Edgewater resources

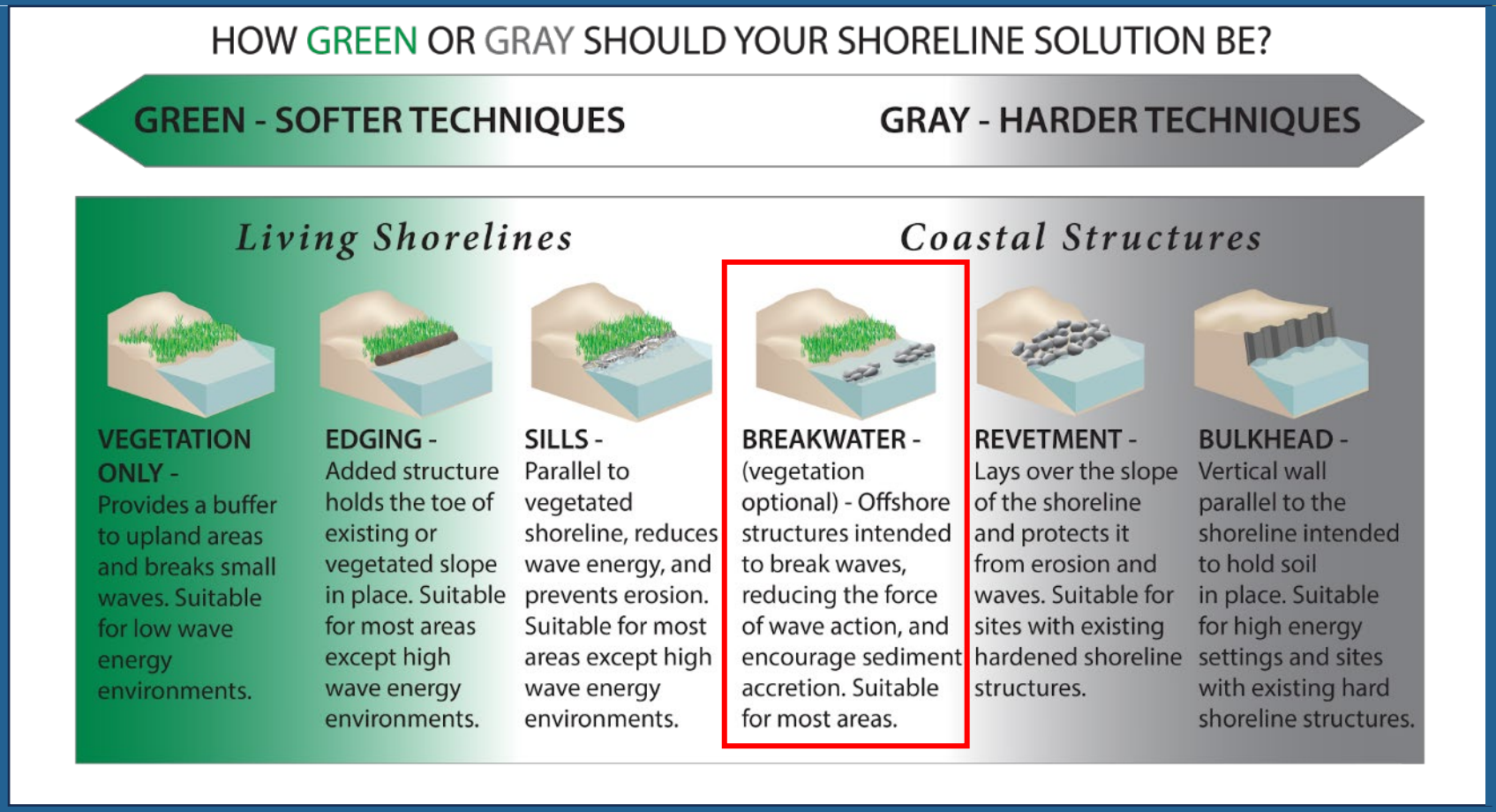
Waterfronts Worldwide

Wave Attenuation and Shoreline Strategies
Gray to Green

Jack Cox, PE, *BC.PE, BC.CE, BC.NE*
Alejandra Lira, CE

December 2023

Marrying Soft & Hard Techniques to Oppose Waves



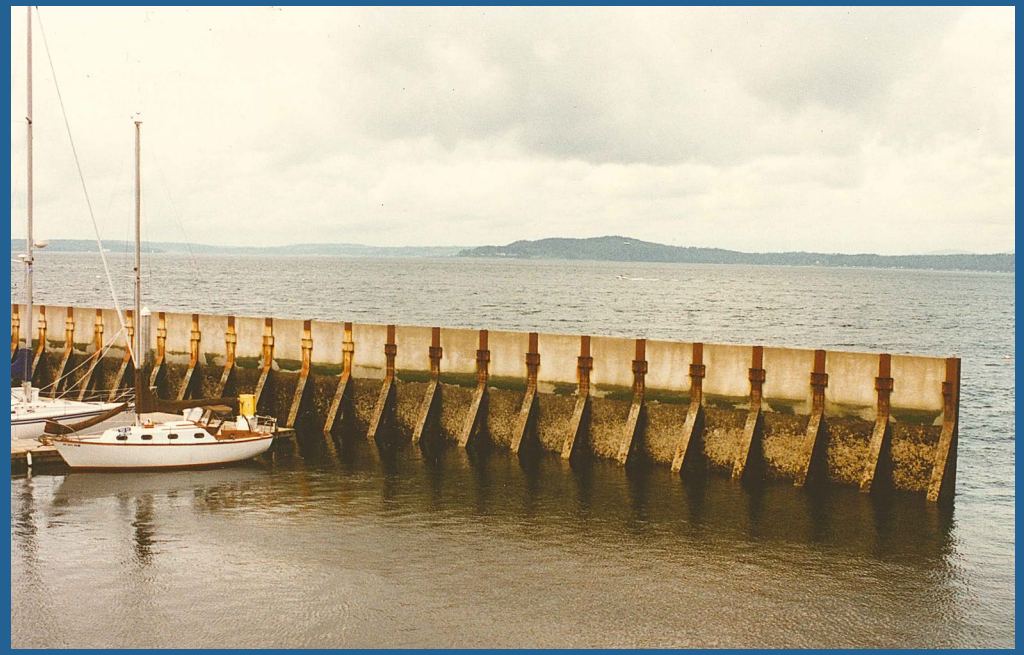
Types of Wave Protection

- Fixed Structures
- Floating Barriers
- Nature Based Strategies

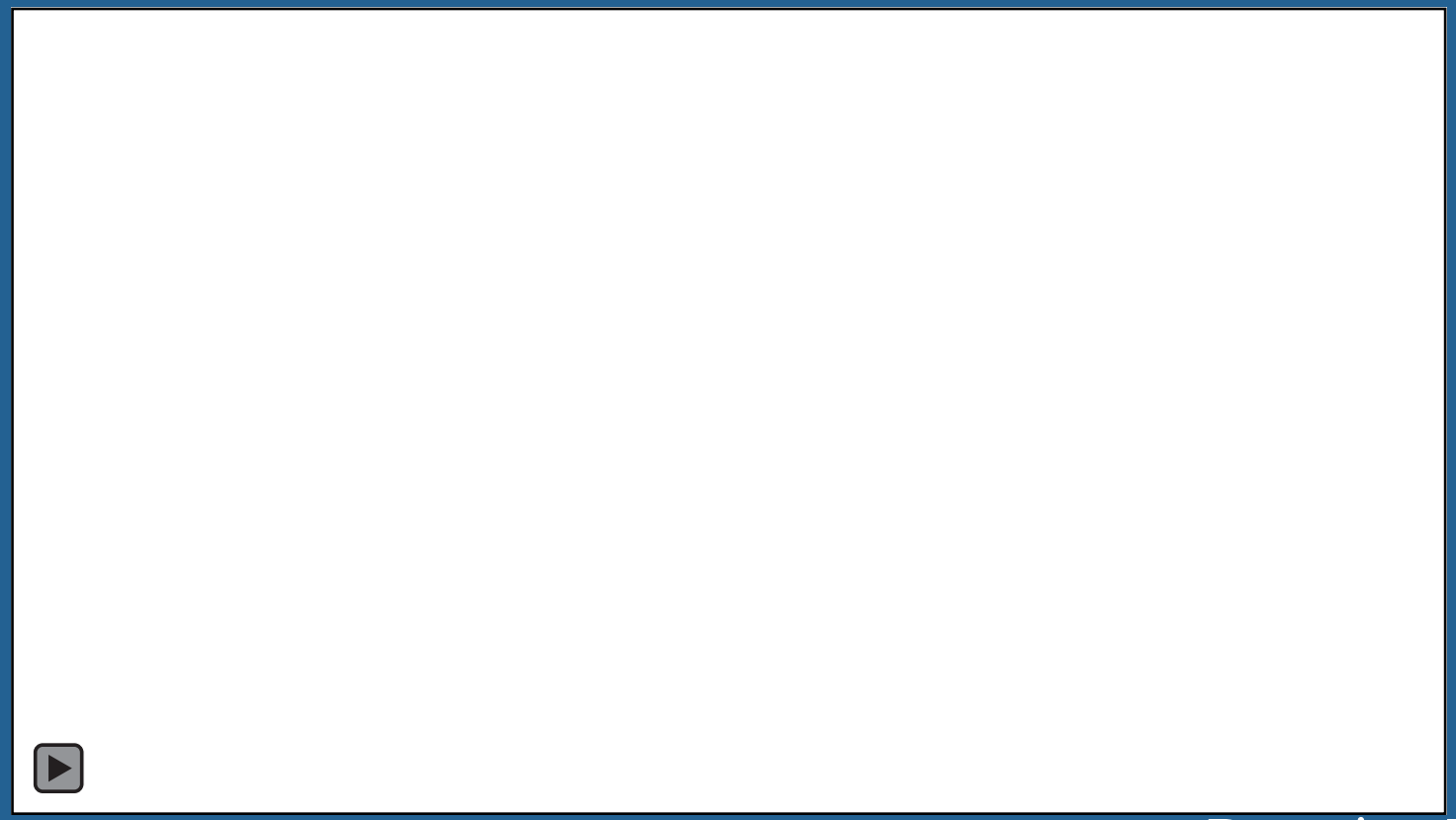
Fixed Breakwaters

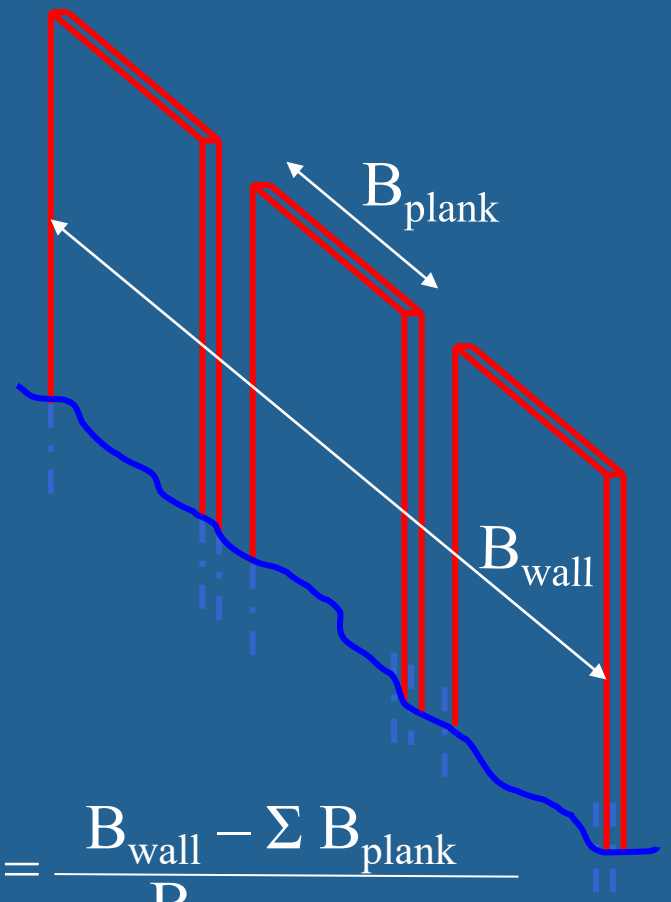
- Walls
- Cribs and caissons
- Rock piles

