Today we’re going to talk about…

- Forces acting on shorelines
- Ice forces
- Difficulty in working with ice
- Techniques that do and don’t work when ice is an issue
- Project examples
So what contributes to shoreline erosion?

- Fetch/Depth across fetch
- Run-up
- Orientation
- Vegetation
- Adjacent structures
- Boats
- Ice
- Erosive forces come from waves (orbital force/wave break plus shear)
So what contributes to shoreline erosion?

- Fetch/Depth across fetch
- Run-up
- Orientation
- Vegetation
- Adjacent structures
- Boats
- **Ice**
- Erosive forces come from waves (orbital force/wave break plus shear)
What does ice do to a shoreline?

• Ice ridges
• Scour/gouging
• Displacement of soil, vegetation, or structures
• Wreaks havoc when it steadily expands
• Wreaks more havoc when it breaks up in spring
What does ice do to a shoreline?

Ice Ridges
Scour/gouging
Displacement of structures
What can we do?

1. Do nothing at all
2. Do nothing, then restore damage
3. Attack its strength
4. Attack its weakness

--Ice is especially difficult to work with because forces are difficult to quantify
--Keep in mind that with living shorelines, maintaining an ecological focus is key

-From Gerald Paul, MN DNR
Do nothing, or do nothing then restore

- May be chosen if there is no risk to structures or human health
- May be the most cost effective option
- May be the only feasible option in some scenarios
Attack its strength

- Structural engineering
  - Concrete
  - Steel
  - Stone
- Tough to accomplish with living shorelines—ice is just too strong
- May be warranted when structures are at risk
Attack its weaknesses

- This is where living shorelines can be very effective—but it takes some innovation.
- Ice is extremely strong in compression but weak in tension.
Attack its weaknesses

- Roughened surfaces or obstructions
  - Rocks
  - Wood
  - Plants
- Gentle slopes
  - 5:1 or gentler
- Sloped “ribs”
- Vegetation
  - Emergent
  - Shrubs
Roughened surfaces and vertical ribs
Roughened surfaces and vertical ribs
Gentle slopes deflect ice and allow vegetation to become established
Gentle slopes deflect ice and allow vegetation to become established.
Ice grows weaker around vegetation, primarily because decaying vegetation produces CO2 and thermal energy.
Ice grows weaker around shrubs—stems act like a thousand springs, and any obstruction will weaken ice

Jane Herbert
Establish plants in “safe spots”, and let them creep out on their own.
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Project Examples
D’Alcorn Site

- 4 mile fetch
- Up to ~3’ ice sheets
- ~4’ waves recorded at site
- Constructed in 2010
NOTES

1. TREATMENT WILL BE PROVIDED BY THE MUSKEGON COUNTY SODDING DISTRICT BOARD FROM A LOCATION IN MUSKEGON COUNTY AT NO COST TO THE CONTRACTOR. MUSKEGON COUNTY Will REQUIRE A CONTRACTOR TO PAY FOR CUTTING AND TRANSPORT OF TREE TO PROJECT SITE.

2. IN THE DUNE GRASS ZONE, INSTALL DUNE GRASS PLANTING SPACED 1' ON-CENTER.

3. IN THE NATIVE SHRUB ZONE, INSTALL 1 GALLON PLANTED PLANTS 3' ON-CENTER.

4. SEED ALL DISTURBED UPLAND AREAS WITH SHORELINE NATIVE SEED MIX AND COVER WITH MULCH 3'-1200# BROWSE BLANKET.
NOTES:
1. ELEVATIONS ARE IN VERTICAL DATUM NAVD 88.
2. SEED ALL DISTURBED UPLAND AREAS WITH SHORELINE NATIVE SOIL MIX AND COVER WITH "KAY-201" EROSION BLANKET.
Rock path failed while shrubs held
Ice pulled neighbor’s rocks into lake
Center Point Bay Marina

• 2 mile fetch
• Up to ~3’ ice sheets
• ~3’ waves recorded at site
• Ice push from multiple directions
• Constructed in 2010
Designed gaps for wildlife passage across the land/water interface
Bulrush climbing onto lake bed
Some things to remember in summary:

- Ice forces can be much stronger than waves, but more difficult to quantify and plan for.
- Trying to go head to head against ice, especially with vegetation alone, can be a losing proposition.
- Ice is strong in compression but weak in tension.
- Any obstructions will weaken ice.
- Slope, shrubs, and surface roughening are your best defenses.
- Expect some level of maintenance, esp in the first few years, since ice is so unpredictable.
- Don’t forget that form must follow function.
Thank You!

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