Natural and Nature-Based Solutions for Shoreline Resiliency

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What is NNBF?

- Natural and nature-based features
- Use natural or nature-based principles to solve societal problems while maintaining ecological integrity
- Most common uses are for flooding and erosion control
- NNBF integrates ecology and engineering to create systems that are functional yet ecologically friendly





What is a *resilient* natural shoreline?

- Has physical and biological characteristics that create stability under a variety of climate-driven conditions
- This includes both low and high water conditions
- Maintains a stable form and function (this does not mean *unchanging*)
- Dynamic stability





What makes a shoreline naturally resilient?

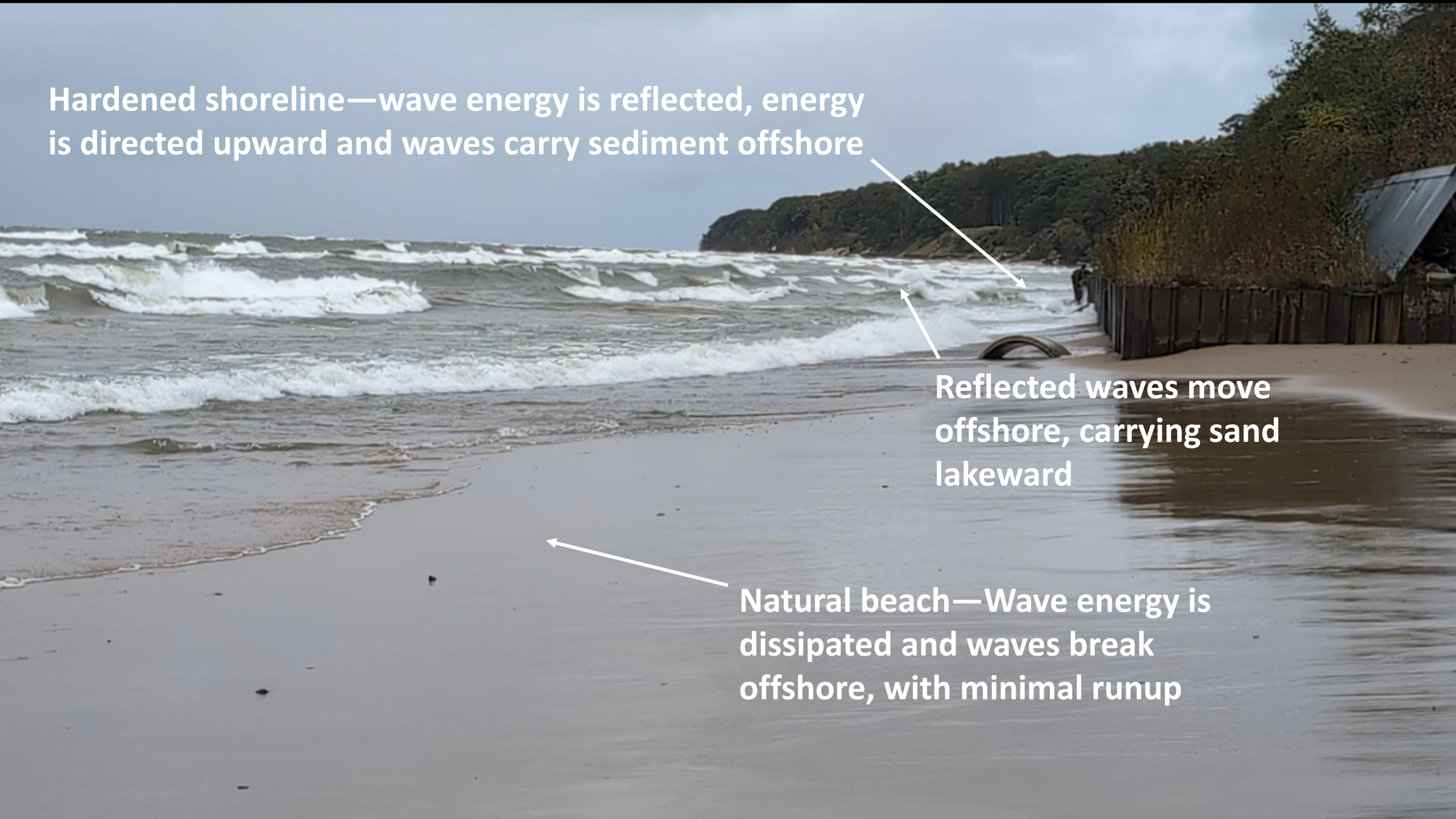
- We study shorelines under a variety of conditions to understand what creates stability