Marina Protection: Panel Breakwalls



Wave Transmission: Porous Walls



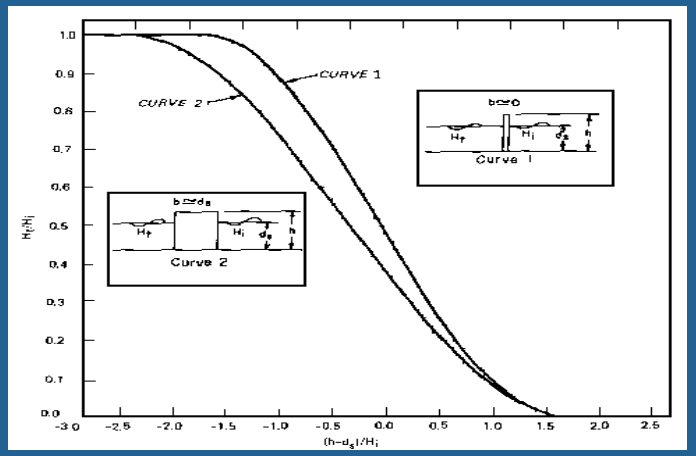


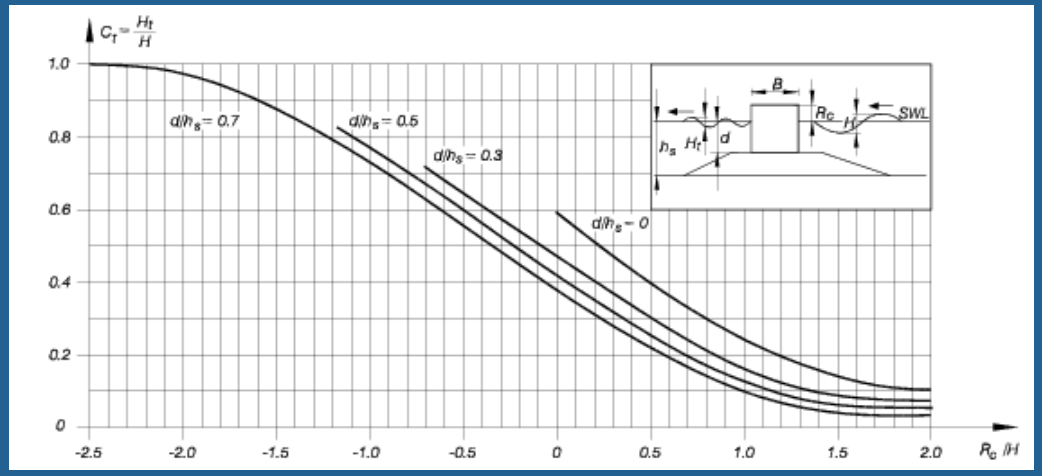
$$\text{Porosity, } P = \frac{B_{wall} - \Sigma B_{plank}}{B_{wall}}$$

Caisson and Crib Breakwaters

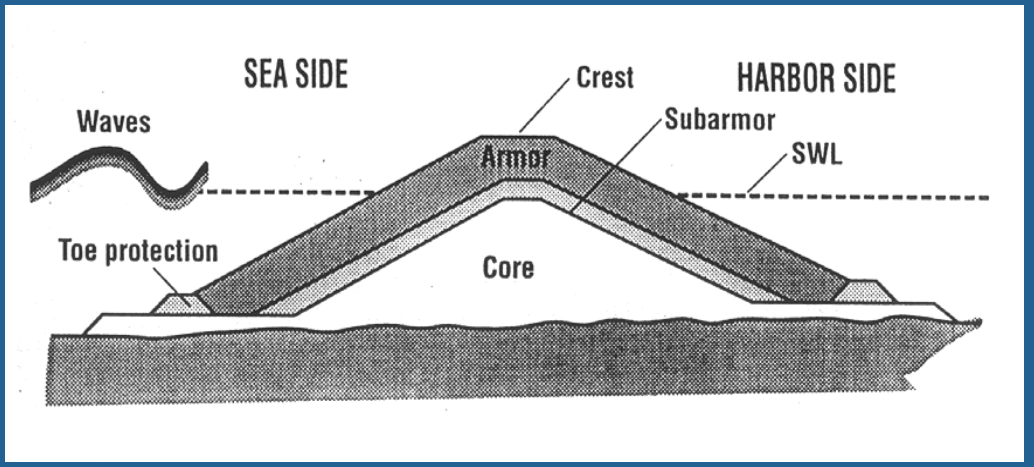
Wave Overtopping Transmission

- Height controls transmission more than breadth
- Sloped breakwaters transmit more than vertical

