



Living on the Edge:

Evaluating Shallow-Water Habitat in Maine Lakes

Jeremy Deeds, Ph.D.

Aquatic Ecologist

Lake Assessment Section

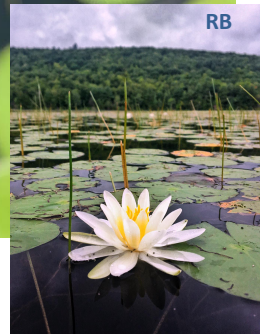
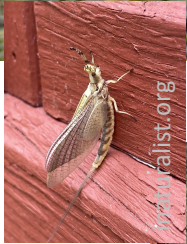
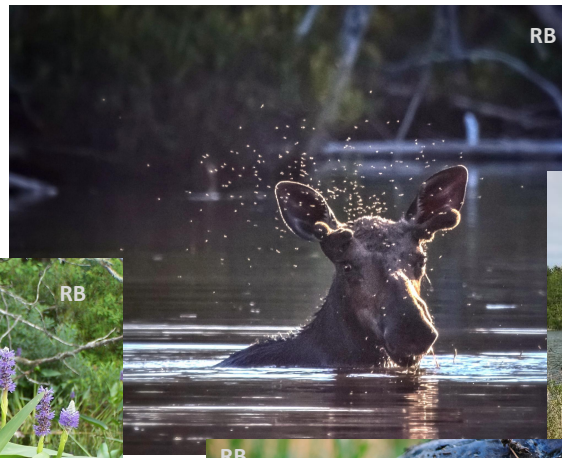
MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

Protecting Maine's Air, Land and Water

Where did it
start for you?







RB = ©Ryan Burton



Littoral Zone



- Habitat Protection: It's the law!
 - §465-A. Standards for classification of lakes and ponds
 - A. Class GPA waters must be of such quality that they are suitable ... as habitat for fish and other aquatic life. ***The habitat must be characterized as natural.***

Littoral Zone



- It's important for lake health
 - US lakes with poor lakeshore habitat were 3 times more likely to be in poor biological health

-National Lake Assessment

Riparian Zone Alterations

- Cleared Riparian Areas:

- Destabilize Shorelines
- Increase Sedimentation and Nutrient Loading
- Simplify both shoreland and Littoral Habitat
 - No woody structure
 - Increased erosion



- Leads to change and loss of littoral habitats*

**2007 and 2012 National Lake Assessments (NLA)*

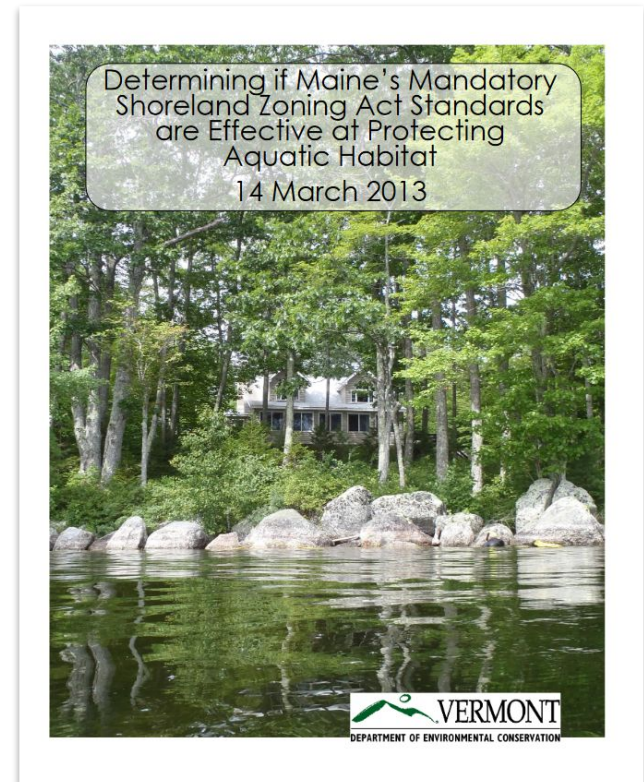
**LakeLine, Vol. 29; Spring 2009*

Images: VT ANR



What About Shoreland Zoning?

- Maine Shoreland Zoning Standards are effective at protecting littoral habitat...



What About Shoreland Zoning?

- Maine Shoreland Zoning Standards are effective at protecting littoral habitat...

*when they
are followed*



Littoral Zone



What's
the
plan?

What do we know

- Littoral Habitats important
- Affected by shoreland development
- We can't interview fish

**I'M GOING TO HAVE TO SCIENCE
THE ~~S~~ OUT OF THIS**



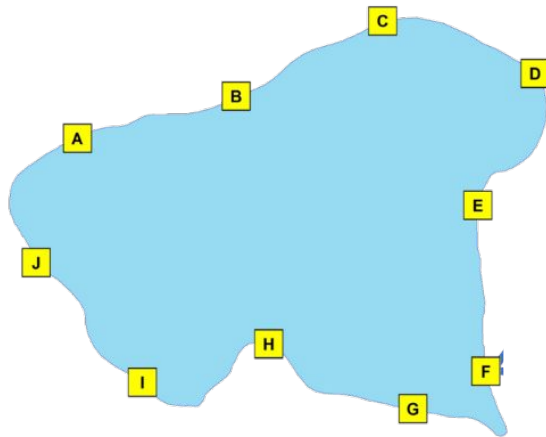
Goals

- Develop measurement techniques
 - Specific to ME
- Define a measurable “natural condition”
- Be able make decisions on littoral habitat conditions for entire lakes
 - Protect & restore lakes that need it most



Littoral Zone Surveys

- Methods adapted from the National Lake Assessments
- Littoral Habitat: Woody structures, substrate composition, macrophyte functional groups, etc.
- Riparian Vegetation: Tree canopy to ground cover
- Human Influences (presence/absence)





Need to have objective decision points



Need to have objective decision points

*We had to research and model
littoral habitat characteristics
and see if shoreland condition
was associated*

This is how we did it....