- Common factors
  - 10:1-20:1 slopes
  - Layers of vegetation—shrubs, bulrushes, grasses
  - Dynamic and transient—sites adapt to changing conditions
  - Not always vegetated

- Nature provides a template for understanding how to restore shorelines

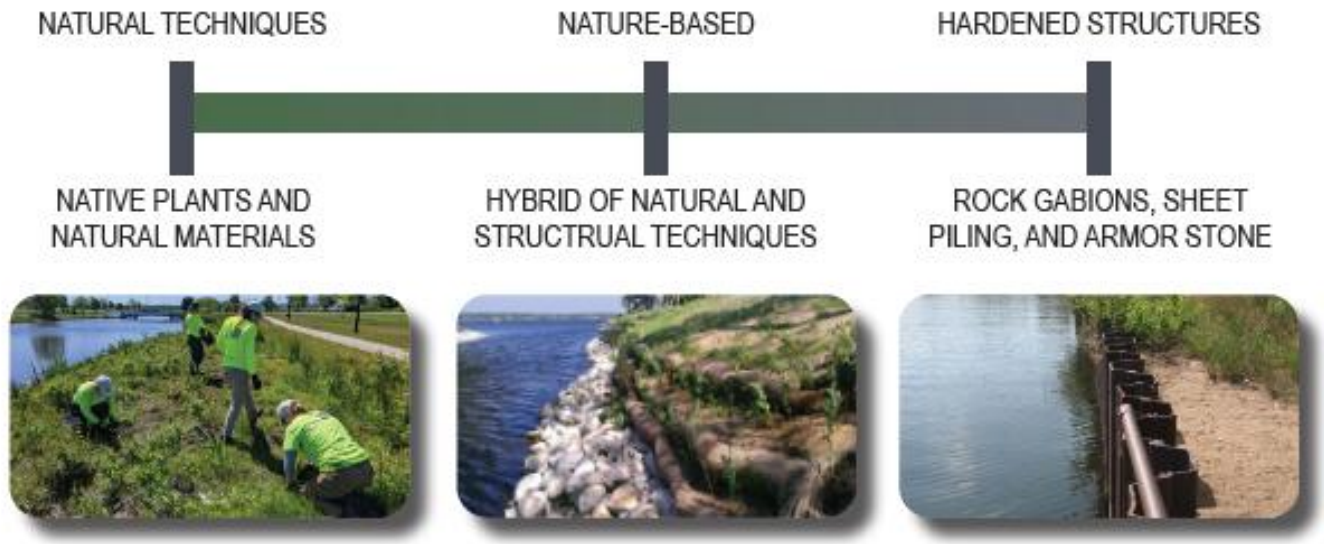





Hardened shoreline—wave energy is reflected, energy is directed upward and waves carry sediment offshore
Reflected waves move offshore, carrying sand lakeward
Natural beach—Wave energy is dissipated and waves break offshore, with minimal runup

