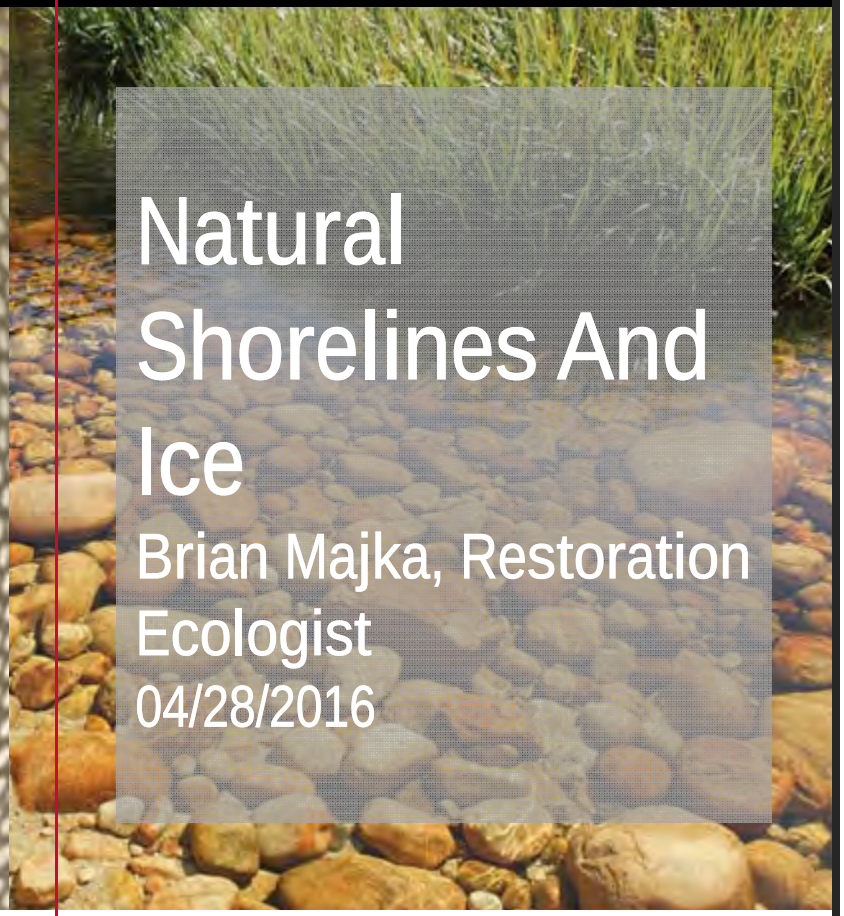
consulting engineers and scientists



Natural Shorelines And Ice

Brian Majka, Restoration Ecologist

04/28/2016

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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

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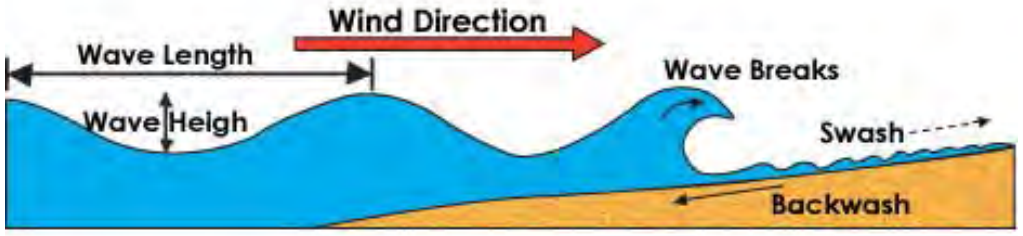
Source: NASA

Source: NPR

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)



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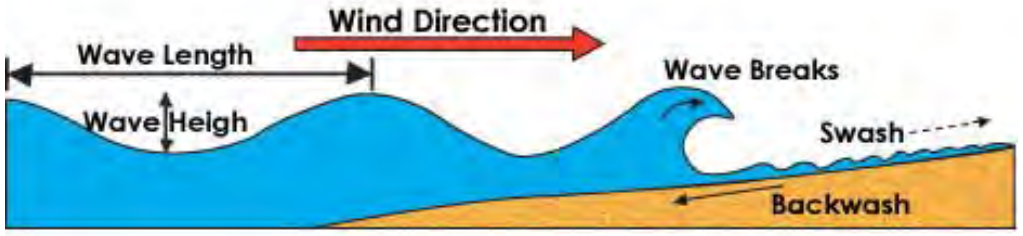

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What does ice do to a shoreline?

- 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

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Ice Ridges

Scour/gouging

Displacement of structures

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What can we do?