Maine Lakes & Lake Stewards of Maine
LAKE CONFERENCE 2025



Lakes of the Edge
"LC"

June 13th, 2025
Farmington, ME

Field Trip
(not really)
Clearwater Lake
SDT Review

*Imagine
YOU are
in charge
of crowd
control*

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Lawyer Conference 2025



"LC"
June 13th, 2025
Farmington, ME

Field Trip
(probably)
Farmington Courthouse
Light Litigation

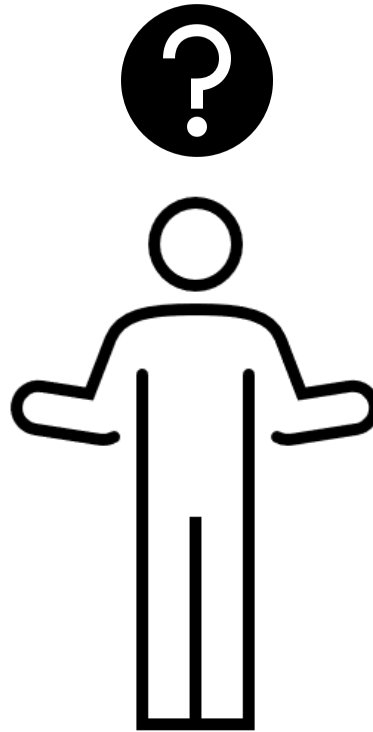


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Lakes at the Edge

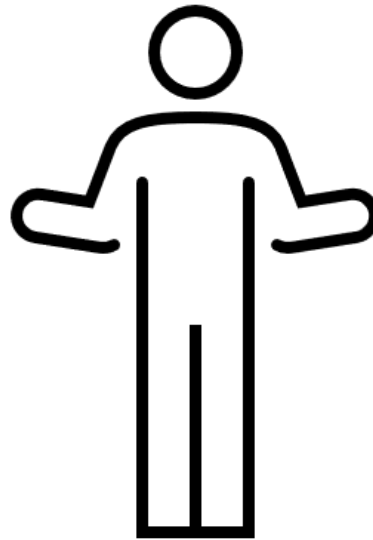
*Diameter*_{hat}



Likely

What will
you look
for?

Hat?



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Unlikely



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Lakes at the Edge

What will
you look
for?

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Accessories?

Paddle



Briefcase



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Lakes at the Edge

What will
you look
for?

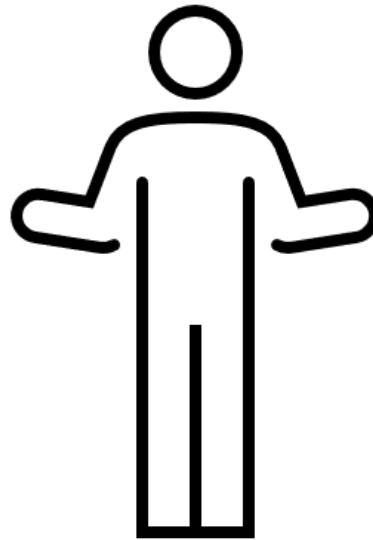
Footwear?

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OR



OR





Lakes at the Edge

Time to Make a Decision!



- Hat (wide)
- Accessories (paddle)
- Footwear (sandal/hiker)

- No Hat
- Accessories (briefcase)
- Footwear (formal)





Lakes at the Edge

Time to Make a Decision!



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Lakes at the Edge

Time to Make a Decision!

(no hat)



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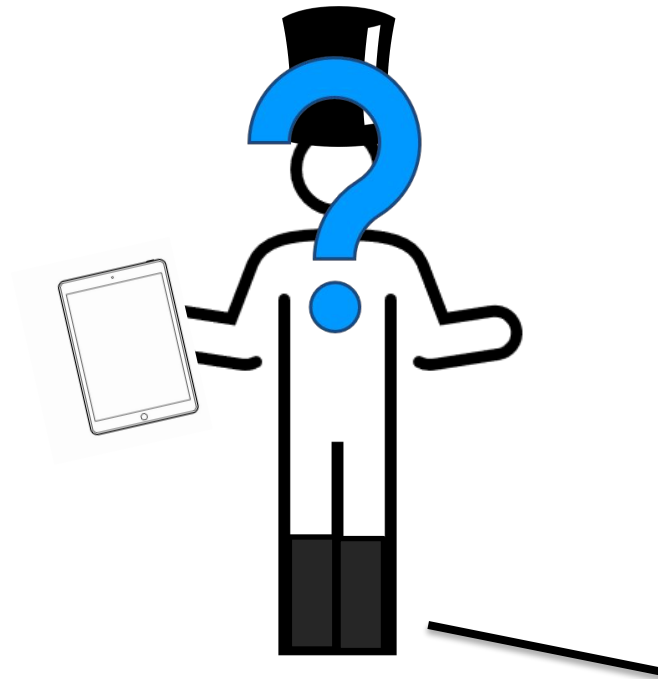


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Lakes at the Edge

Time to Make a Decision!



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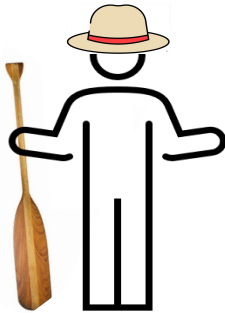


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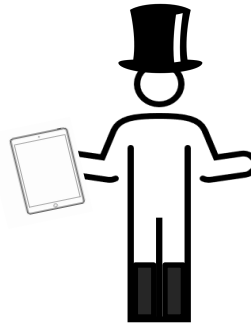


Lakes at the Edge

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Lakes



Lawyers

□ *Need to find out what works*



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Lakes at the Edge

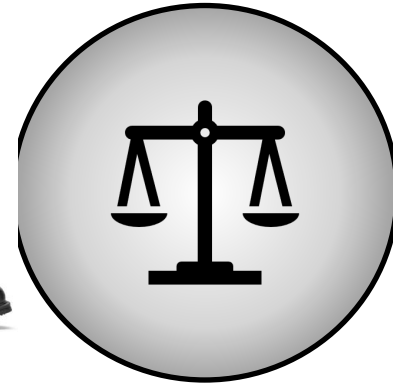


Lakes



Lawyers

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Lawyer Conference 2025



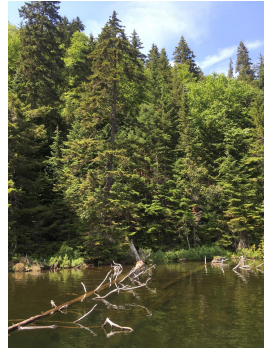
□ *Need to find out what works*



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Lakes of the



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Lakes



Lawyers

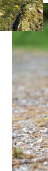
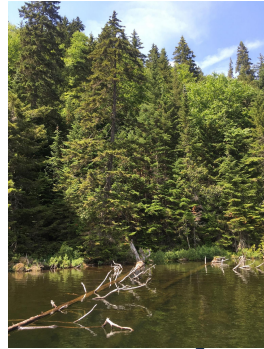
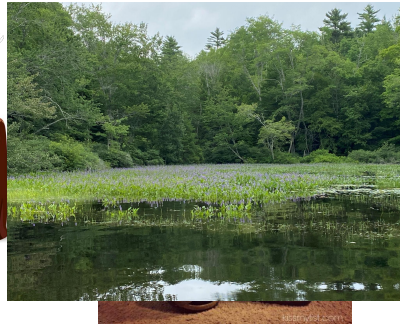
□ Need to find out what works