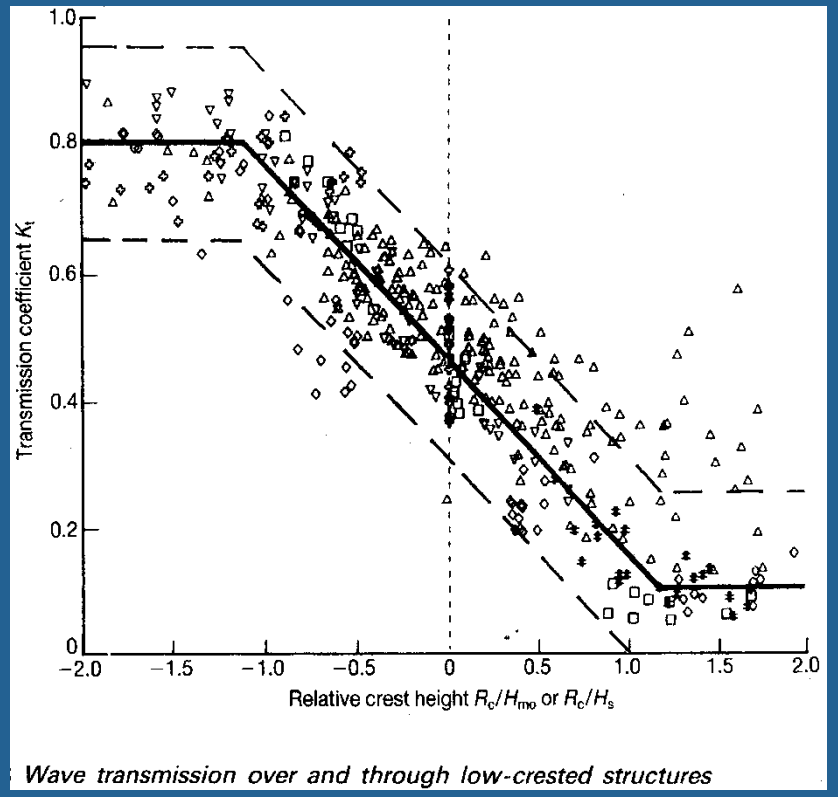




Wave Protection: Rubble Mounds

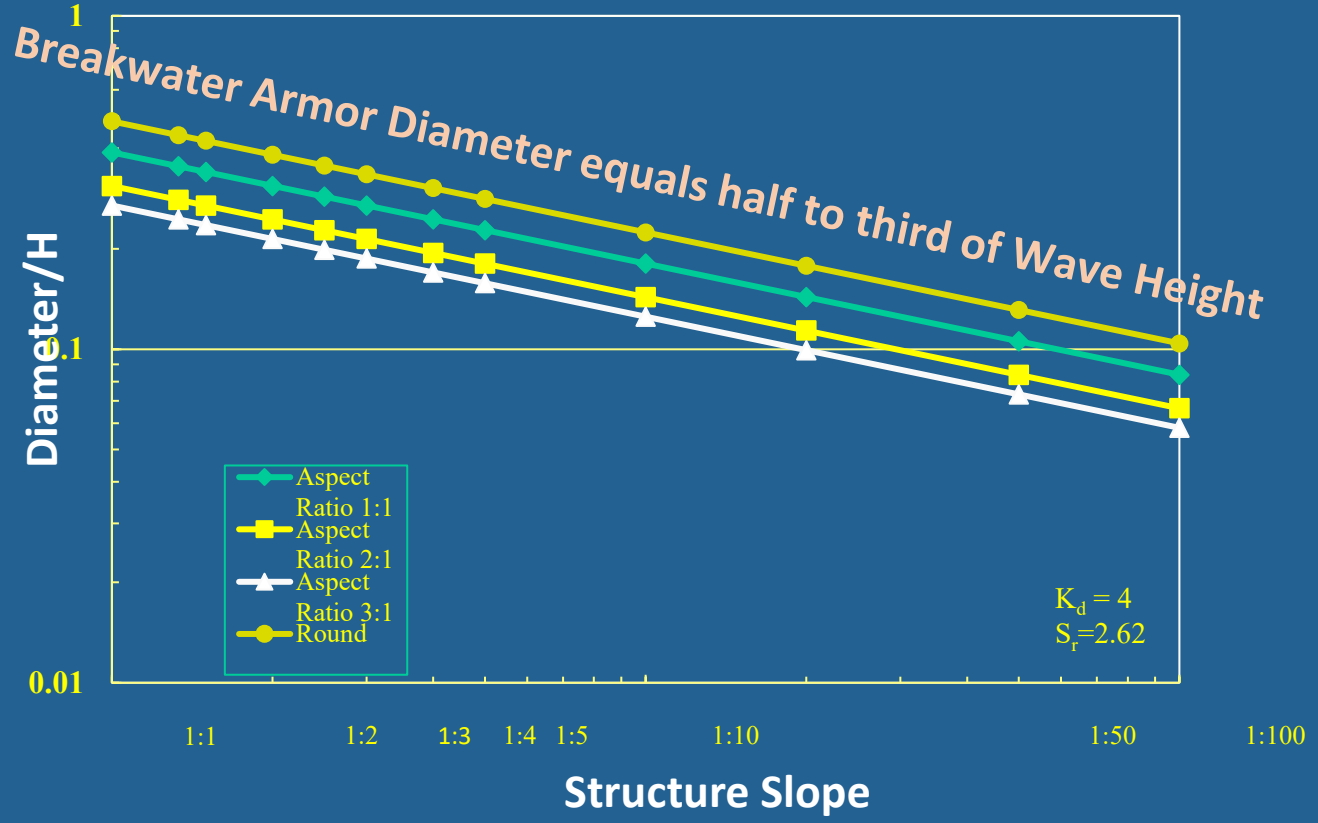


Wave Transmission for Armor Sizing for Rock Breakwaters



Wave transmission over and through low-crested structures

Hudson Armor Relation



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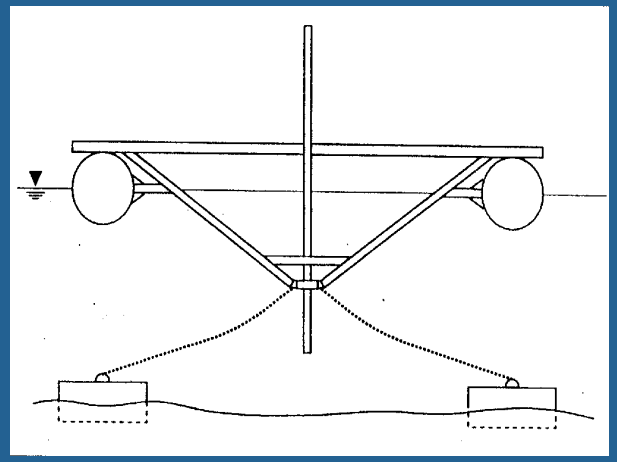
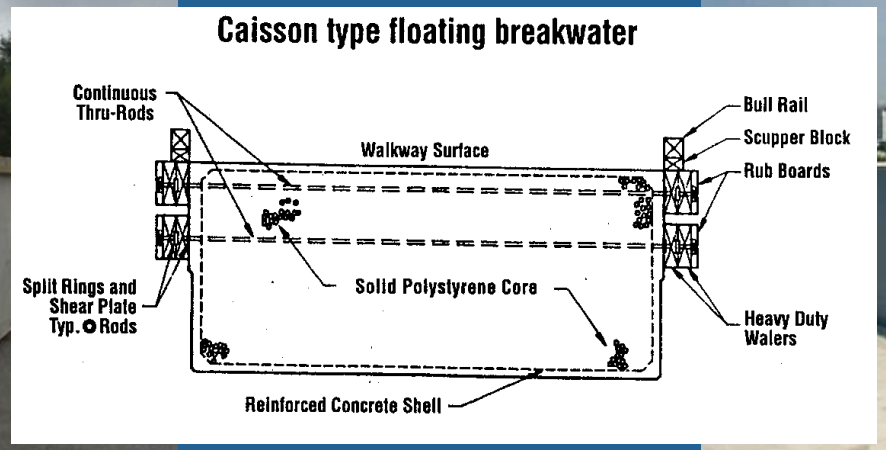
Floating Barrier Types (Wave Attenuators)

- Reflective
  - Panels
  - Prisms
- Absorptive
  - Matrix

Attenuator Types: Single Panel

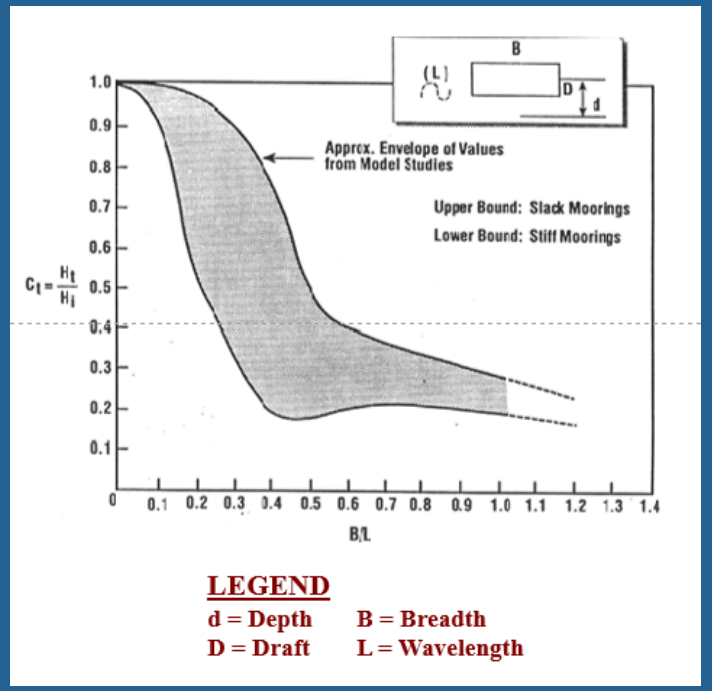


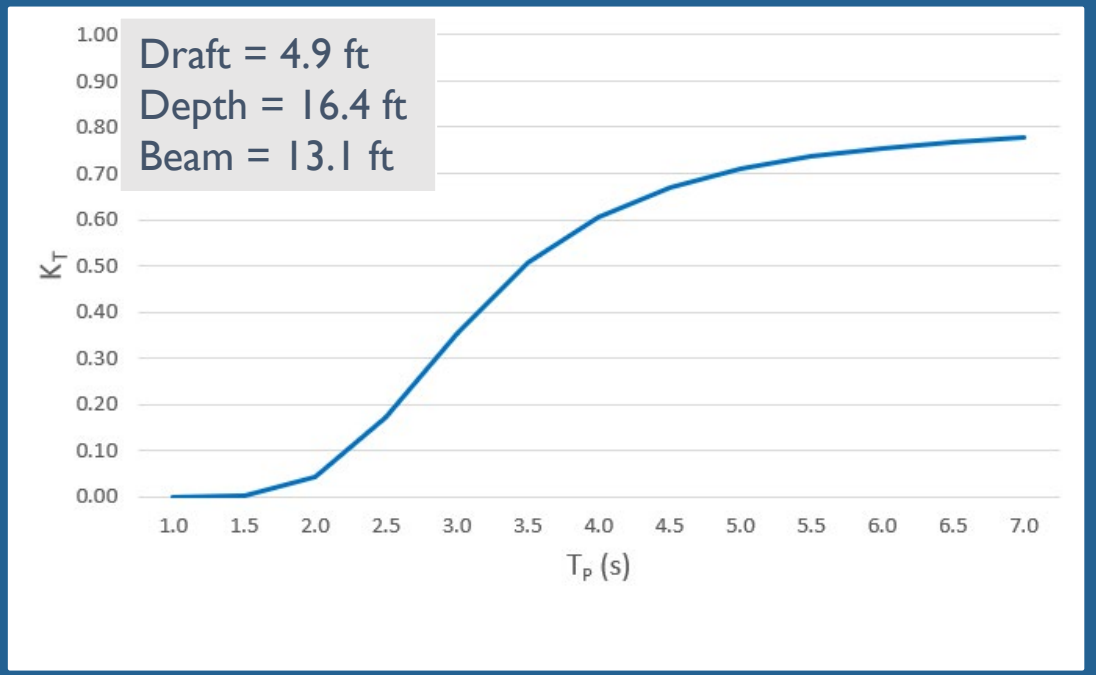
Wave Attenuator: Prisms



Attenuator Types: Double Fence (Pi)

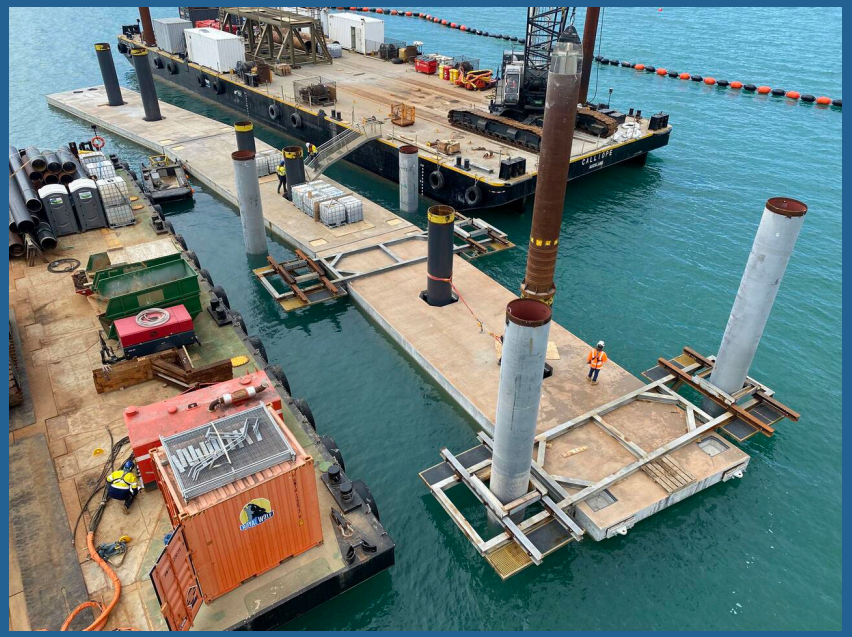
Typical Floating Barrier Wave Defense Performance





Edgewater resources

Wave Attenuator for Longer Periods



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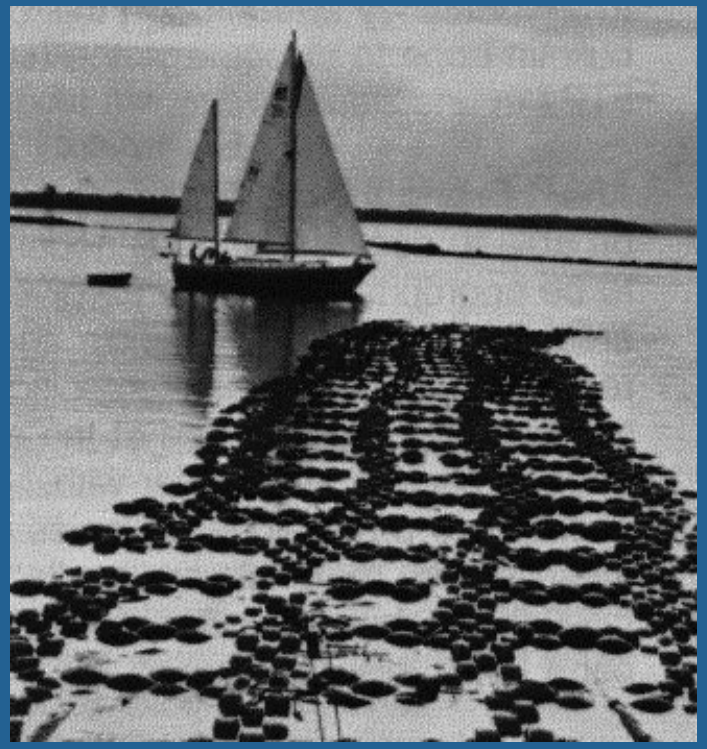
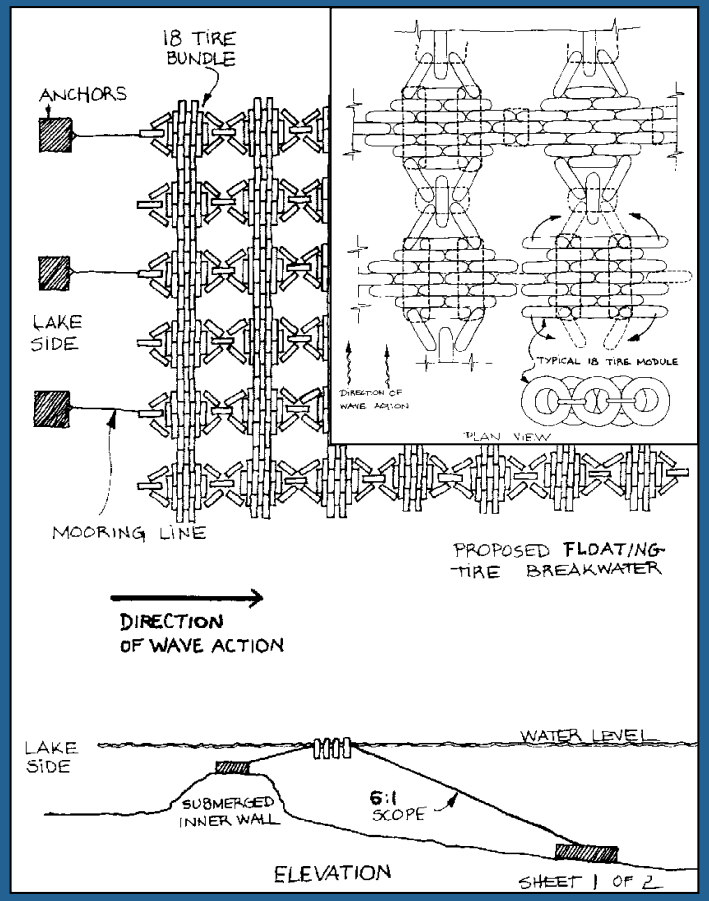
Wave Attenuator: Absorptive

