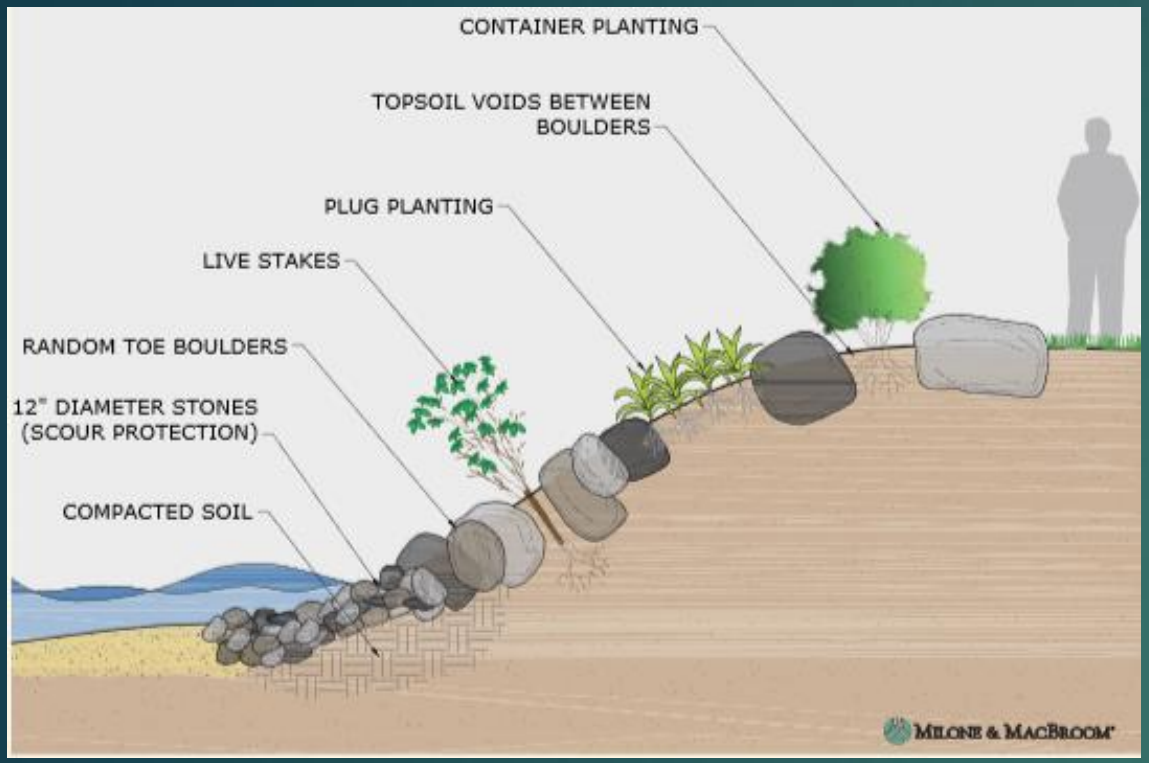
- Stone
- Topsoil
- Erosion Control Matting
- Vegetation
  - Grasses
  - Shrubs
  - Trees