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Lakes of the



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Lakes



Lawyers

□ Need to find out what works





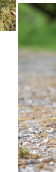
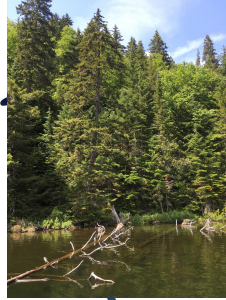
Diminished
Habitat



Natural
Habitat

□ *Need to find out what works*





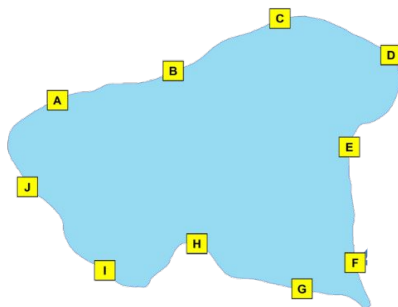
Diminished
Habitat



Natural
Habitat

□ *Need to find out what works*





Diminished
Habitat



Natural
Habitat

□ *Need to find out what works*



Study Design

- Undeveloped lakes vs. highly developed lakes
- Find measurements that show a difference from the 'natural' condition



Diminished
Habitat



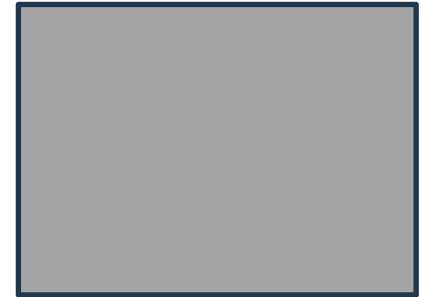
Natural
Habitat

□ Need to find out what works



Study Design – Model Development

- Look for signals in Littoral Habitat: Woody structures, substrate, plants, etc.
- Found metrics that showed measurable differences in habitat, reflected shoreland condition



Diminished
Habitat



Natural
Habitat

□ Need to find out what works



Findings: *Important Measurements*

- Percent Sand
- Substrate Particle Size Variability
- Large Woody Habitat
- Floating leaved plant cover
- Littoral Habitat cover
- Habitat Diversity
- Total Plant Cover
- Total Woody Habitat

Diminished
Habitat



Natural
Habitat



A few years, ~100 lakes, and one publication later....

LAKE AND RESERVOIR MANAGEMENT
<https://doi.org/10.1080/10402381.2023.2207490>

 **Routledge**
Taylor & Francis Group

 Check for updates

Assessment indices of littoral habitat condition for lakes in Maine and New England, United States

Jeremy Deeds^a , Aria Amirbahman^b, Kirsten Hugger^c, Philip R. Kaufmann^{d,e}, Leslie J. Matthews^f, Kellie Merrell^g and Stephen A. Norton^g

^aMaine Department of Environmental Protection, Augusta, Maine, USA; ^bDepartment of Civil, Environmental and Sustainable Engineering, Santa Clara University, Santa Clara, California, USA; ^cNew Hampshire Department of Environmental Services, Concord, New Hampshire, USA; ^dUS Environmental Protection Agency, Office of Research and Development, Center for Public Health and Environmental Assessment, Pacific Ecological Systems Division, Corvallis, Oregon, USA; ^eDepartment of Fisheries, Wildlife and Conservation Sciences, OR State University, Corvallis, Oregon, USA; ^fVermont Department of Environmental Conservation, Montpelier, Vermont, USA; ^gSchool of Earth and Climate Sciences, University of Maine, Orono, Maine, USA

ABSTRACT

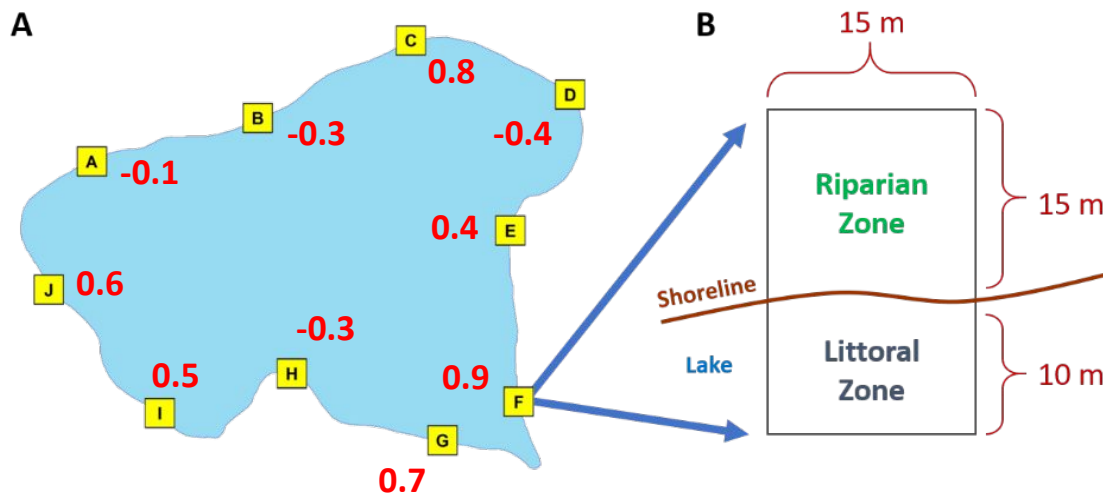
Deeds J, Amirbahman A, Hugger K, Kaufmann PR, Matthews LJ, Merrell K, Norton SA. 2023. Assessment indices of littoral habitat condition for lakes in Maine and New England, United States. *Lake Reserv Manage*. XX:XXX–XXX.

Littoral habitat is critical for lake biota but is adversely affected by residential shoreland development through the loss and reduced structural complexity of lakeshore vegetation. There currently exists no assessment methodology for evaluating littoral habitat condition of individual lakes in the northeastern United States. We addressed this assessment need by creating multimetric indices of littoral habitat condition that focus on lakeshore residential development as the primary stressor. We did this by using habitat metrics derived primarily from National Lake Assessment (NLA) physical habitat (PHAB) survey field observations to

KEYWORDS

Littoral habitat assessments;
National Lake Assessment;
physical habitat surveys;
shoreland development; water
quality standards