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

-From Gerald Paul, MN DNR

--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

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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

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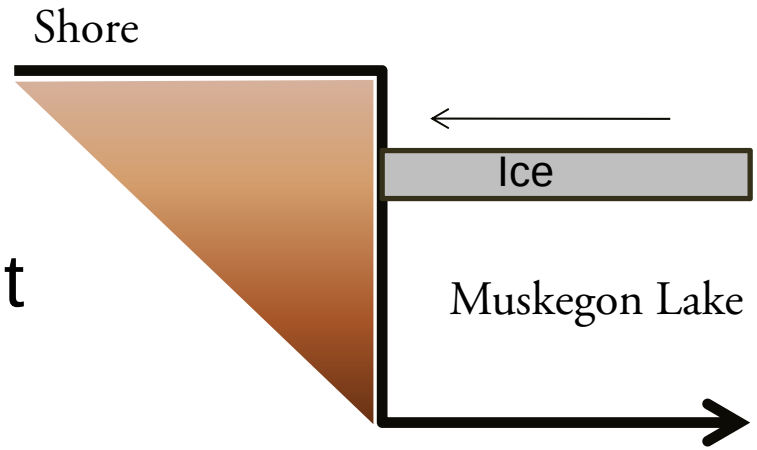
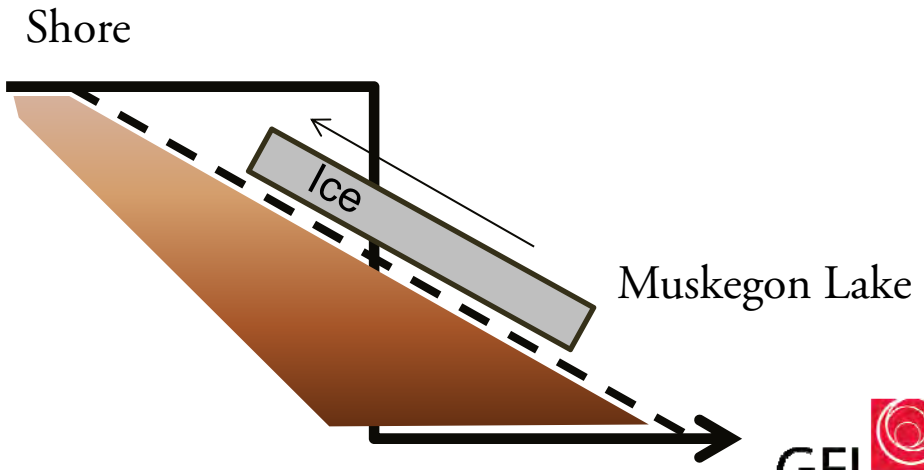
Attack its weaknesses

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





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Attack its weaknesses

- Roughened surfaces or obstructions
  - Rocks
  - Wood
  - Plants
- Gentle slopes
  - 5:1 or gentler
- Sloped “ribs”
- Vegetation
  - Emergent
  - Shrubs