Digging Deep Reveals the Intrinsic World of Roots

Bioengineering Underway

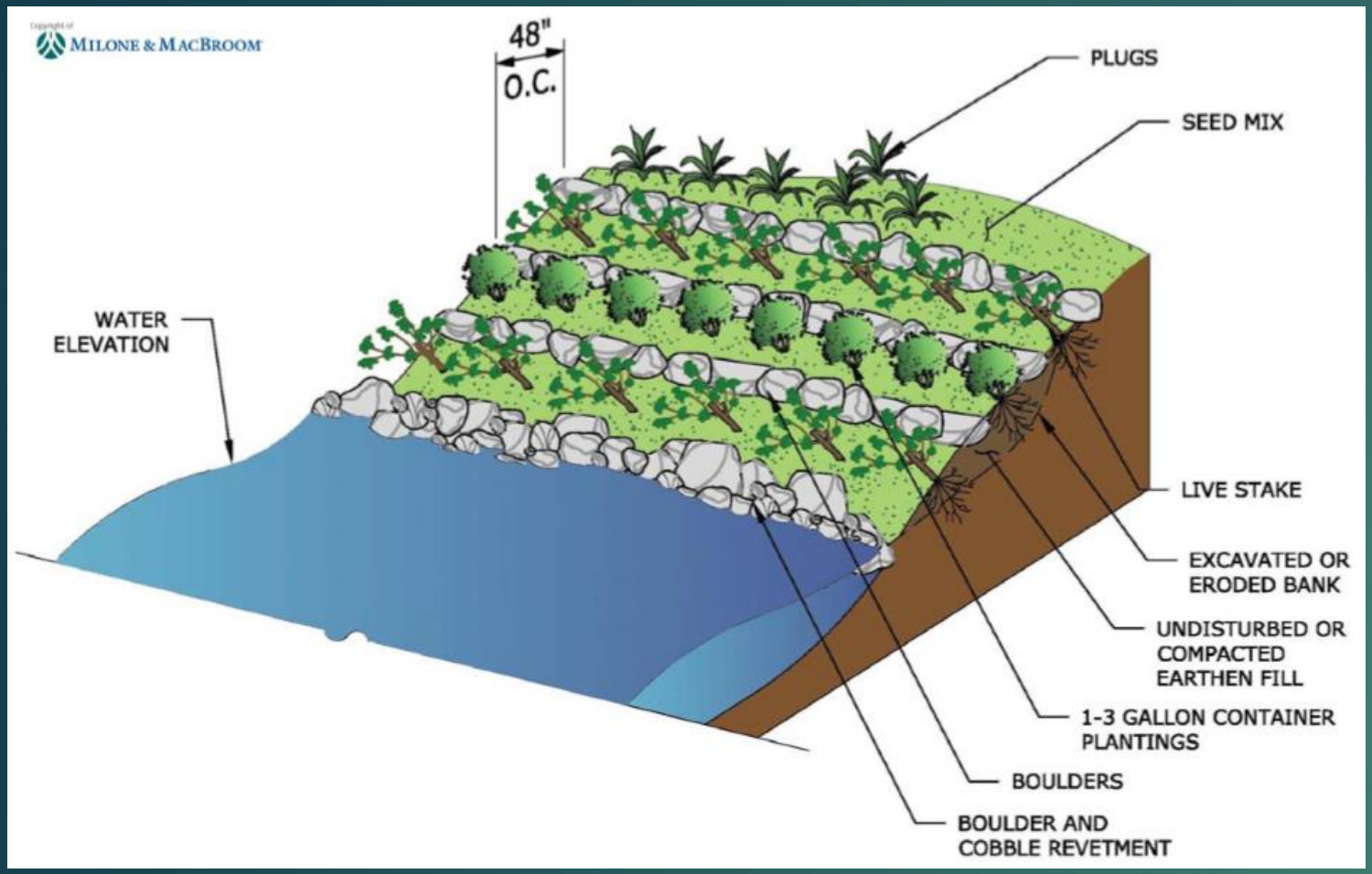
Restoration in progress

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

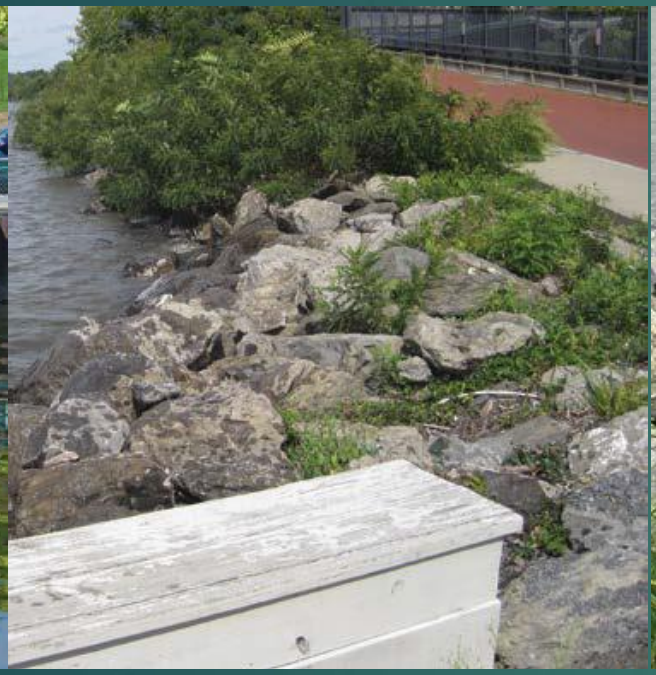
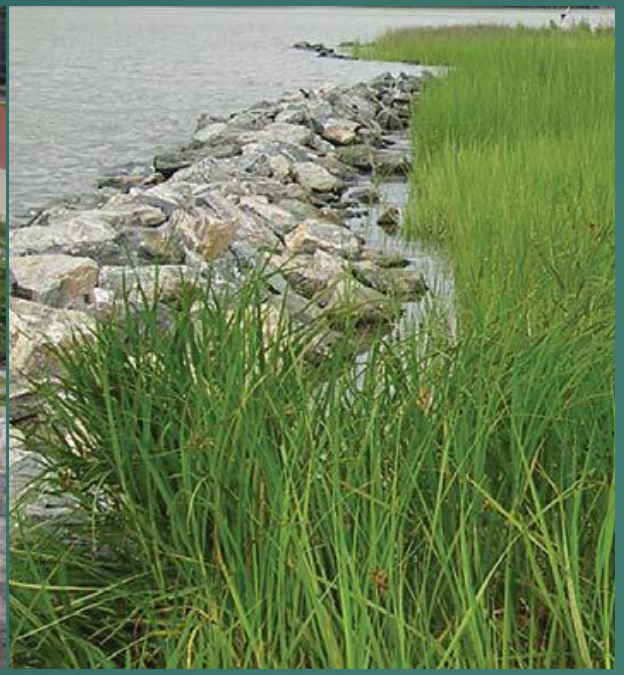
Be WISE about Building in the Shore Zone