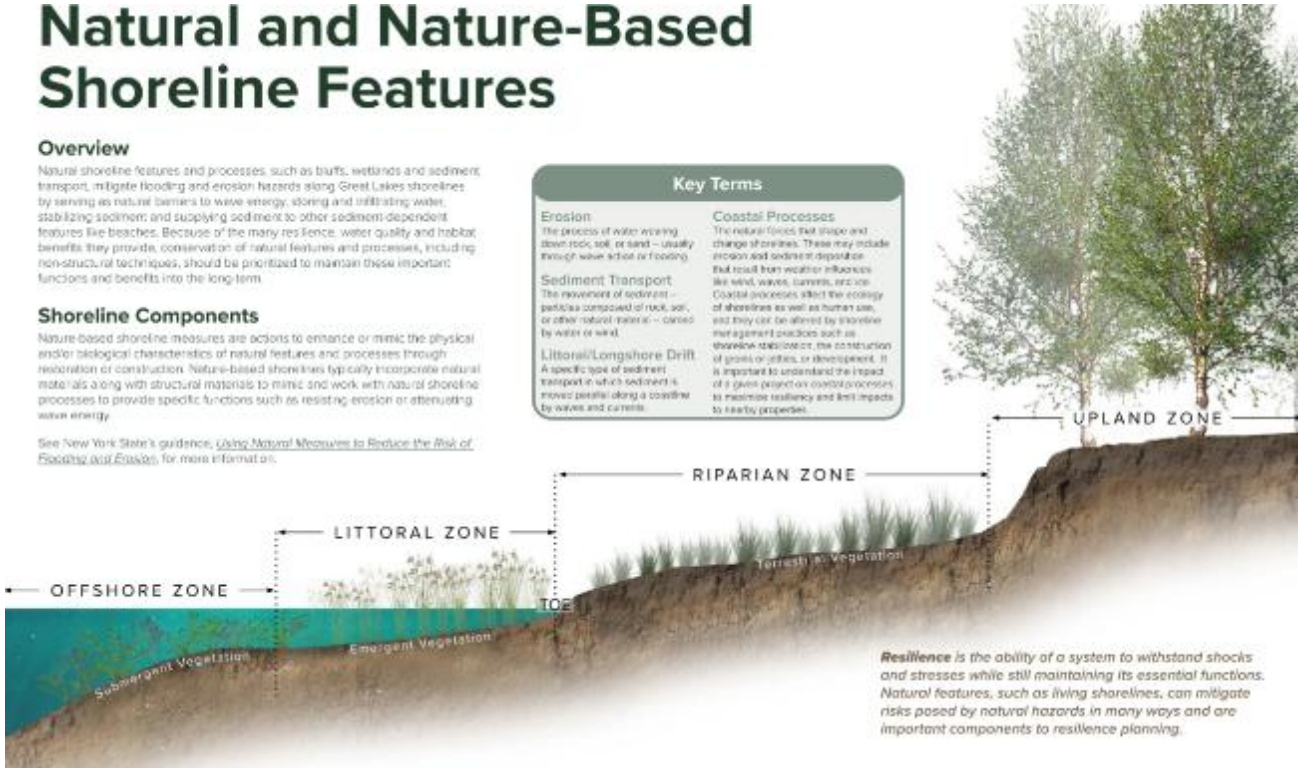
NNBF Practices

- Non-structural
  - Structure relocation
  - Conservation easements
  - Preservation
- Vegetative
  - Ultimately rely only on plants to hold the shoreline
  - Typically include only planting, seeding, and 100% biodegradable erosion control materials
- Form-Based Techniques
  - Used to directly attack wave energy
  - Rock based techniques
  - Wood, depending on how configured
- Process-Based Techniques
  - Work with natural systems based on waves and sediment transport
  - Shoreline grading to absorb energy
  - Wood to retain sediment



So what are we really doing?

- Changing shoreline conditions to reflect or dissipate waves and/or ice
- Planting Plants
- Using Rock
  - Toe protection
  - Nearshore
  - Offshore
- Changing the slope
- Building dunes
- Building/restoring wetlands
- Using wood
  - Brush bundles
  - Logs
- The details and configurations will vary, and that's where the skill and experience come in



Shoreline Grading and Sloping

- Gentler slopes=more stable slopes
- Gentler slopes dissipate wave energy
- Allows vegetation to chase water levels up and down
- Combined with biodegradable materials and native plantings





Grand Trunk Boat Launch



Grand Trunk Boat Launch



Grand Trunk Boat Launch



Beach and Dune Restoration

- Sand strategically placed to re-build beaches and dunes
- Sand should come from dredge spoils or inland sources
- Sand gradation can be important
- Typically supplemented with native plantings and sand fencing



Arcadia Township dune restoration

- Lake Michigan shoreline
- Sunset Station—failed seawall structure
- Community wanted natural dunes back
- Initial phase included removal of seawall structure and construction of dunes
- Project was so well-received that new dunes are being designed to supplement