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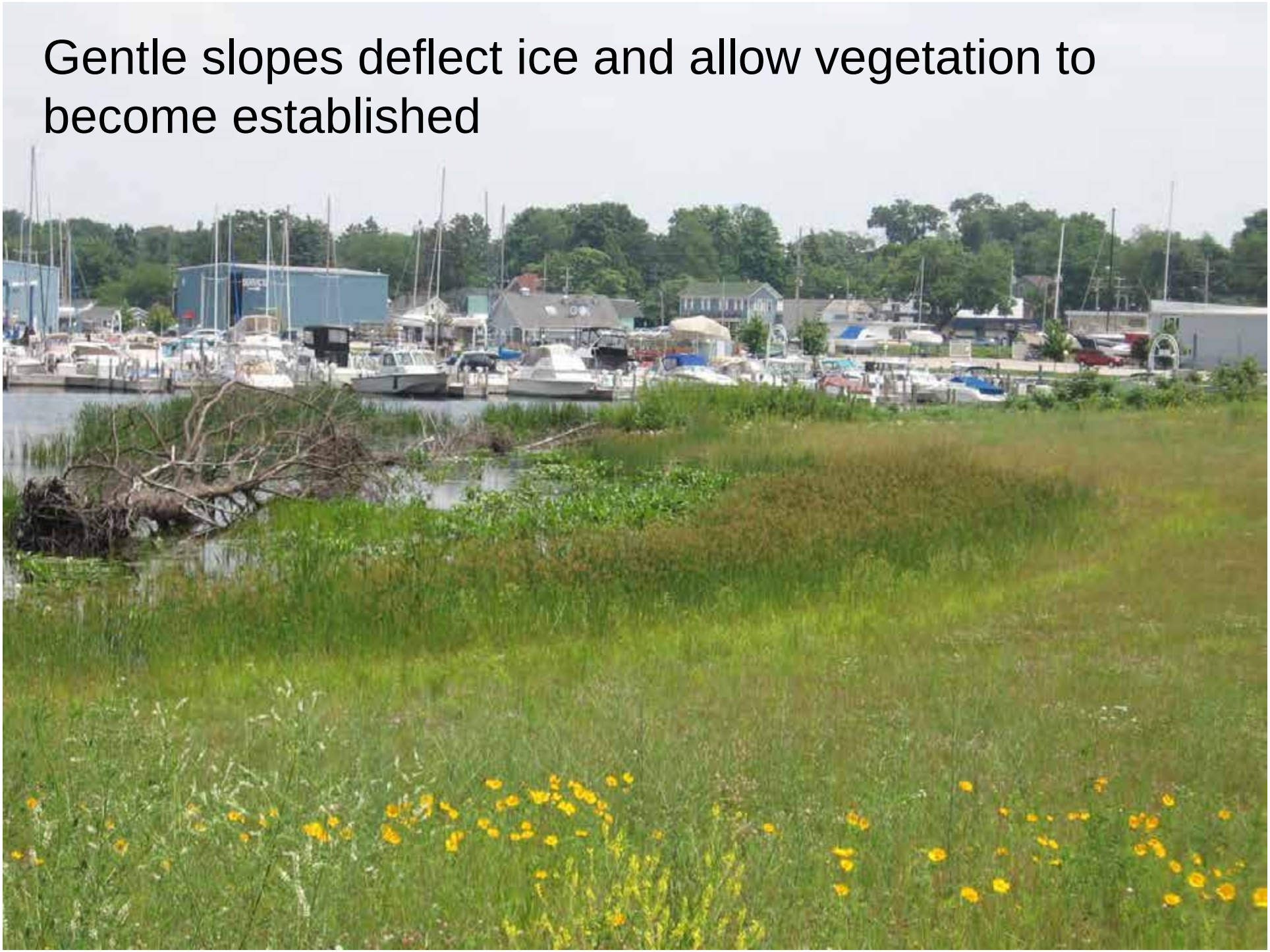