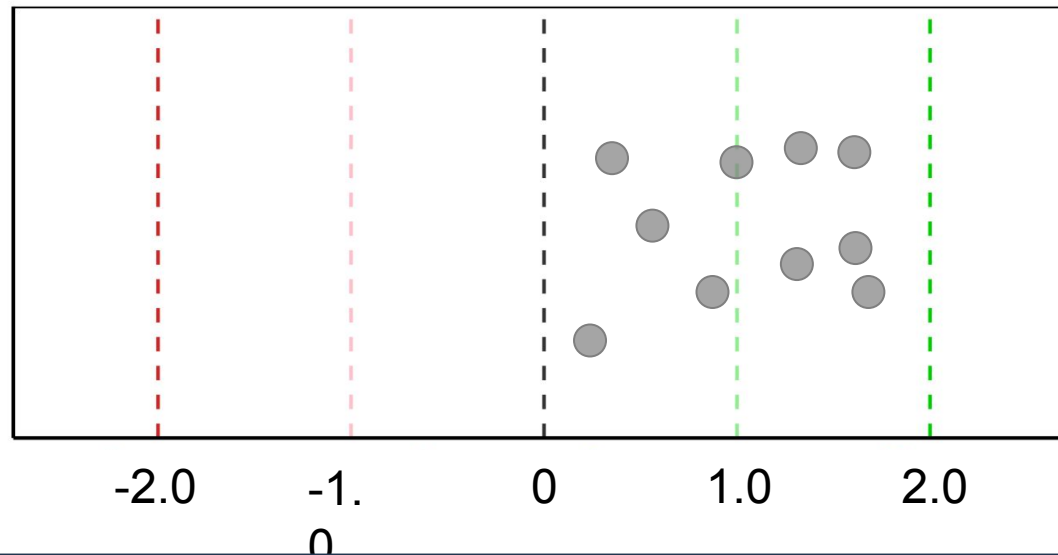


Linear Discriminant Model:

$$\begin{aligned}
 & \text{SUB_SAND} * -1.442 \\
 + & \text{TOTMAC} * -0.738 \\
 + & \text{LK_SMNTCVR} * -0.027 \\
 + & \text{TWH} * -0.231 \\
 + & \text{FLOAT} * 0.517 \\
 + & \text{SUB_VAR} * -5.458 \\
 + & \text{SUB_PSIZE} * -0.197 \\
 + & \text{FC_LWH} * 0.913 \\
 + & \text{SHANNON} * 1.508 \\
 + & \text{LK_LITCVRB} * 4.675
 \end{aligned}$$

LDA SCORE



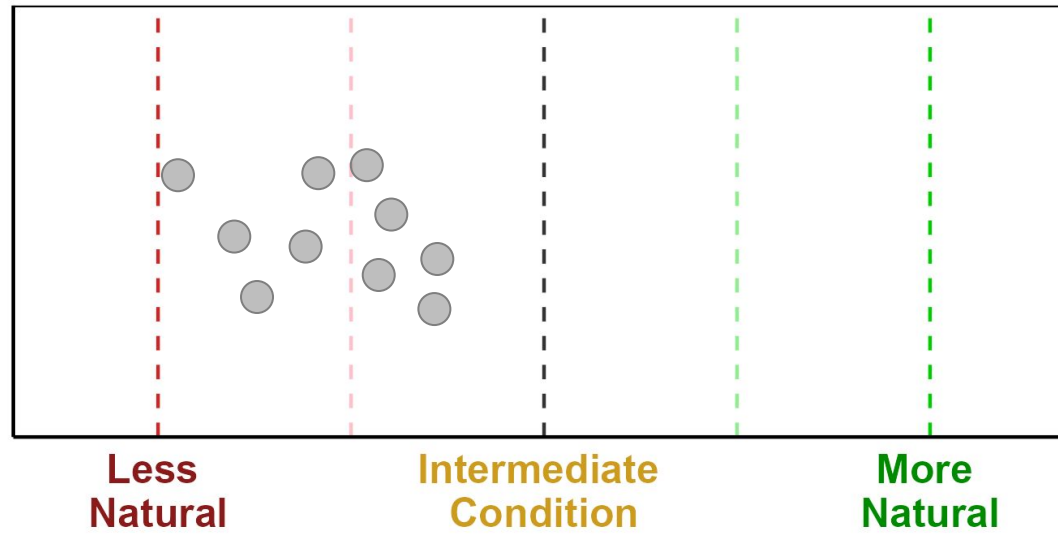


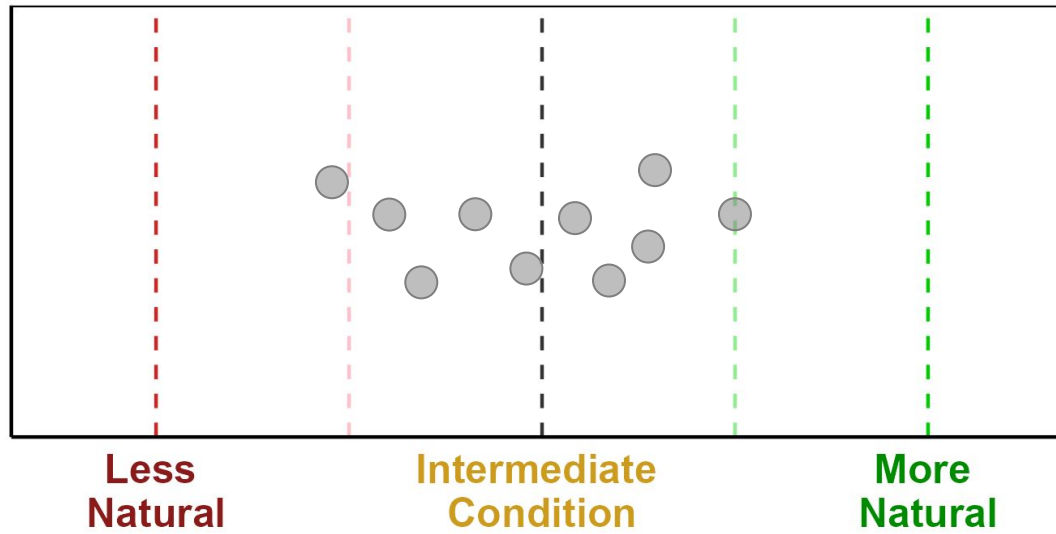
Diminished
Habitat



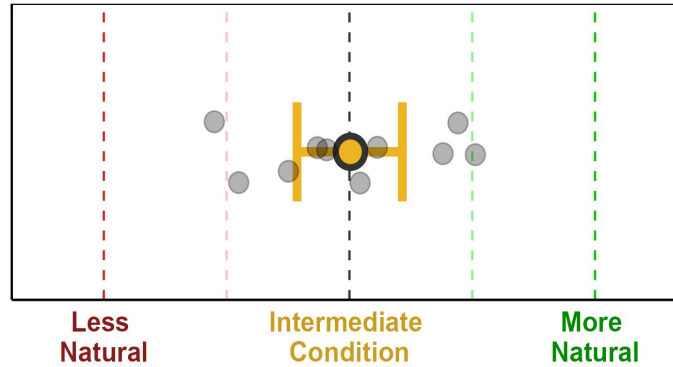
Natural
Habitat







Confidence Intervals



Value falls within this interval 95% of time
(9,500/10k pulls)