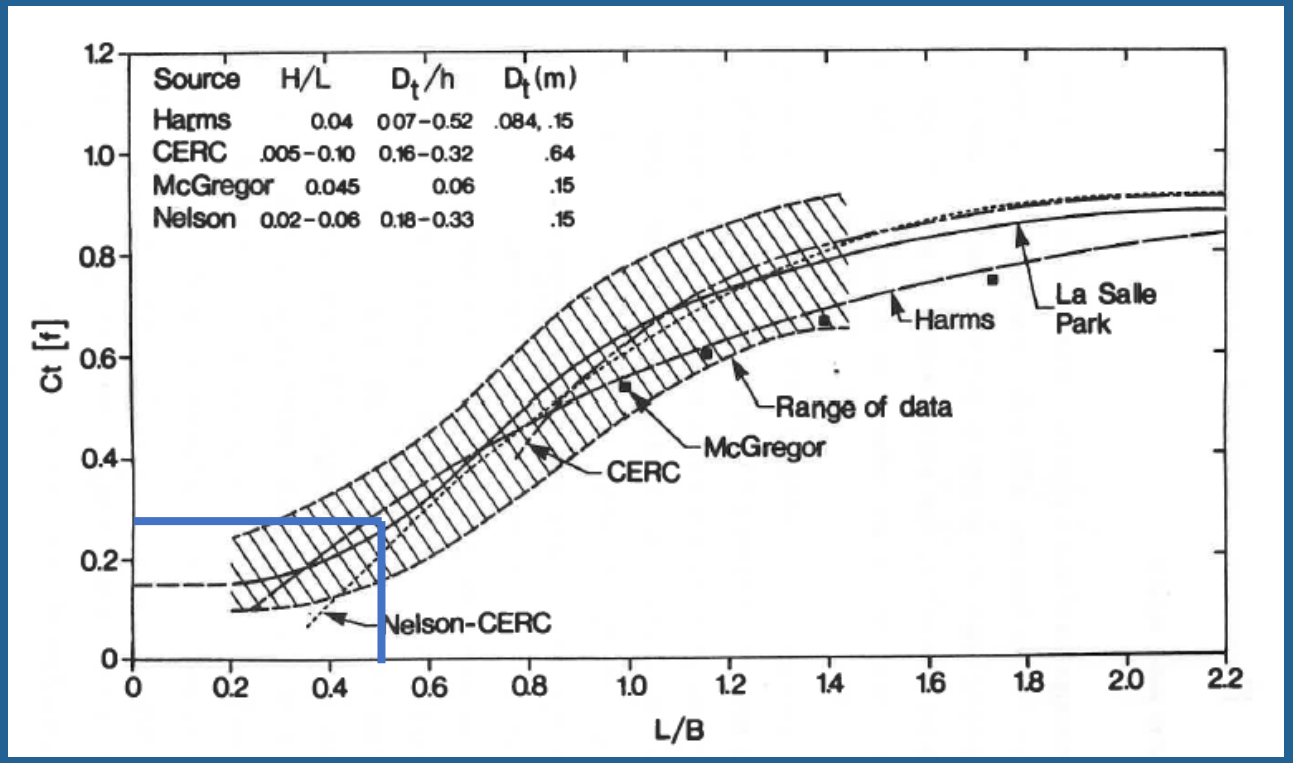




Floating Tire (Absorptive) Breakwater Performance

Significant Wave Height H_s (ft)	Wave Attenuation Coefficient C_t	
	Predicted	Measured
1.5	0.2	0.5
1.8	0.2	0.4
2.1	0.4	0.7
3.2	0.5	* 4/

FTB performance half as good as Mass Attenuator



For FTB to perform adequately, its breadth needs to be twice the wavelength or at least 200 ft wide.

Edgewater resources

Engineering with Nature Features

- Use Living armor for wave protection
- Integrate habitat forward ideas
- Emulate natural processes and shapes
- Finesse better outcomes by harnessing Nature

Softened Shoreline Edges Solutions in Variable Water Levels.

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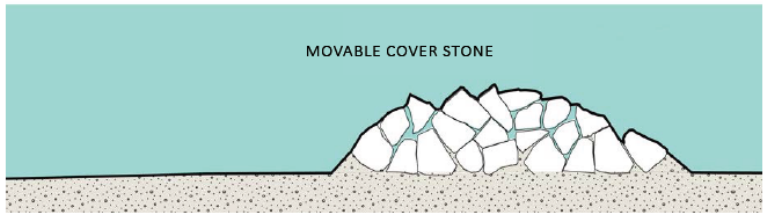
Submerged Eco-wave Dampening

INITIAL PLACEMENT

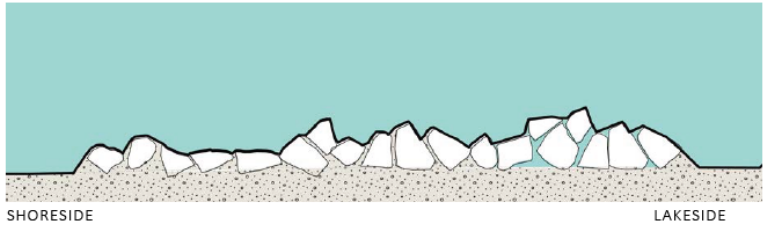
WATER LEVEL



Rocks (1.5'-3' Diameter) are placed in piles on lake bottom. Sand is placed around the mounds.

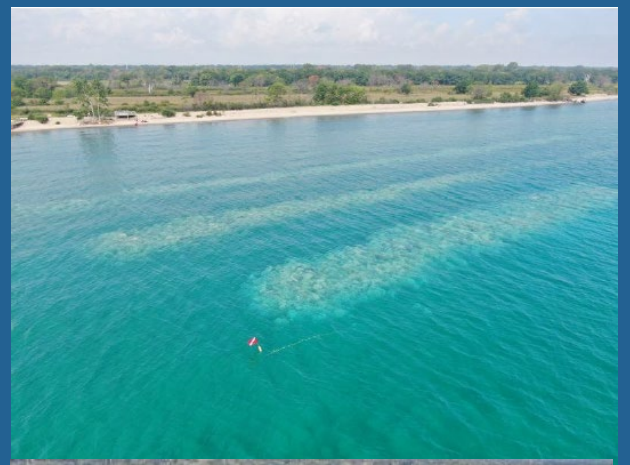
OVERTIME

WATER LEVEL



Eventually, rocks may be replaced towards the shore, creating an uneven spread of cover on top of material, and reducing wave energy.

Early monitoring data has shown fish already utilizing the rubble ridges for habitat