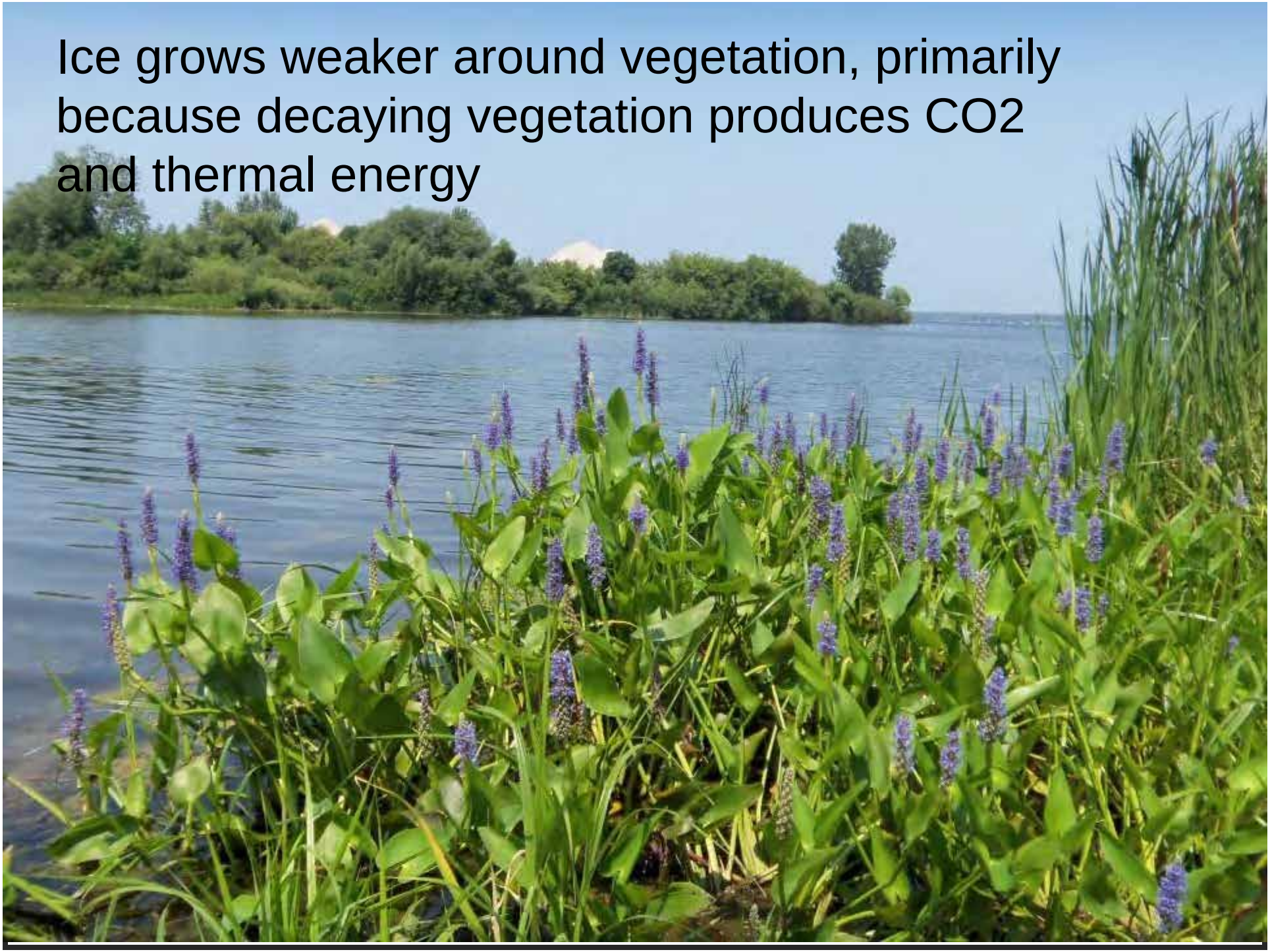
Roughened surfaces
and vertical ribs