- 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

Don't Make It So Hard Cont'd!

- 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

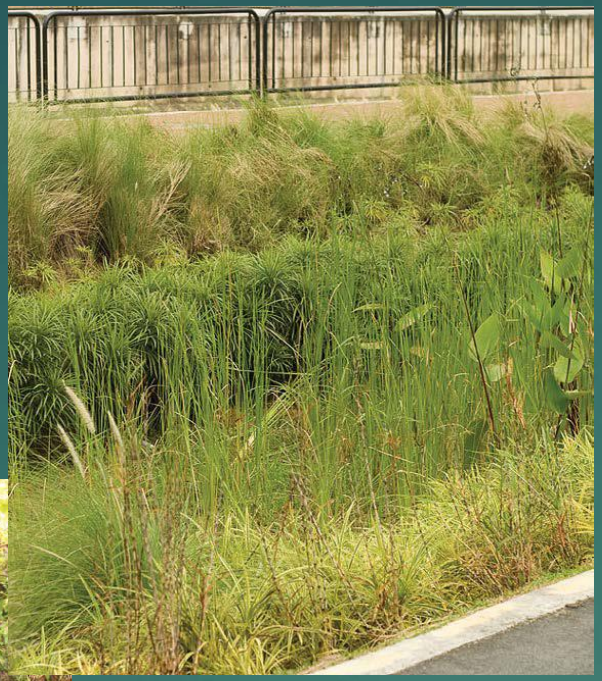
- Include as much vegetation as possible, on both land and water side, for multiple benefits