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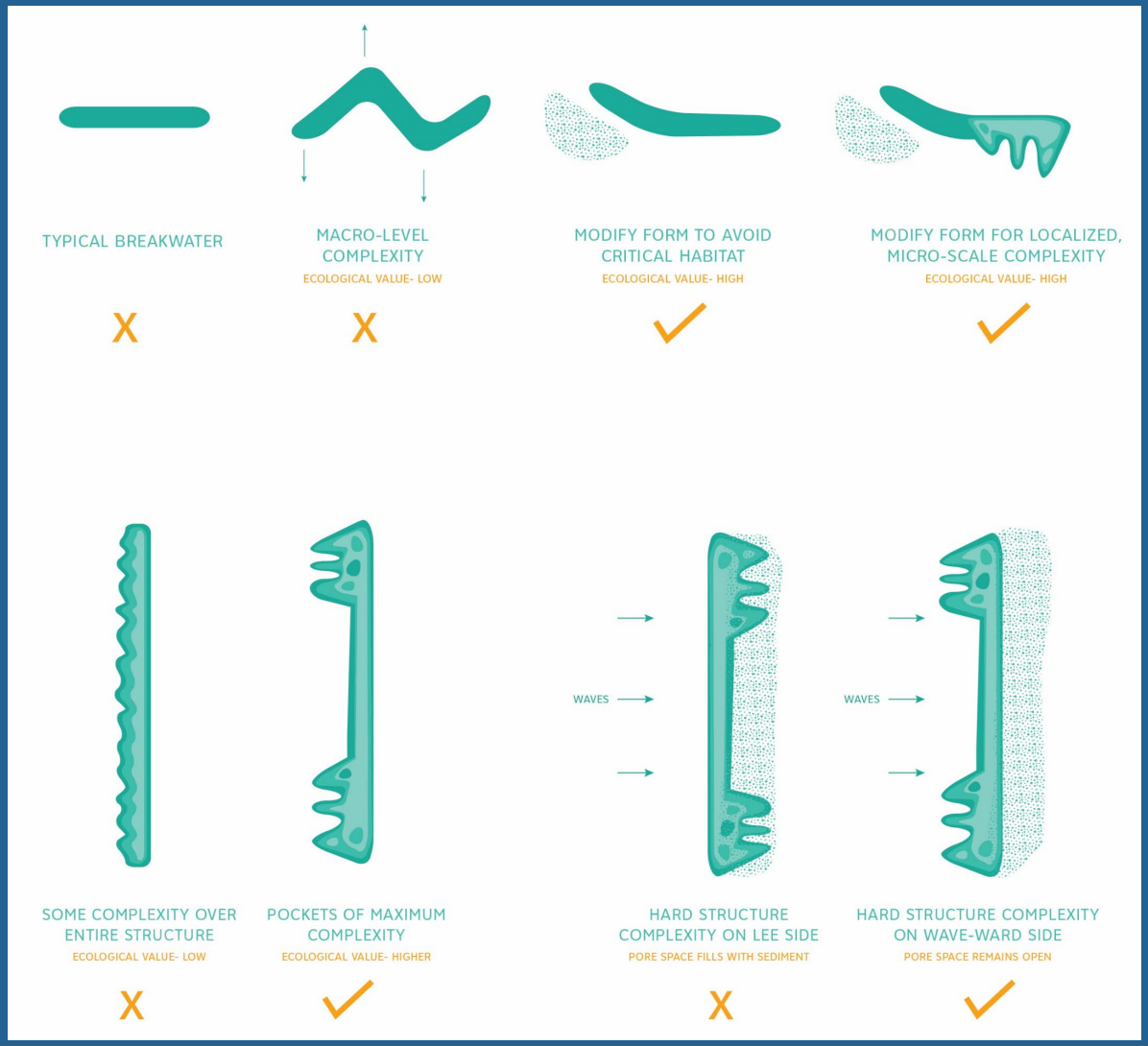
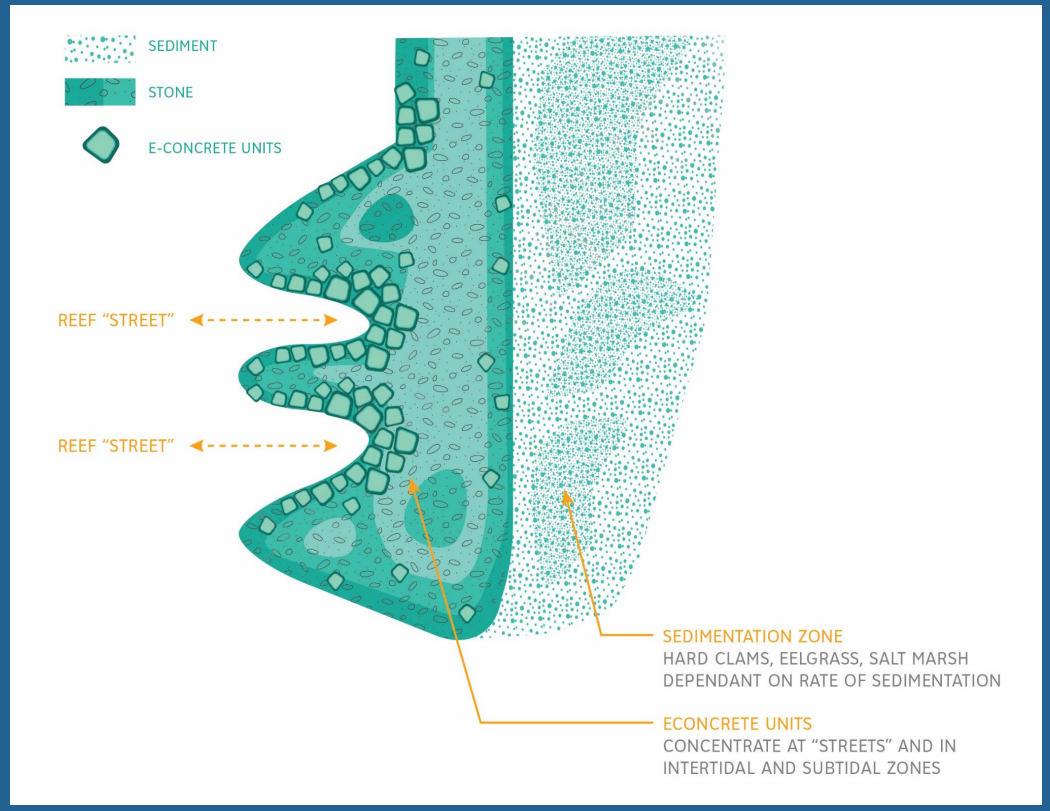
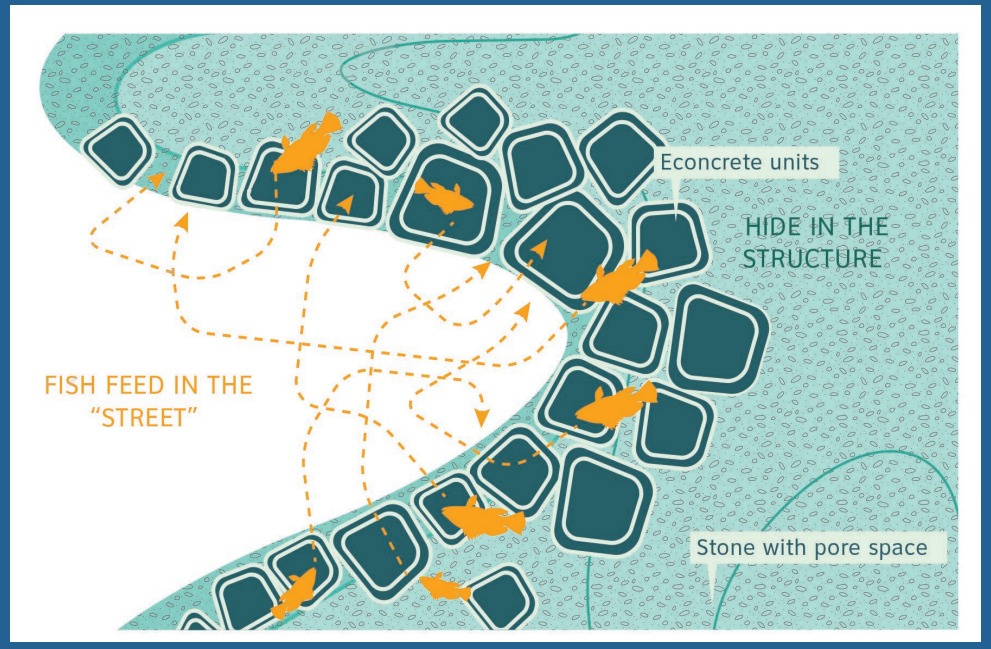
Theory of Ecology Based Breakwater Geometries



Introducing Reef Fingers and Fish Streets





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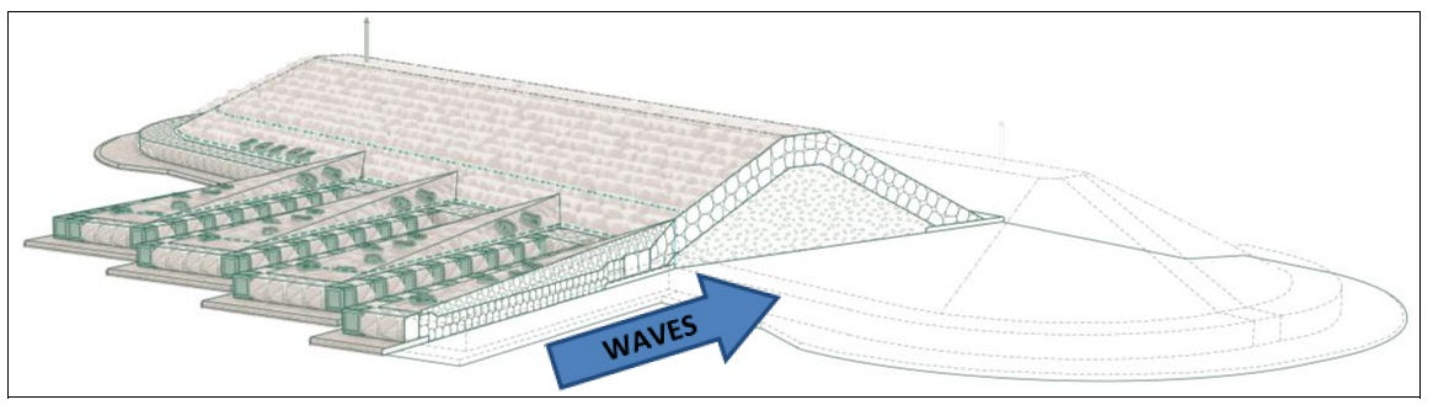
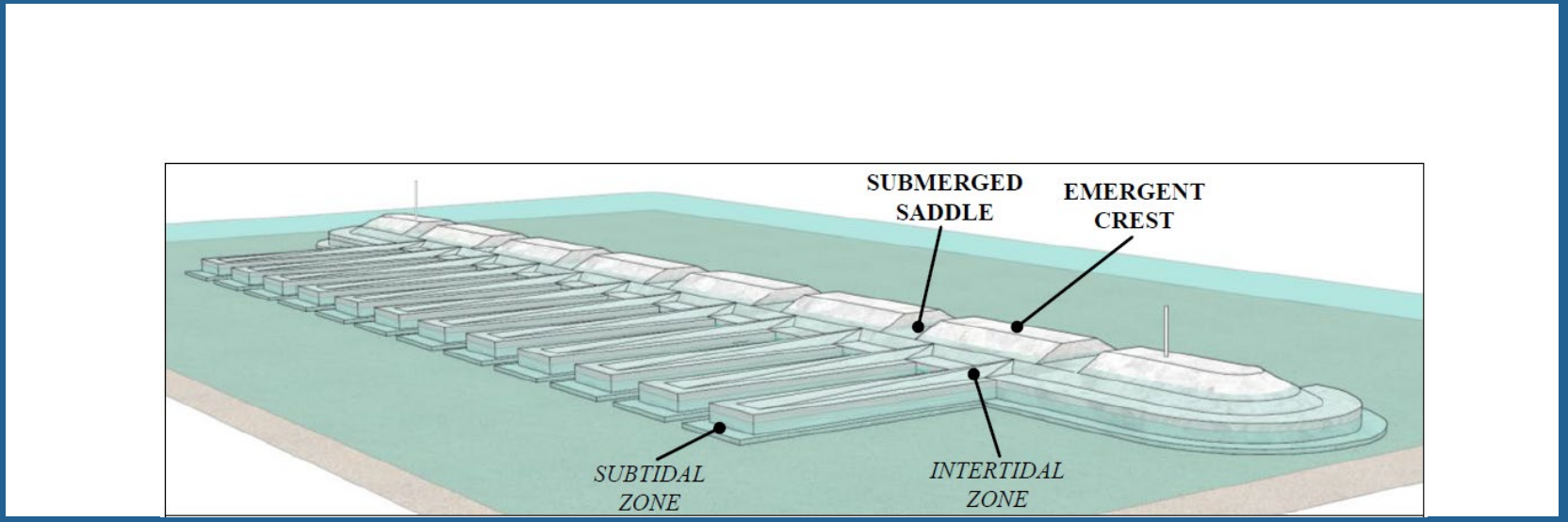
Depictions of Fish Fingers Added to a Breakwater





Marina Protection
Habitat Island Breakwater System
Ft Pierce FL

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Storm Protect and Passively Dredge Marina Basin by Using Custom Shaped Eco-Breakwater Islands

Pre-condition

Post-condition

Edgewater resources

The Design Solution: Curvilinear Overlapping Habitat Islands

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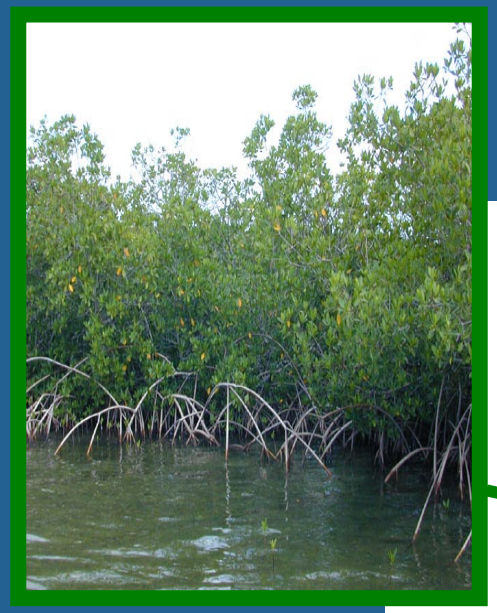
Create Multi and Diverse Habitats



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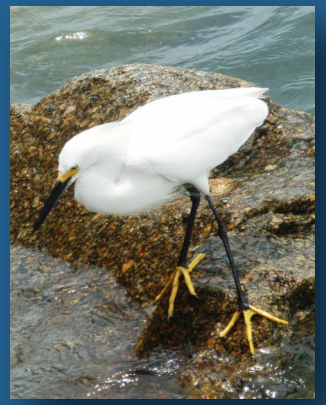
Ecological Achievement