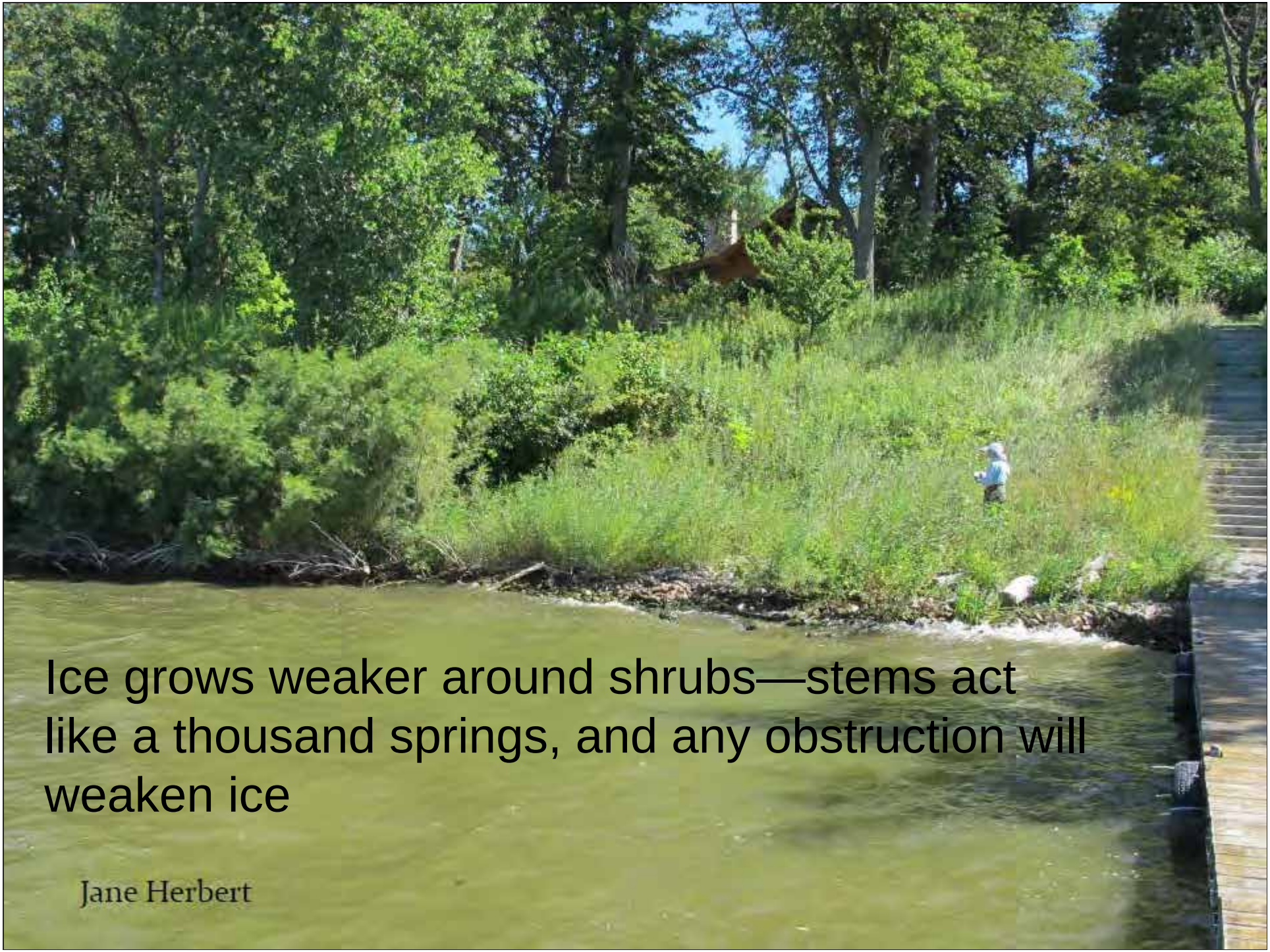
Roughened surfaces and vertical ribs

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

Establish plants in “safe spots”, and let them creep out on their own

Establish plants in “safe spots”, and let them creep out on their own

Establish plants in “safe spots”, and let them creep out on their own

Project Examples

D’Alcorn Site

- 4 mile fetch
- Up to ~3’ ice sheets
- ~8’ waves recorded at site
- Constructed in 2010