Confidence Intervals

Replicates re-sampling 10,000 times

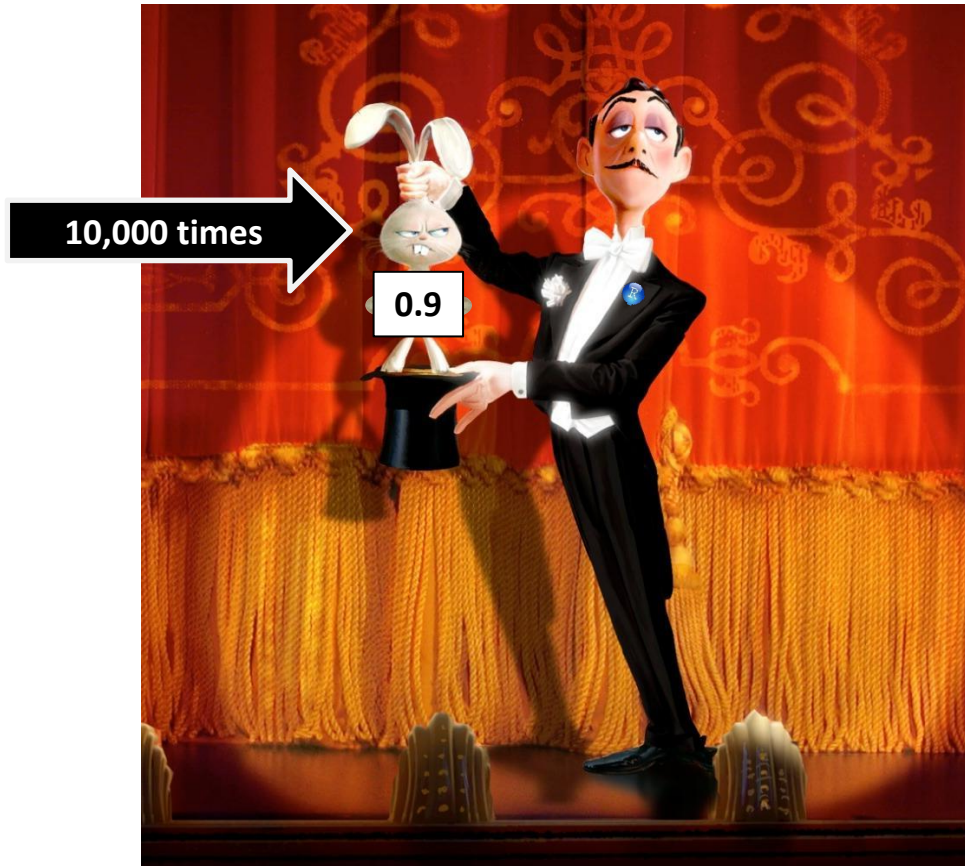


- Individual Site Scores
- Mean Model Score
- 95% Confidence Interval



Confidence Intervals

Value falls within this interval 95% of time
(9,500/10k pulls)

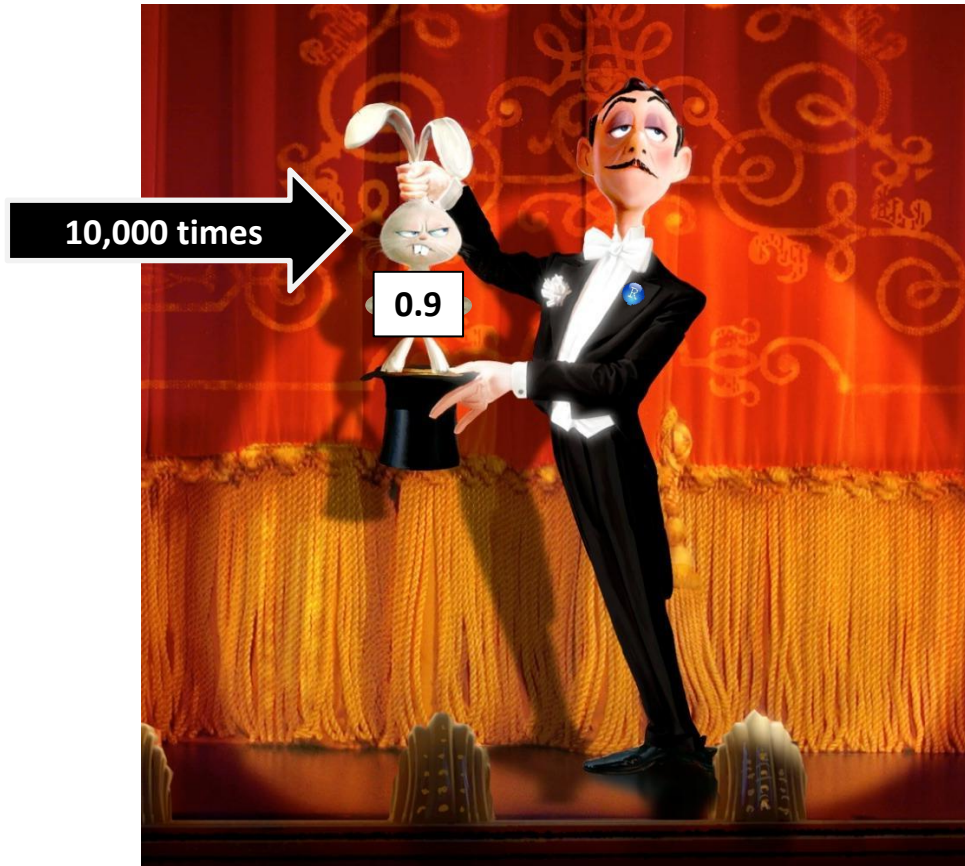


- Individual Site Scores
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Confidence Intervals