Mosaic Habitat Creation

- Total island area = 15 acres
- Total habitat created = 21.7 acres
  - Oyster habitat = 1.3 acres
  - Artificial reef /riprap substrate = 6.3 acres
  - Mangrove communities = 1.5 acres
  - Coastal dune habitat = 2.2 acres
  - Seagrass recruitment = 8.1 acres
  - Shorebird habitat = 2.3 acres

Completed Habitat Island Protected Marina and Shoreline

2016 ASCE COPRI Project Excellence Award

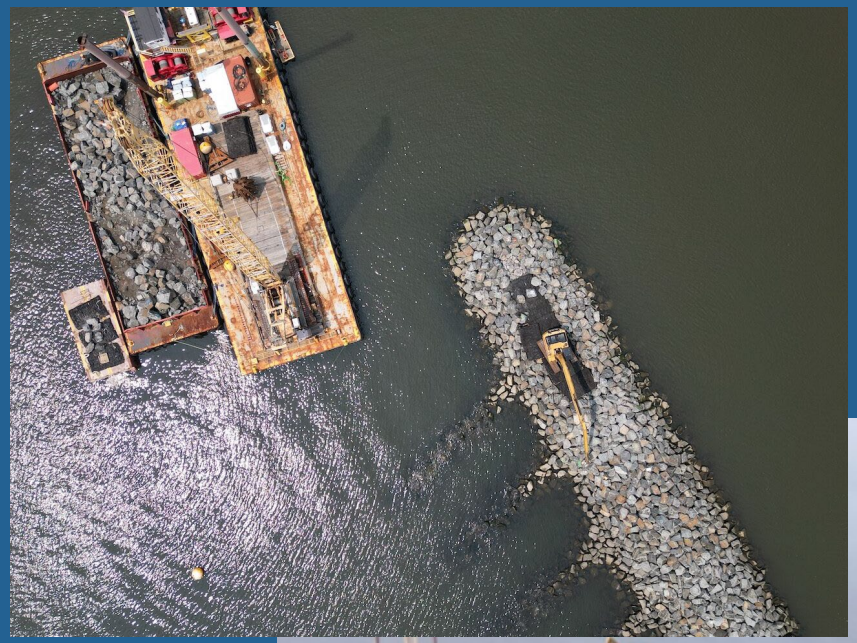
Total Cost of Island Breakwater System: $19.8 million

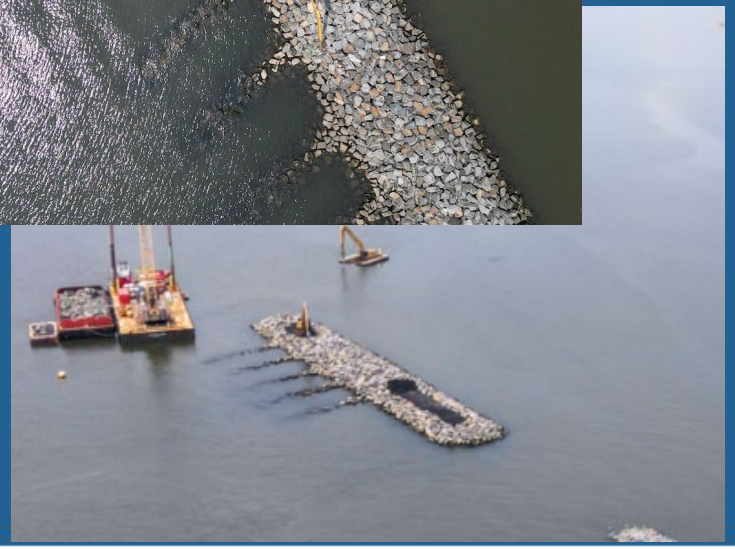
Edgewater resources

Atlantic Coast Hazard Reduction
"Living Breakwaters"
Tottenville, NJ

Edgewater resources

Living Breakwater Features





Note Fish Finger Appendages

Note armor shaped with imitation miniature tide pools

Shoreline Stabilization and Restoration Using Non-intrusive EWN Solutions Illinois Beach State Park Zion, IL

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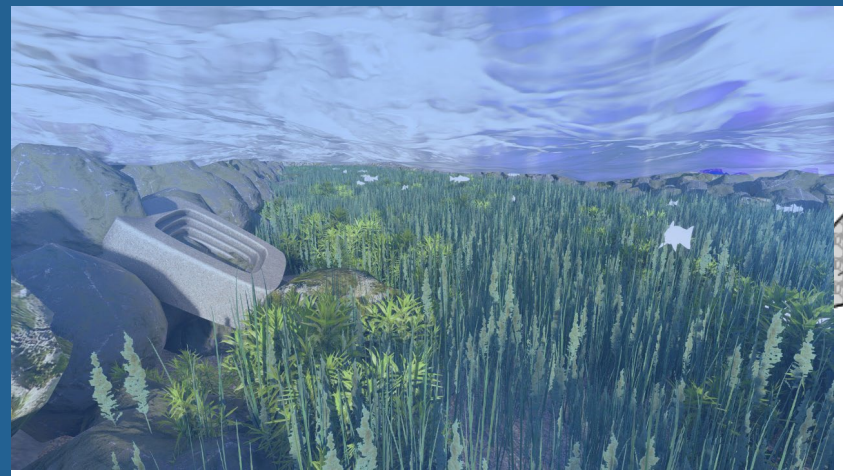
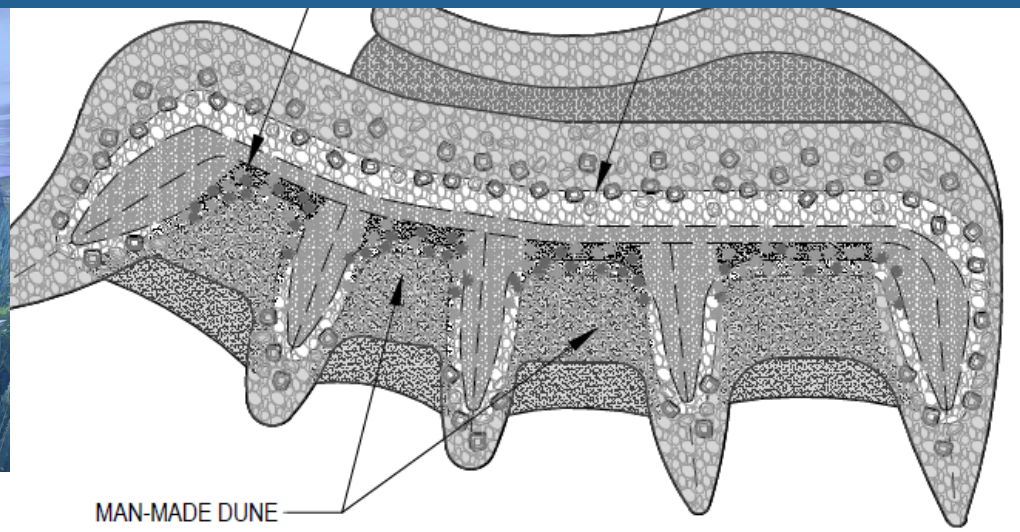
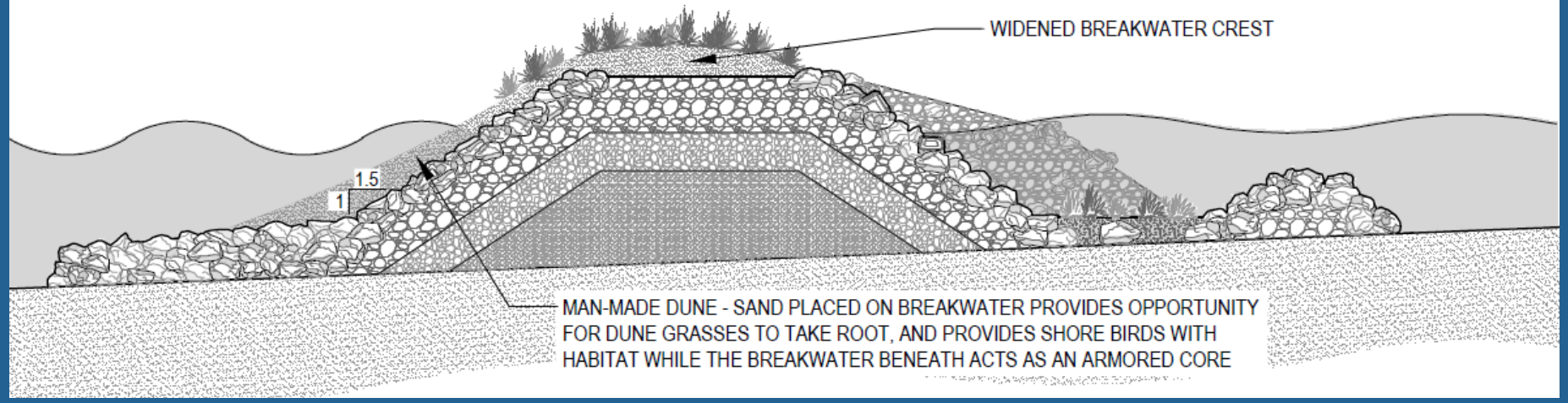
Aquatic/Intertidal Habitat Creation