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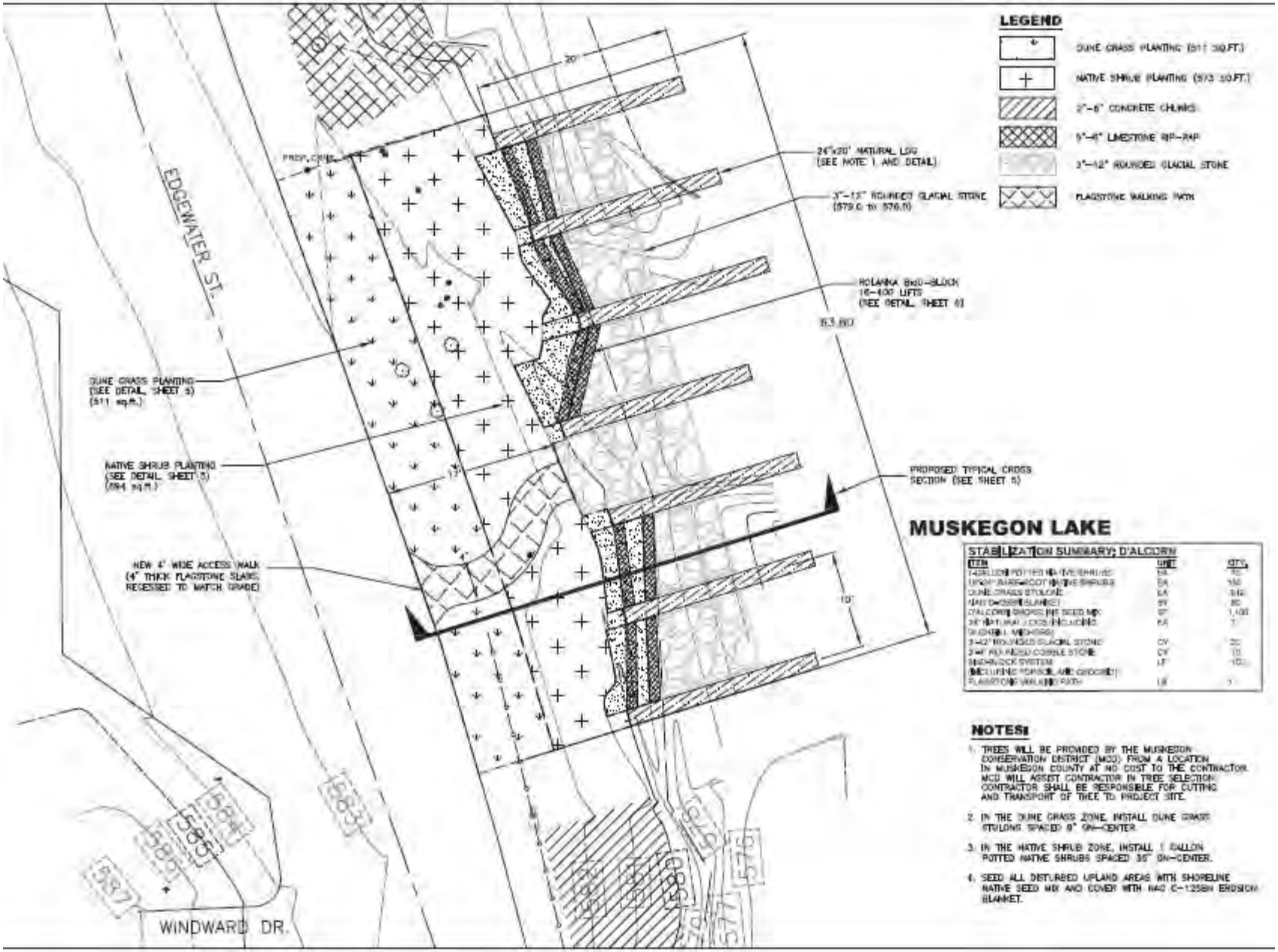
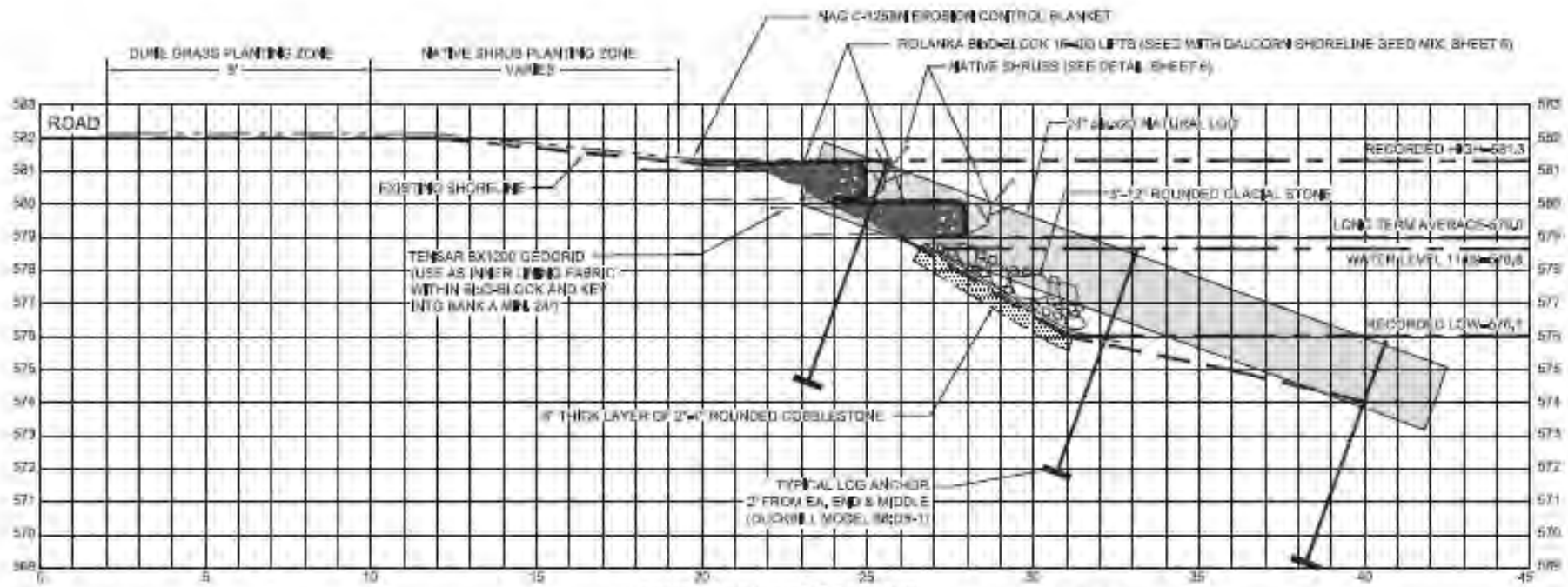
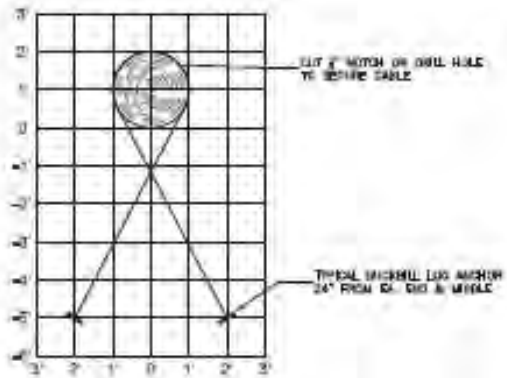