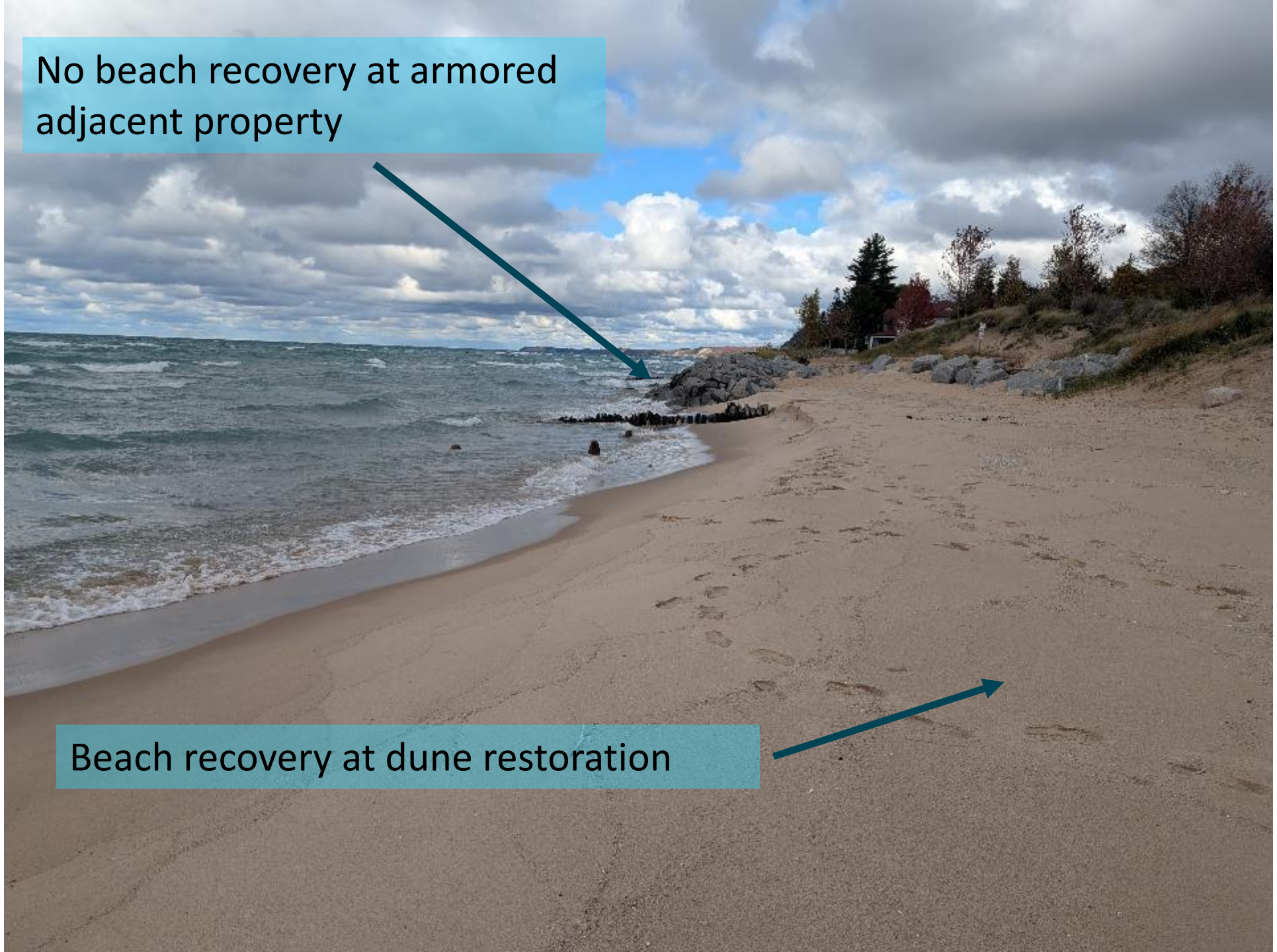
KEEP OFF




Re-built dune


Restored dune


Restored dune


No beach recovery at armored adjacent property
Beach recovery at dune restoration

Dynamic Revetments

- Mimic naturally occurring cobble shorelines
- ~2-8” stone placed on a gentle slope (~7:1 or greater)
- Some movement of stone is allowed (dynamic stability)
- Allows natural movement of water and sediment
- Allows public access and wildlife passage across shoreline















Woody Structures

- Wood can act as armoring, but can also promote sediment retention, depending on how it's placed
- Effectiveness and effects highly influenced by shoreline conditions, wood geometry and anchoring, and time
- Significant habitat benefits, even if it is sometimes less beneficial for sediment retention





Source: Braun et. al 2022

Kitchel-Lindquist Dunes Preserve



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Thank You!

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