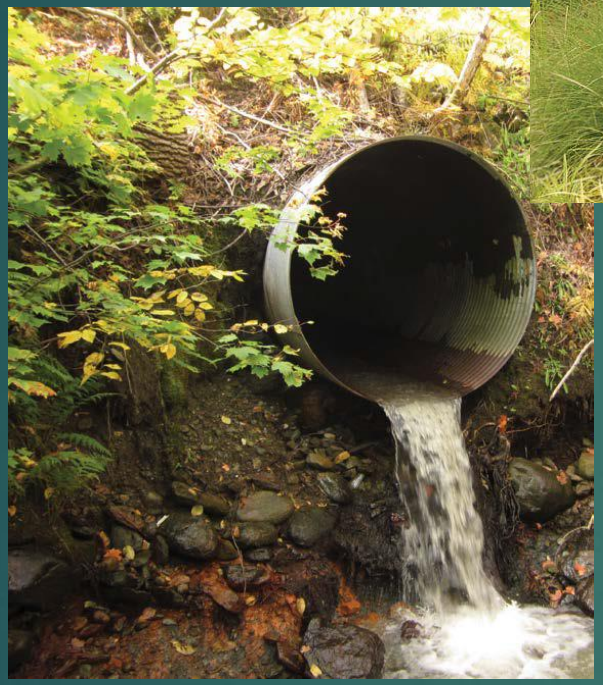
Resist Tidiness

- 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

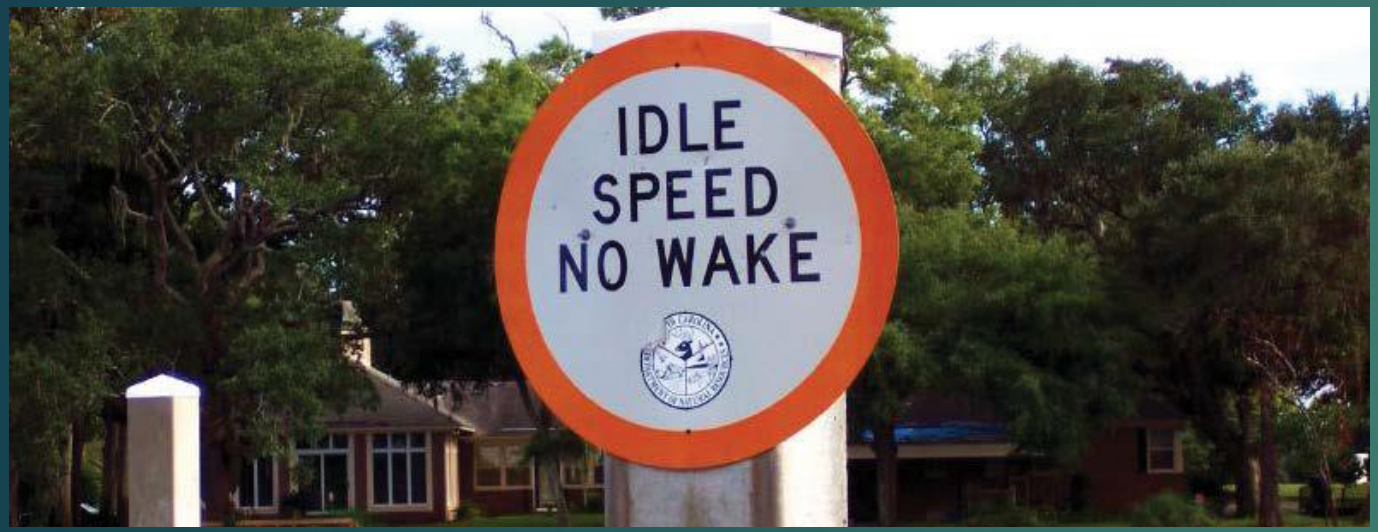




Reduce Damages from Waves, Wakes, and Currents

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

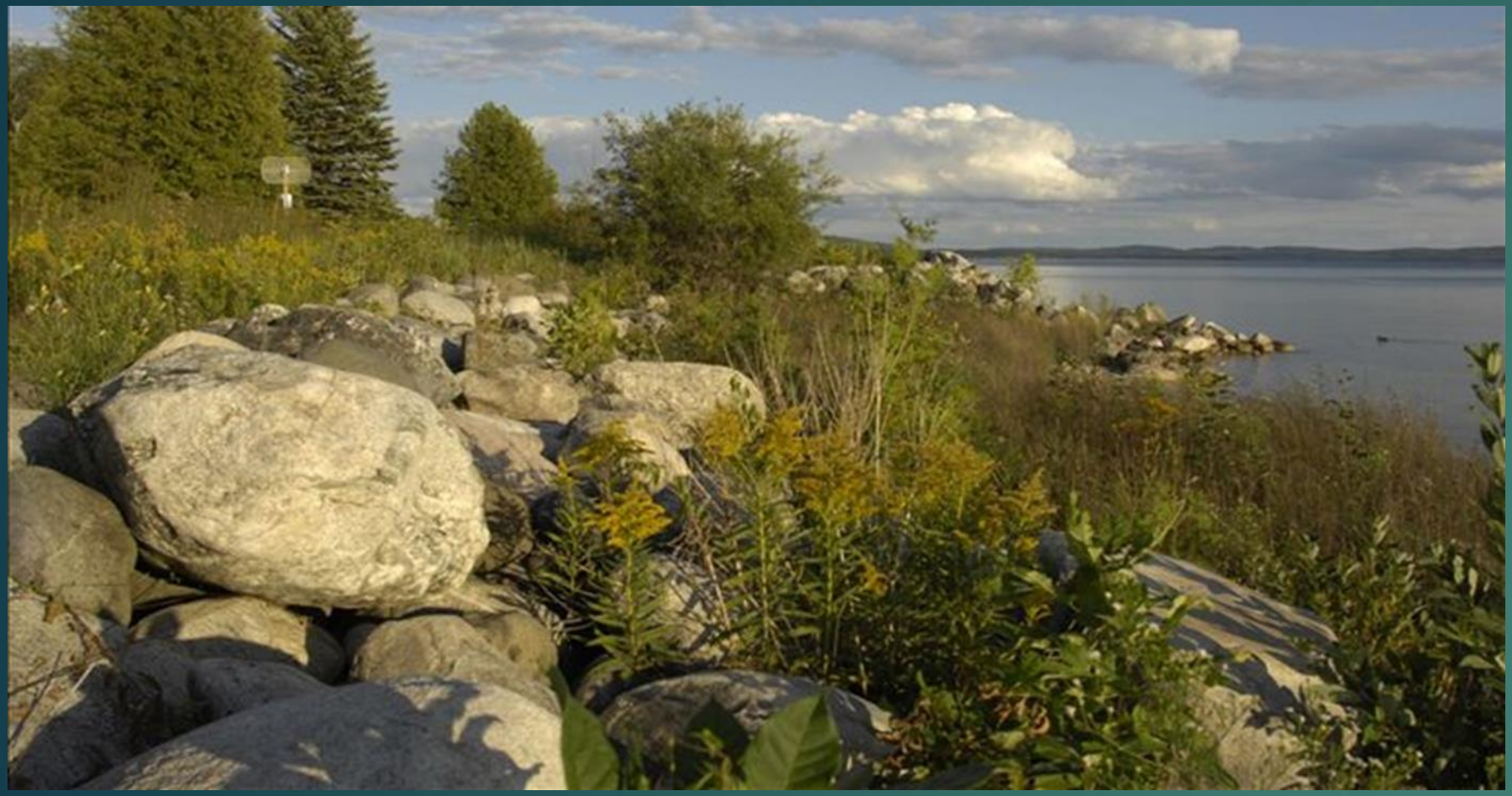
- Provide erosion control and protect upland land use
- Provide alternative options to hard structures, such as bulkheads and rip rap revetments
- Protect water by capturing polluted runoff
- Increase coastal greenery
- Increase biodiversity of habitats
- Minimize cost over life span of shoreline stabilization

Shoreline Restoration

Game of Stones

Detroit Riprap

Layered Stones & Vegetation



Traditional Landscaped Shore Zone

A Precarious Building Lot!

We're Making Beach Front 52

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!

Concrete Rubble Anyone?

Hodge Podge

Beautiful House, But……


Ditto

Let the Next Owner Worry About It!


Well Done, Can You Help Me?