LEGEND
DUNE GRASS PLANTING (511 SQ.FT.)
NATIVE SHRUB PLANTING (573 SQ.FT.)
2"-6" CONCRETE CHUNKS
5"-6" LIMESTONE RIP-RAP
3"-12" ROUNDED GLACIAL STONE
FLAGSTONE WALKING PATH
24"x20' NATURAL LOG (SEE NOTE 1 AND DETAIL)
3"-12" ROUNDED GLACIAL STONE (579.0 to 576.0)
ROLANKA BIOD-BLOCK 16-400 LIFTS (SEE DETAIL, SHEET 6)
DUNE GRASS PLANTING (SEE DETAIL, SHEET 5) (511 sq.ft.)
NATIVE SHRUB PLANTING (SEE DETAIL, SHEET 5) (594 sq.ft.)
NEW 4' WIDE ACCESS WALK (4" THICK FLAGSTONE SLABS, RECESSED TO MATCH GRADE)
PROPOSED TYPICAL CROSS SECTION (SEE SHEET 5)
EDGEWATER ST.
WINDWARD DR.
20'
13'
10'
MUSKEGON LAKE
STABILIZATION SUMMARY: D'ALCORN
ITEM
UNIT
QTY.
NOTES:
1. TREES WILL BE PROVIDED BY THE MUSKEGON CONSERVATION DISTRICT (MCD) FROM A LOCATION IN MUSKEGON COUNTY AT NO COST TO THE CONTRACTOR. MCD WILL ASSIST CONTRACTOR IN TREE SELECTION. CONTRACTOR SHALL BE RESPONSIBLE FOR CUTTING AND TRANSPORT OF TREE TO PROJECT SITE.
2. IN THE DUNE GRASS ZONE, INSTALL DUNE GRASS STOLONS SPACED 9" ON-CENTER.
3. IN THE NATIVE SHRUB ZONE, INSTALL 1 GALLON POTTED NATIVE SHRUBS SPACED 36" ON-CENTER.
4. SEED ALL DISTURBED UPLAND AREAS WITH SHORELINE NATIVE SEED MIX AND COVER WITH NAG C-125BN EROSION BLANKET.



PROPOSED CROSS SECTION

SCALE IN FEET



DUCKBILL ANCHOR CONFIGURATION

SCALE IN FEET

NOTES:

1. ELEVATIONS ARE IN VERTICAL DATUM NAVD 88.
2. SEED ALL DISTURBED UPLAND AREAS WITH SHORELINE NATIVE SOD MIX AND COVER WITH NAG-SC125BN EROSION BLANKET.

DUCKBILL ANCHOR DETAIL (MODEL 88i DB-1)

NOT TO SCALE

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

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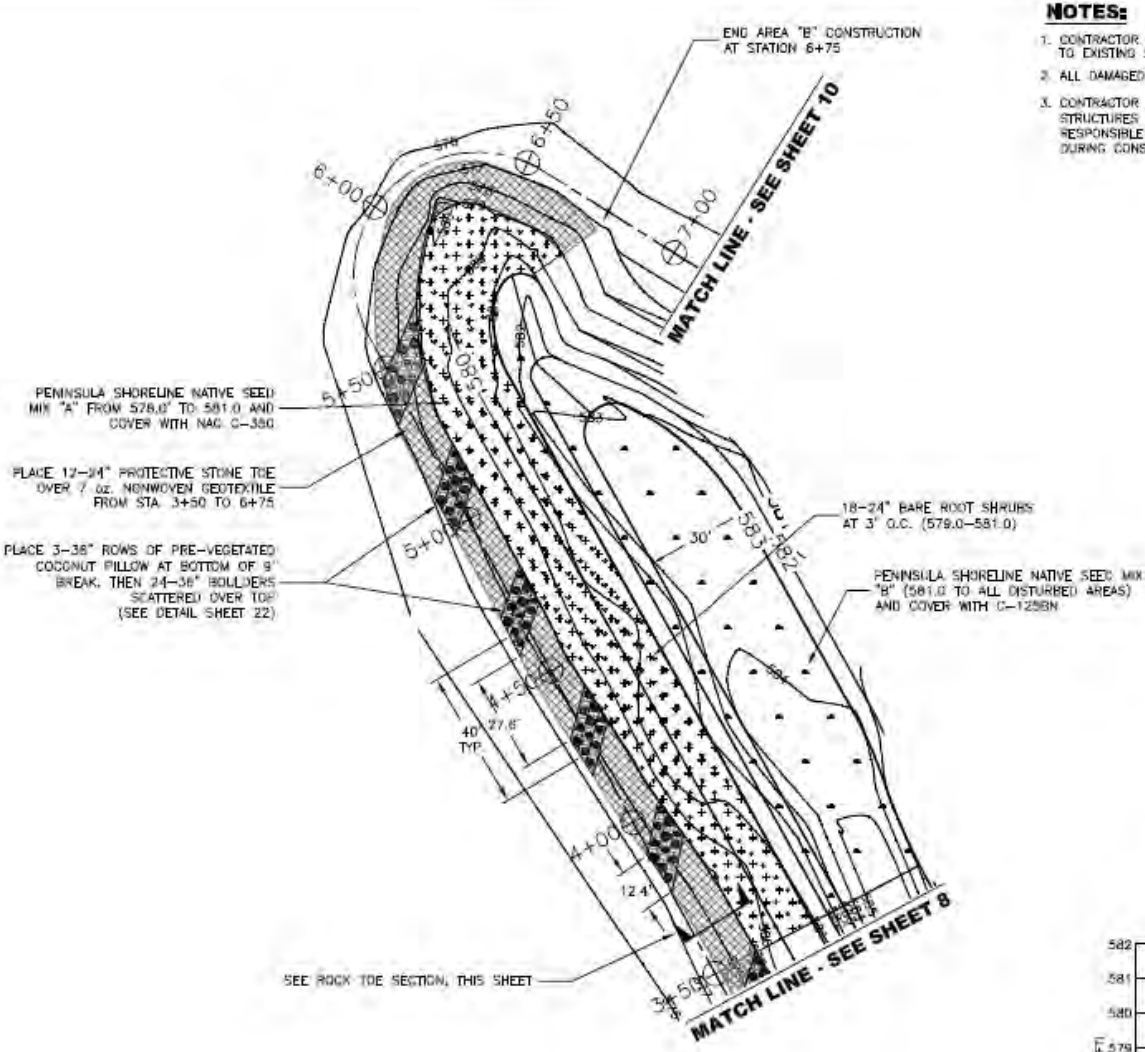
North
Muskegon
Muskegon State Park
Muskegon
2 miles
Project site