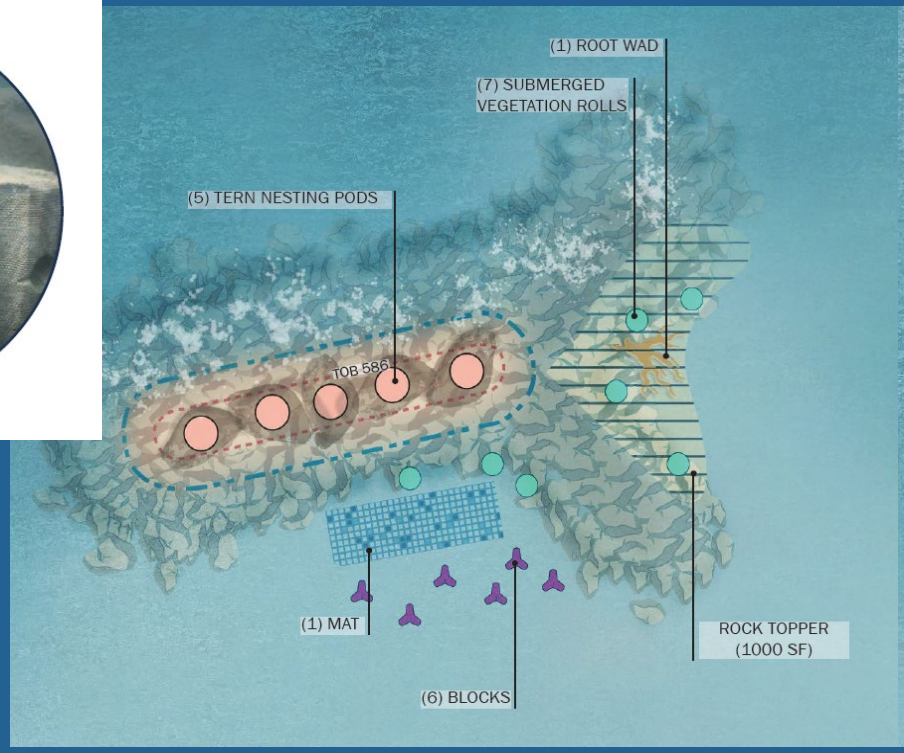


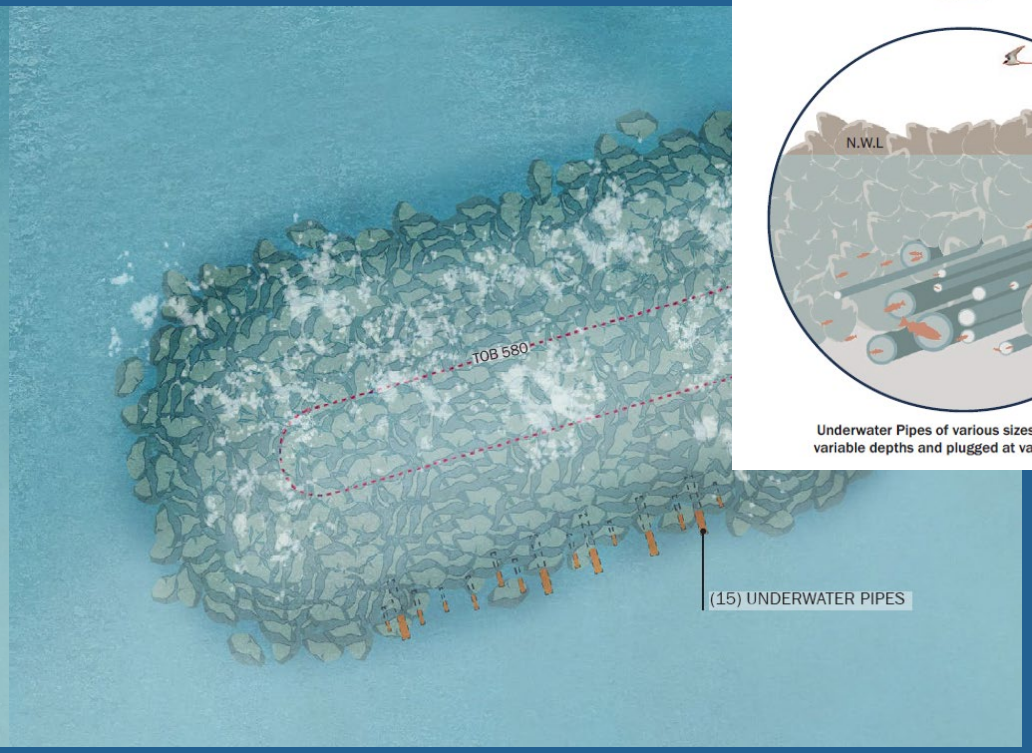


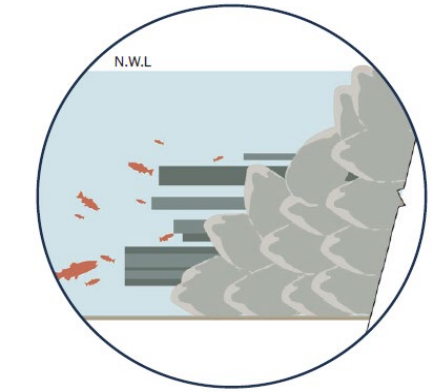
Aquatic Habitat Features

Concrete Mats

Concrete Blocks







Underwater Pipes of various sizes, organized at variable depths and plugged at variable lengths.

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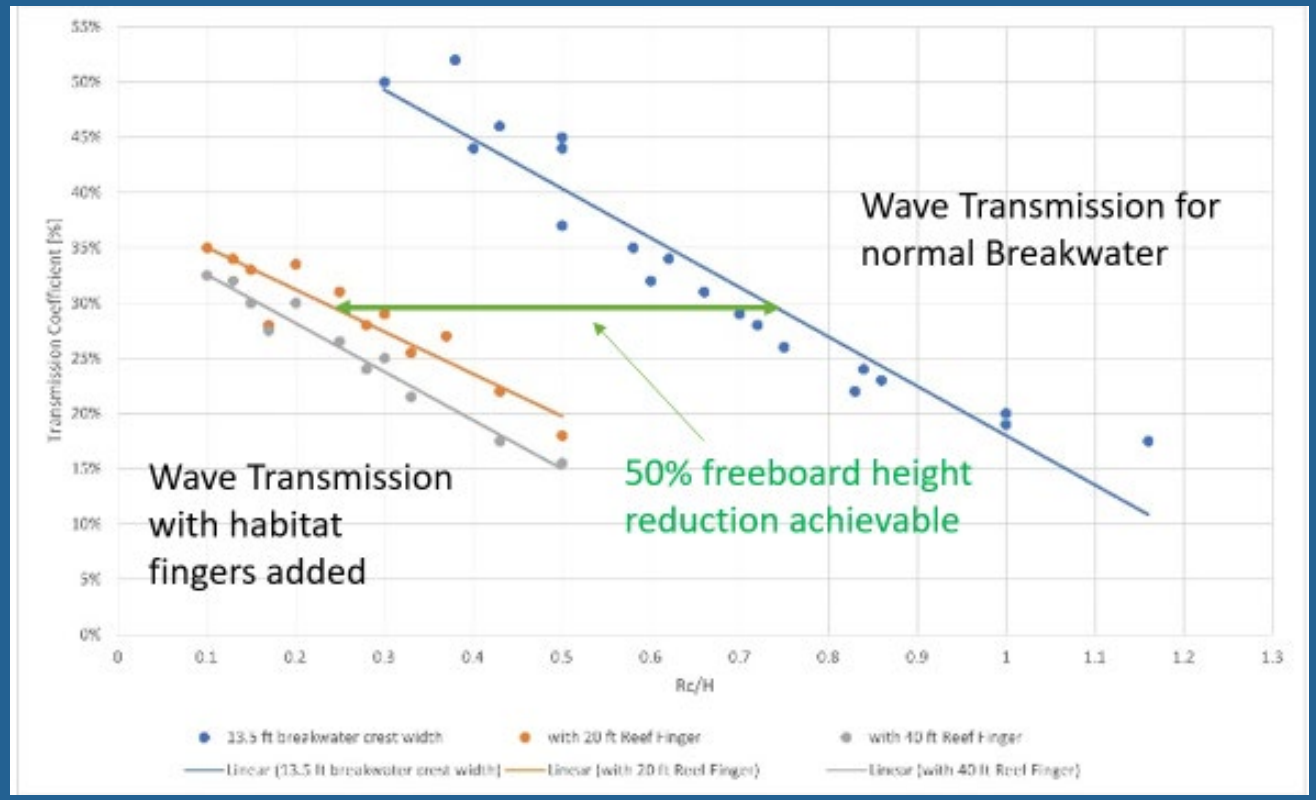
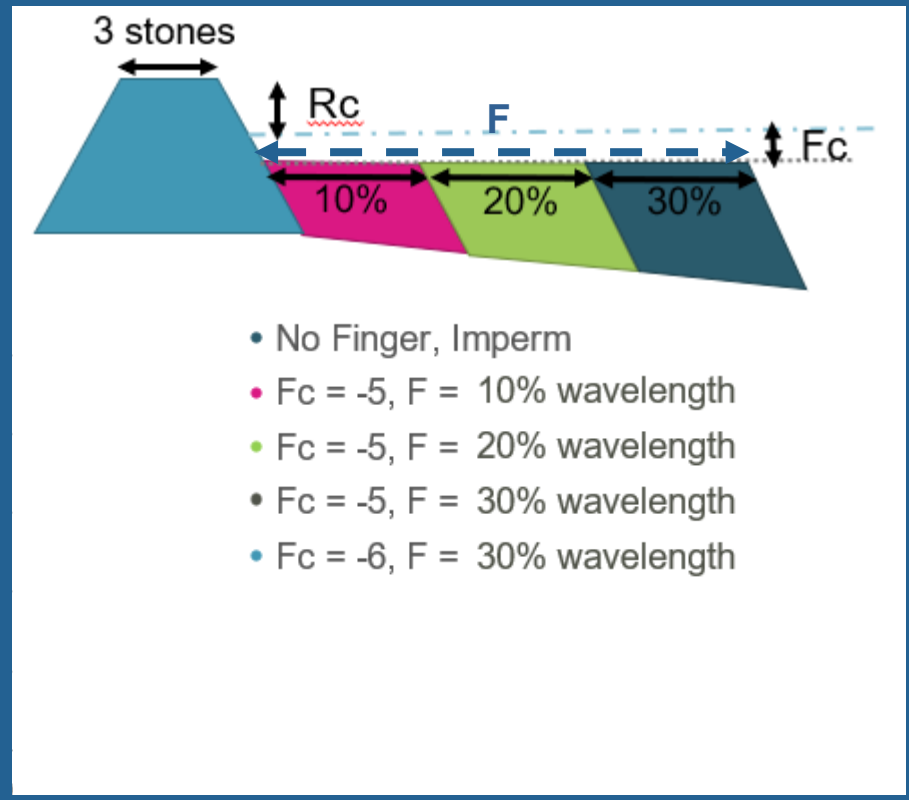
Avian Habitat Features

Obverse Fish Fingers Reduce Needed Height of Breakwater





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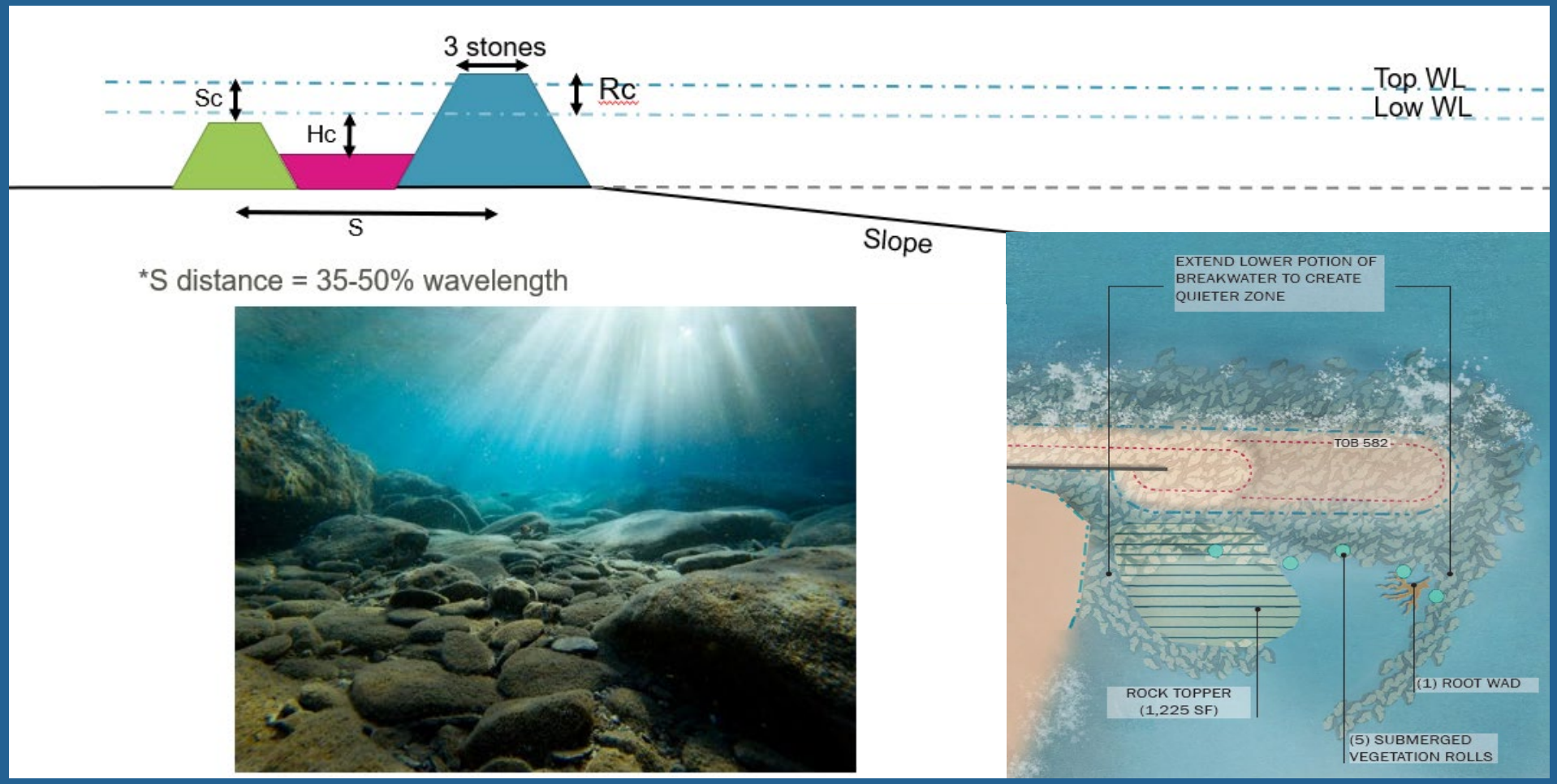
Lee Side Habitat Pool Concept