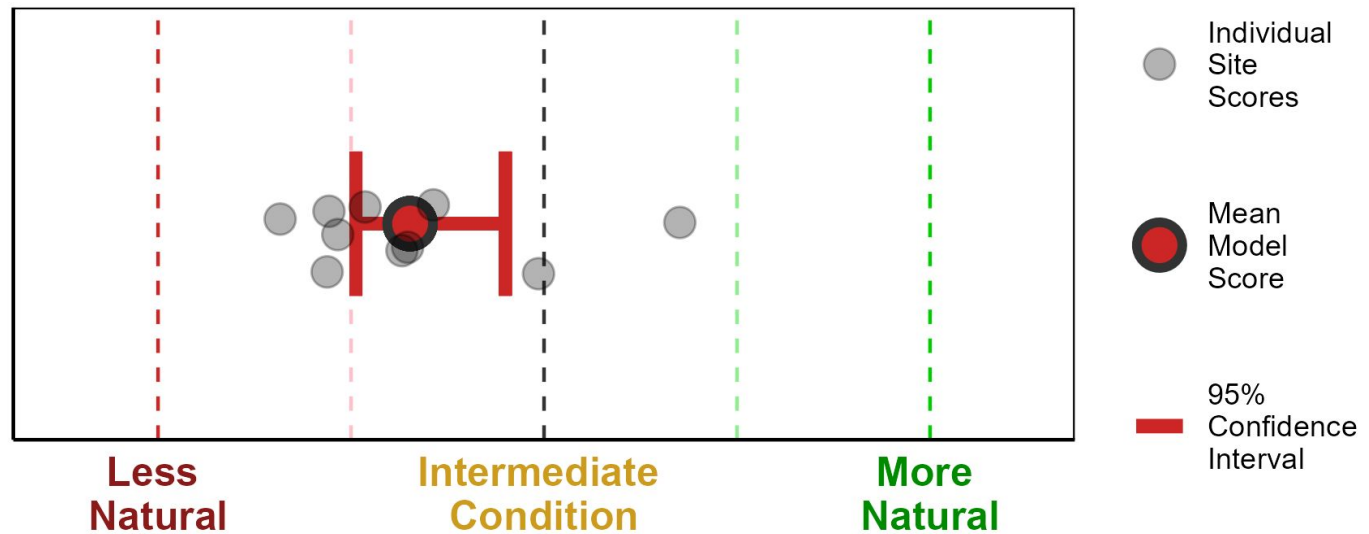
Value falls within this interval 95% of time
(9,500/10k pulls)



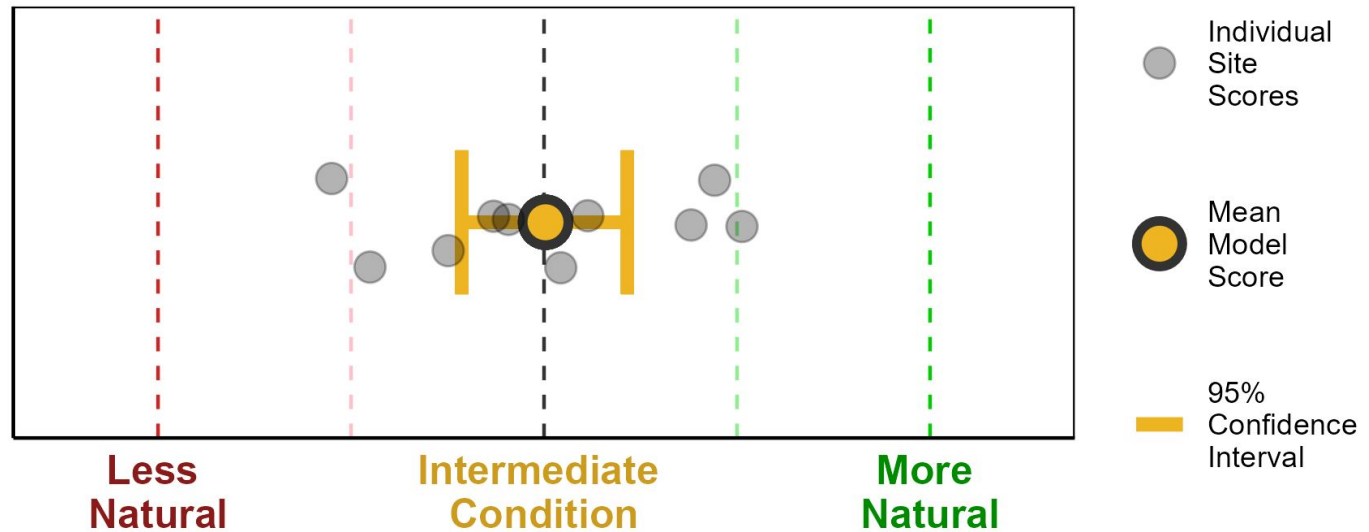
- Individual Site Scores
- Mean Model Score
- 95% Confidence Interval



Scoring a Lake



Scoring a Lake



Scoring a Lake

More Natural

Habitat is in good condition – work to keep it that way!

Intermediate Condition

Shoreland development is affecting littoral habitat condition. Restoration and enhancement could be highly effective.

Less Natural

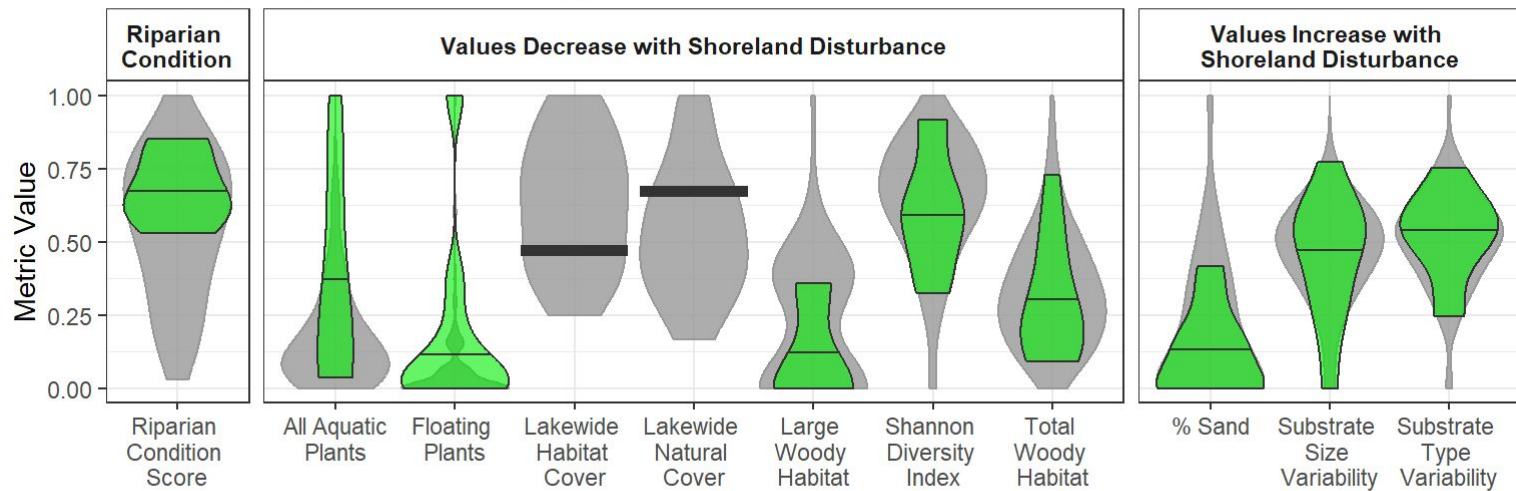
Littoral habitat is of diminished quality. Lake should be prioritized for shoreland restoration.