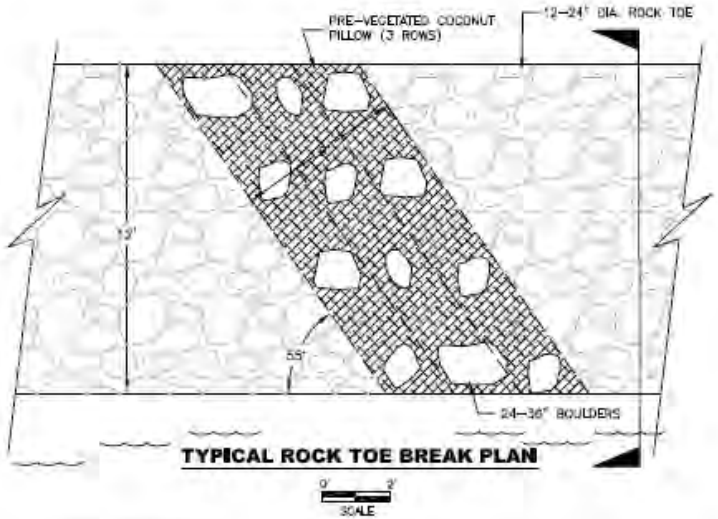
NOTES:

1. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING DAMAGE TO EXISTING STRUCTURES, ASPHALT PATH OR TURF GRASS.
2. ALL DAMAGED TURF GRASS SHALL BE REPAIRED BY RE-SEEDING.
3. CONTRACTOR SHALL AVOID ALL EXISTING CONDUIT, PIPING, AND STRUCTURES WITHIN PROJECT AREA. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO ANY STRUCTURES DAMAGED DURING CONSTRUCTION.

LEGEND

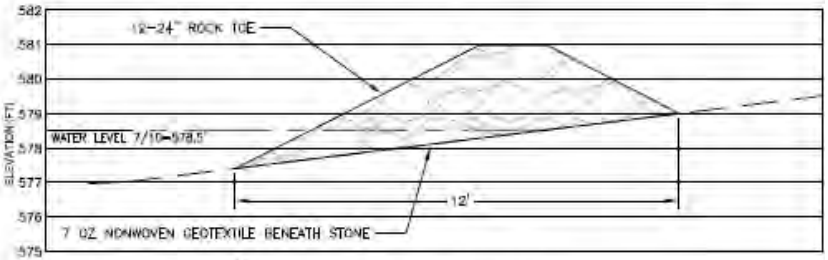
- EXISTING CONTOUR
- PROPOSED CONTOUR
- 2+50 STATIONING MARKER
- PENINSULA SHORELINE NATIVE SEED MIX "A"
- PENINSULA SHORELINE NATIVE SEED MIX "B"
- 18–24" BARE ROOT SHRUBS 3' O.C.
- PRE-VEGETATED COCONUT PILLOW
- ROCK TOE





TYPICAL ROCK TOE BREAK PLAN

0' 2'
SCALE



ROCK TOE SECTION

0 2'

BEFORE YOU DIG CALL MISS DIG

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

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Thank You!

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