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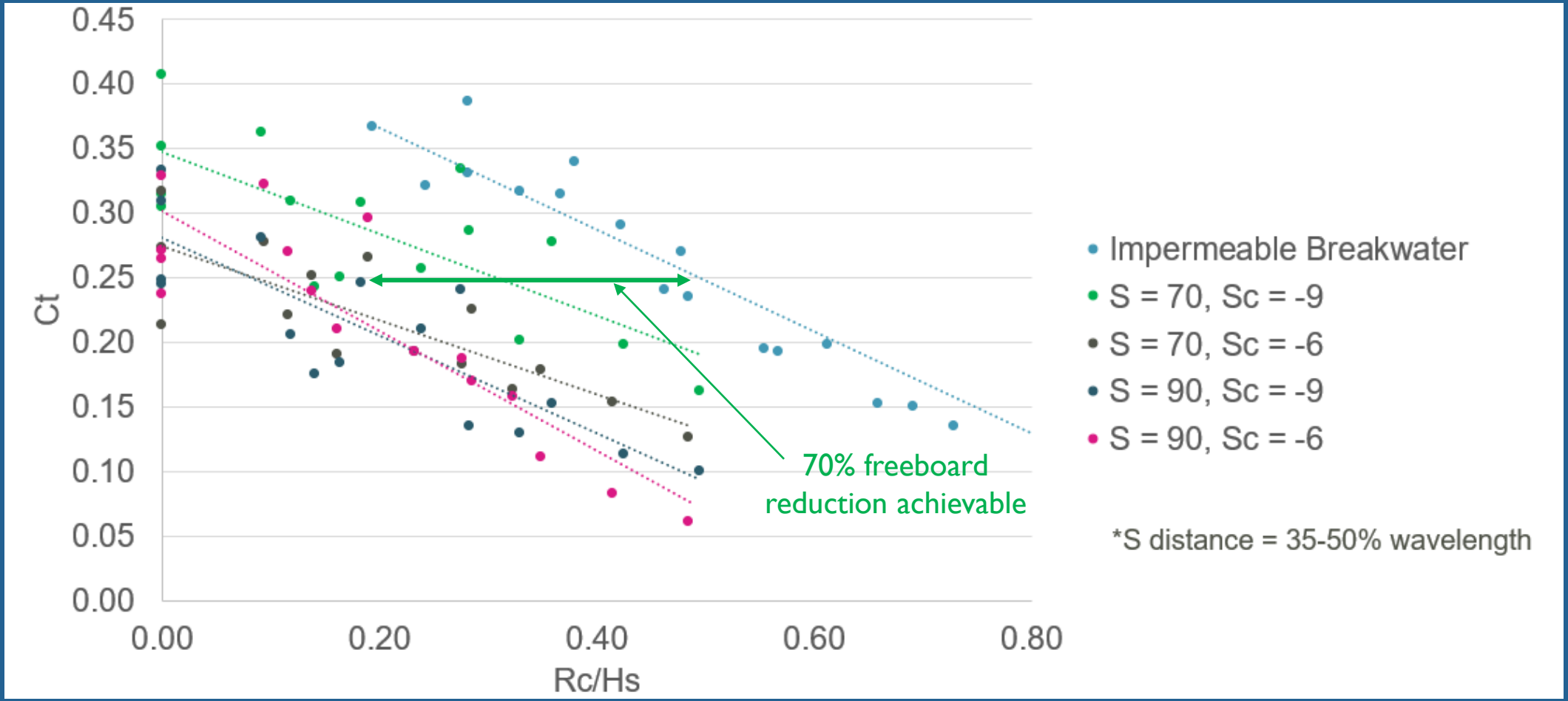
Lee Side Habitat Pool Improves Marina Tranquility



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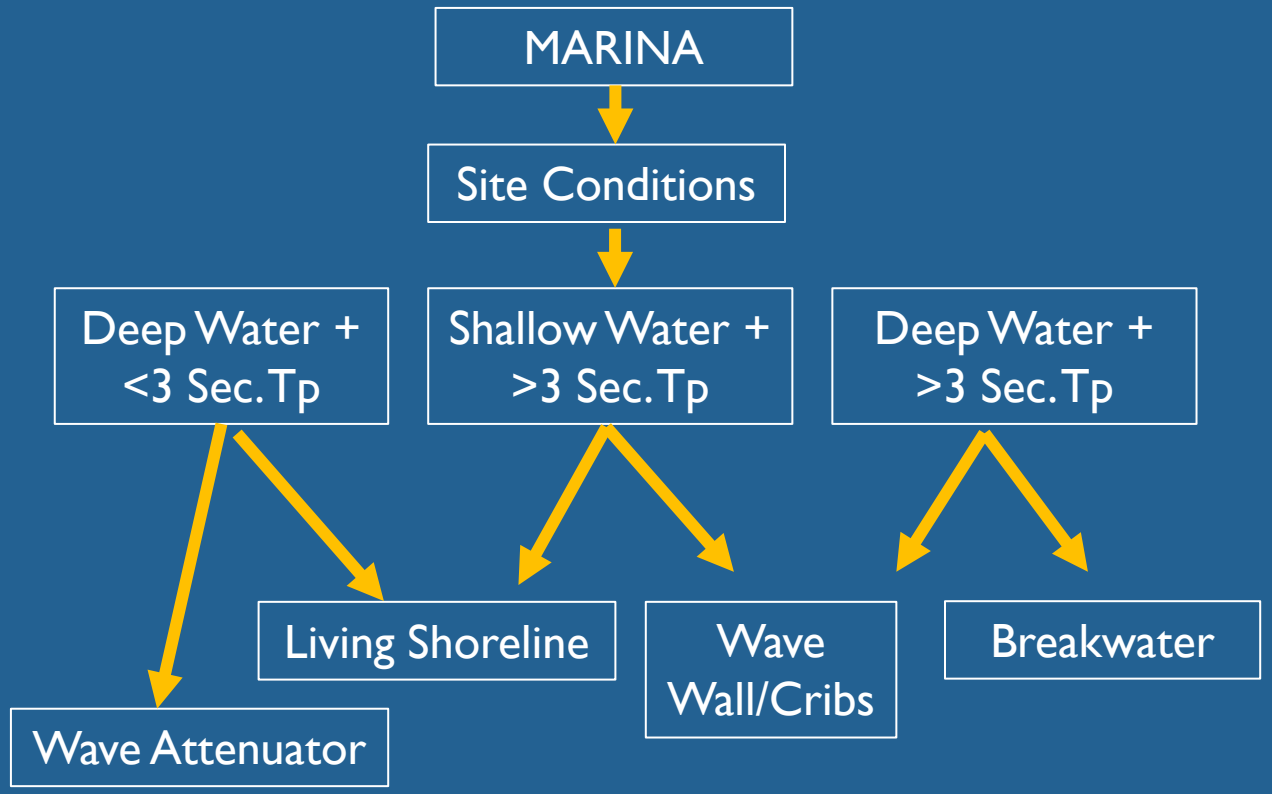
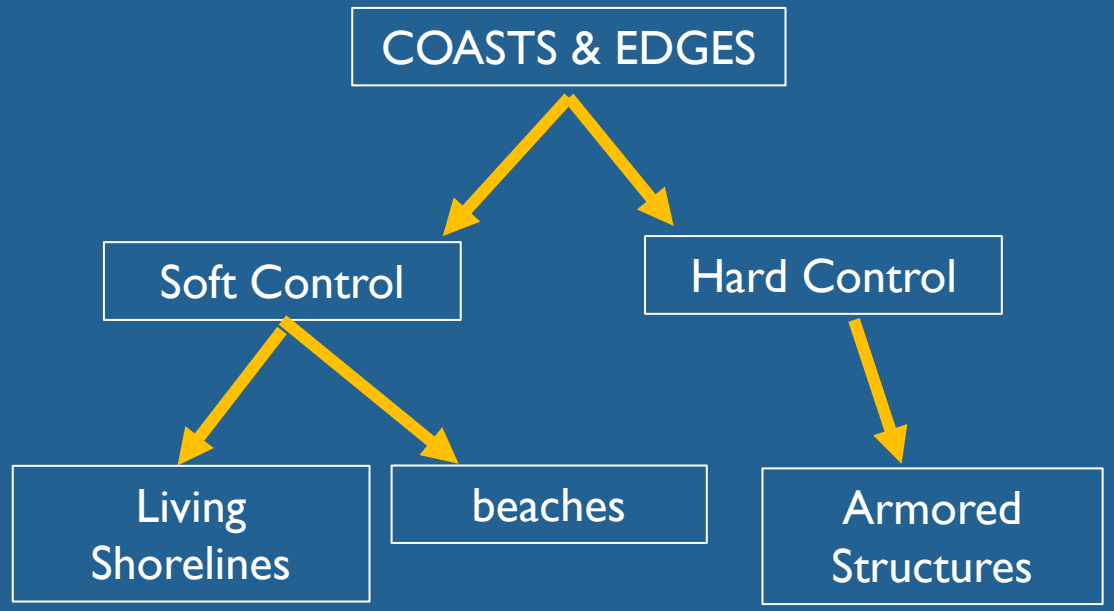
What are you trying to protect?





Consider your options.
Traditional approaches to shoreline and harbor protection may often be replaced with eco compatible alternatives offering:
similar costs,
equal performance,
better aesthetics,
regulatory preference,
self sustainability
natural resilience by emulating actual physical processes versus forced conditions

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Waterfronts Worldwide

Wave Attenuation and Shoreline Strategies
Gray to Green

Jack Cox, PE, *BC.PE, BC.CE, BC.NE*
Alejandra Lira, CE

December 2023