Evaluating a Lake

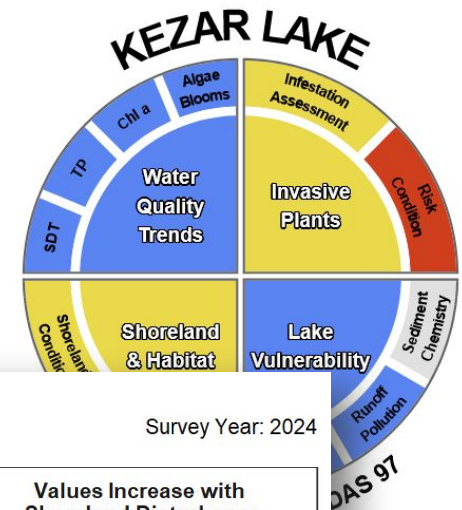
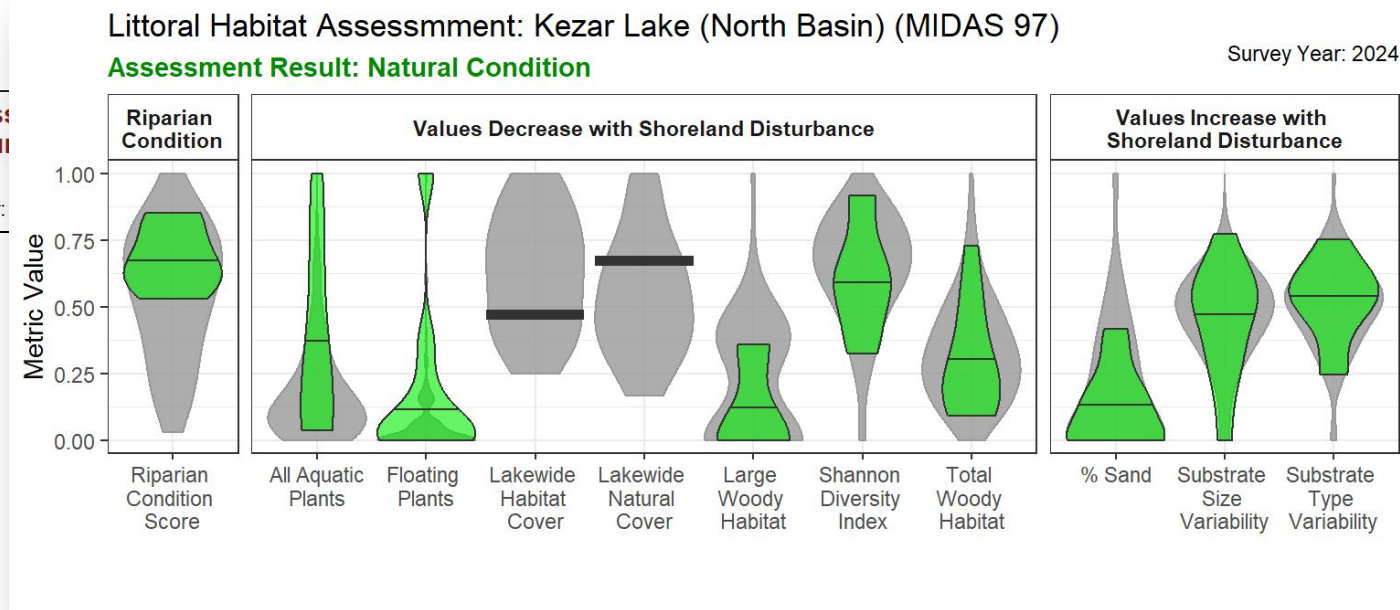
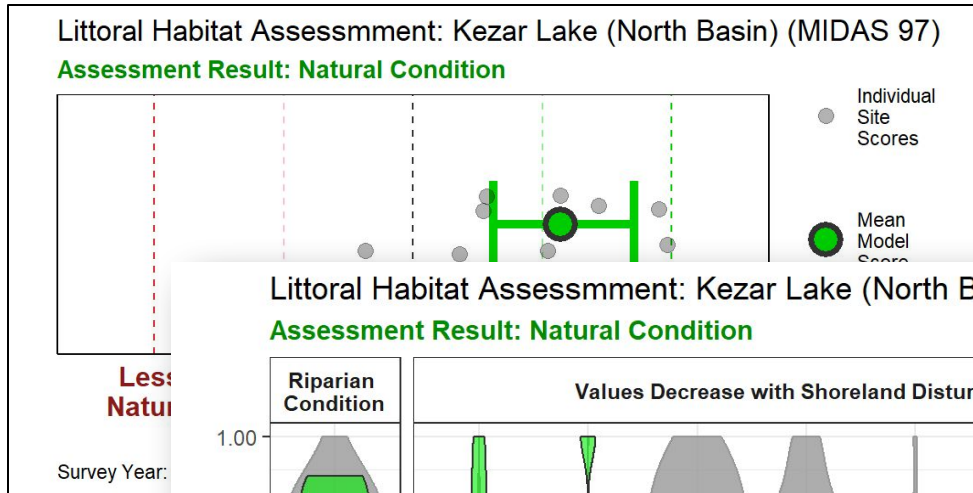
Assessment Result: Natural Condition

Survey Year: 2024



Info in the new Scorecard

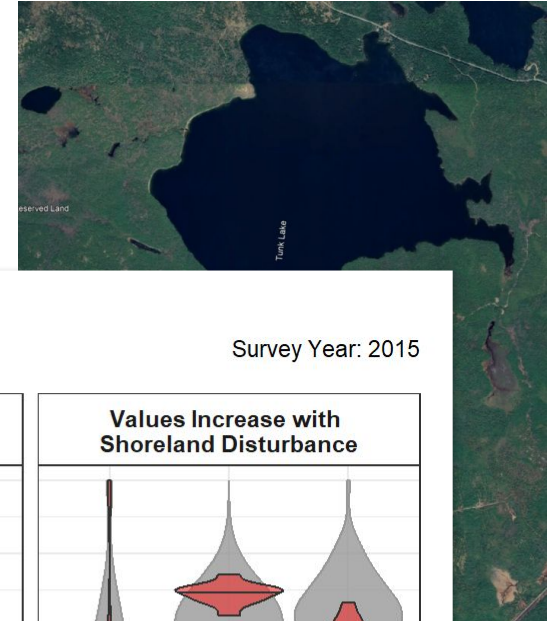
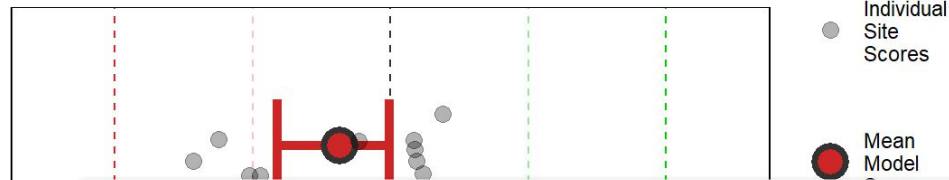
(Coming soon)