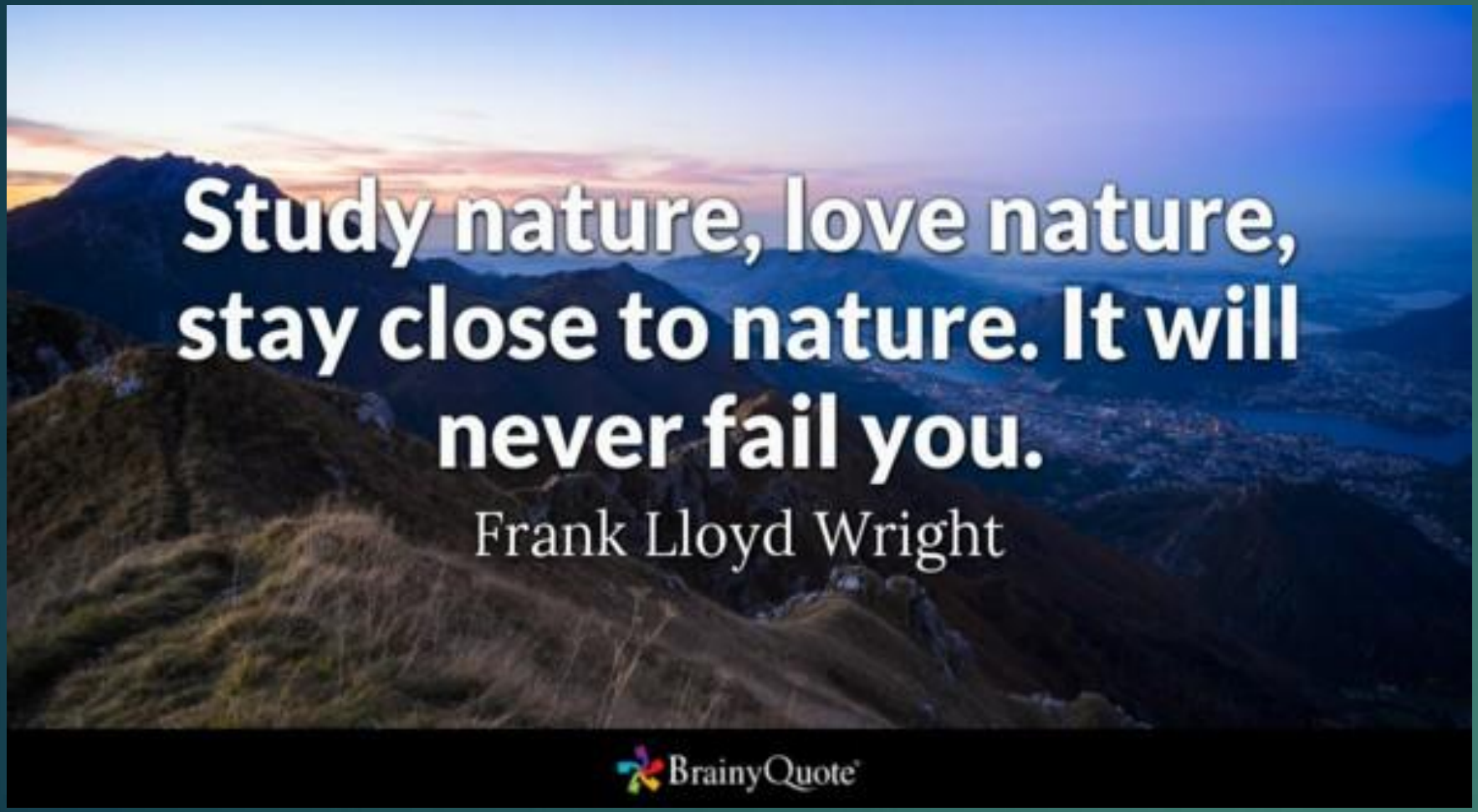
Shoreline Notes

- 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

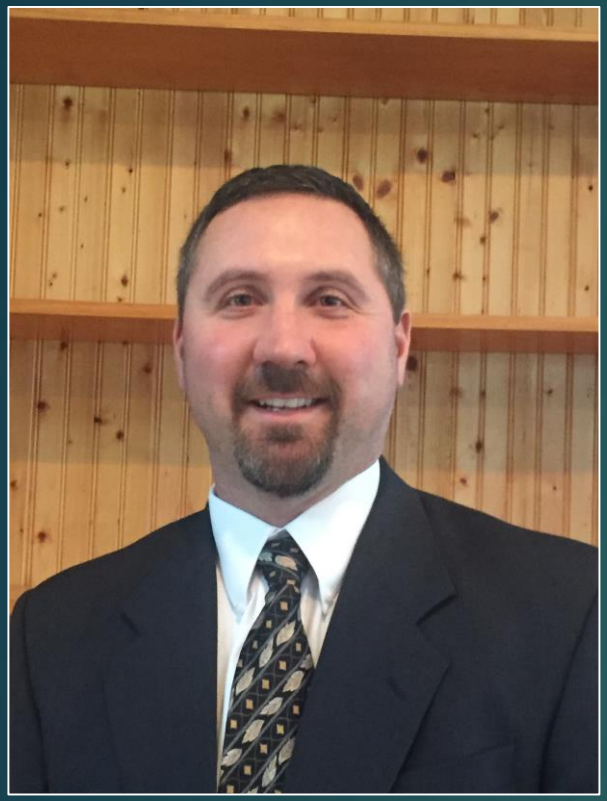
Restoration/Resiliency Grant Opportunities

- 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

Closing Remark



Your Presenter



References

- David L. Strayer. Managing Shore Zones for Ecological Benefits Handbook. Hudson River Sustainable Shorelines. www.hrnerr.org/Hudson-river-sustainable-shorelines
- Milone & MacBroom. March 2014. FirstLight Power's Shoreline Management Manual. A Homeowner's Guide to Shoreline Stabilization and Vegetative Buffer Zones.

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Questions & Answers