There are always exceptions

Littoral Habitat Assessment: Tunk Lake (MIDAS 4434)

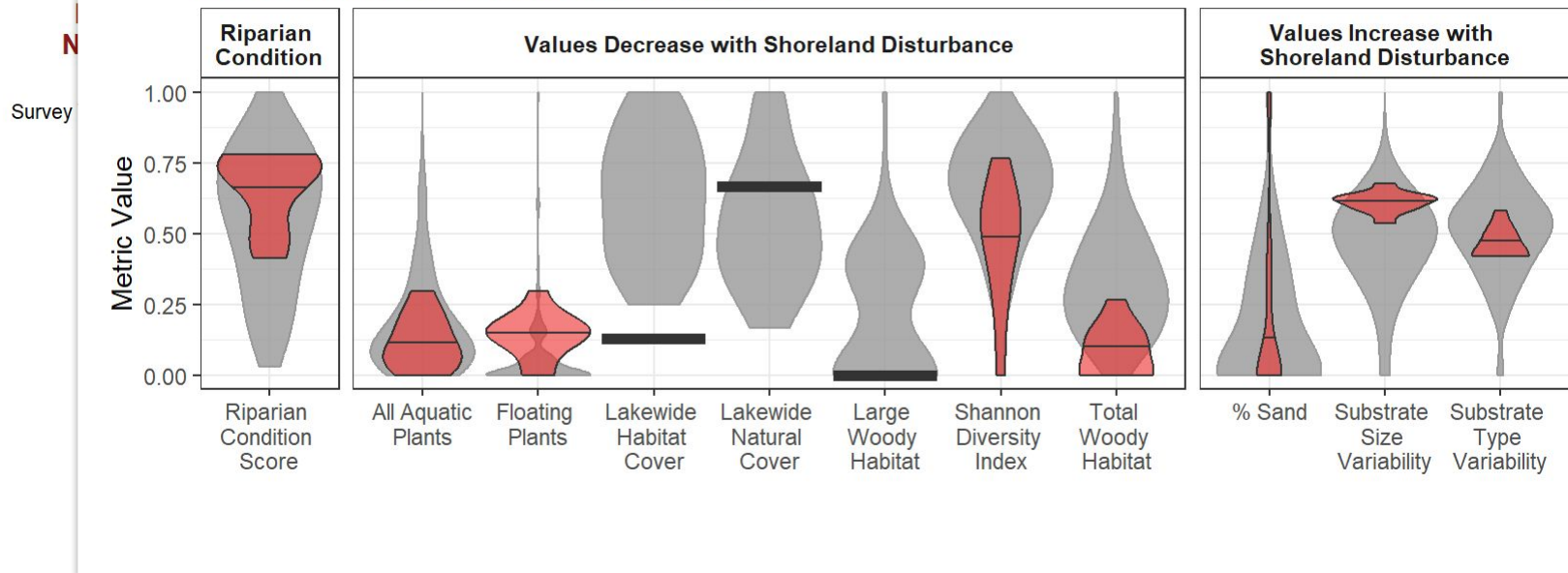
Assessment Result: Diminished Condition



Littoral Habitat Assessment: Tunk Lake (MIDAS 4434)

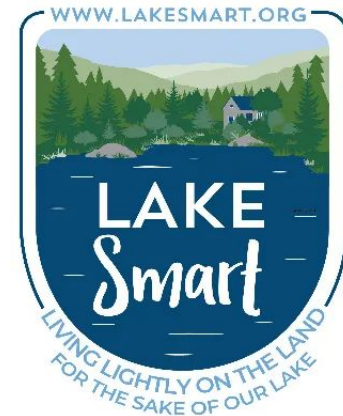
Assessment Result: Diminished Condition

Survey Year: 2015



What's Next?

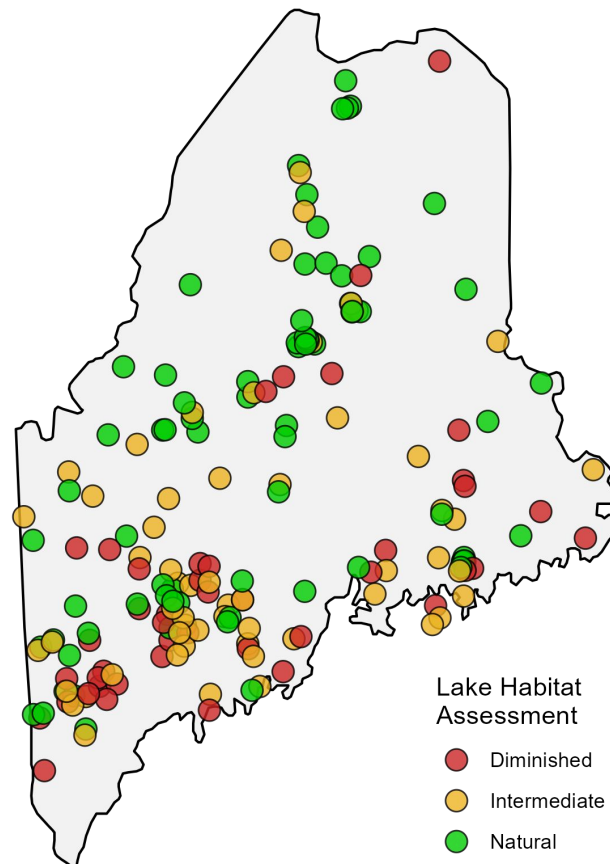
- These are whole-lake evaluations
- Looking at lakewide Habitat Impairment
 - Similar to water quality or trophic decline
- Prioritize for shoreland restoration activities
- LakeSmart



Where we're at now

Maine PHAB Results
Through 2024

- 177 Lakes surveyed
- Statewide Assessment finishing next year



What You Can Do

- Maintain & establish riparian buffers of native vegetation
- Leave littoral habitat in place if not a hazard
- Spread the word within your networks
- LakeSmart is a great resource



Acknowledgements

- ME DEP: Linda Bacon, Ryan Burton (& photos), Josh Noll, Patrick Lind, John McPhedran, Denise Blanchette, Doug Suitor, Karen Hahnel, Tom Danielson, Emily Zimmerman, et al.
- Aria Amirbahman & Stephen Norton, UMaine
 - Phil Kaufmann, US EPA





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