Lake Protection

Paul Radomski | Lake Ecologist

September 2019

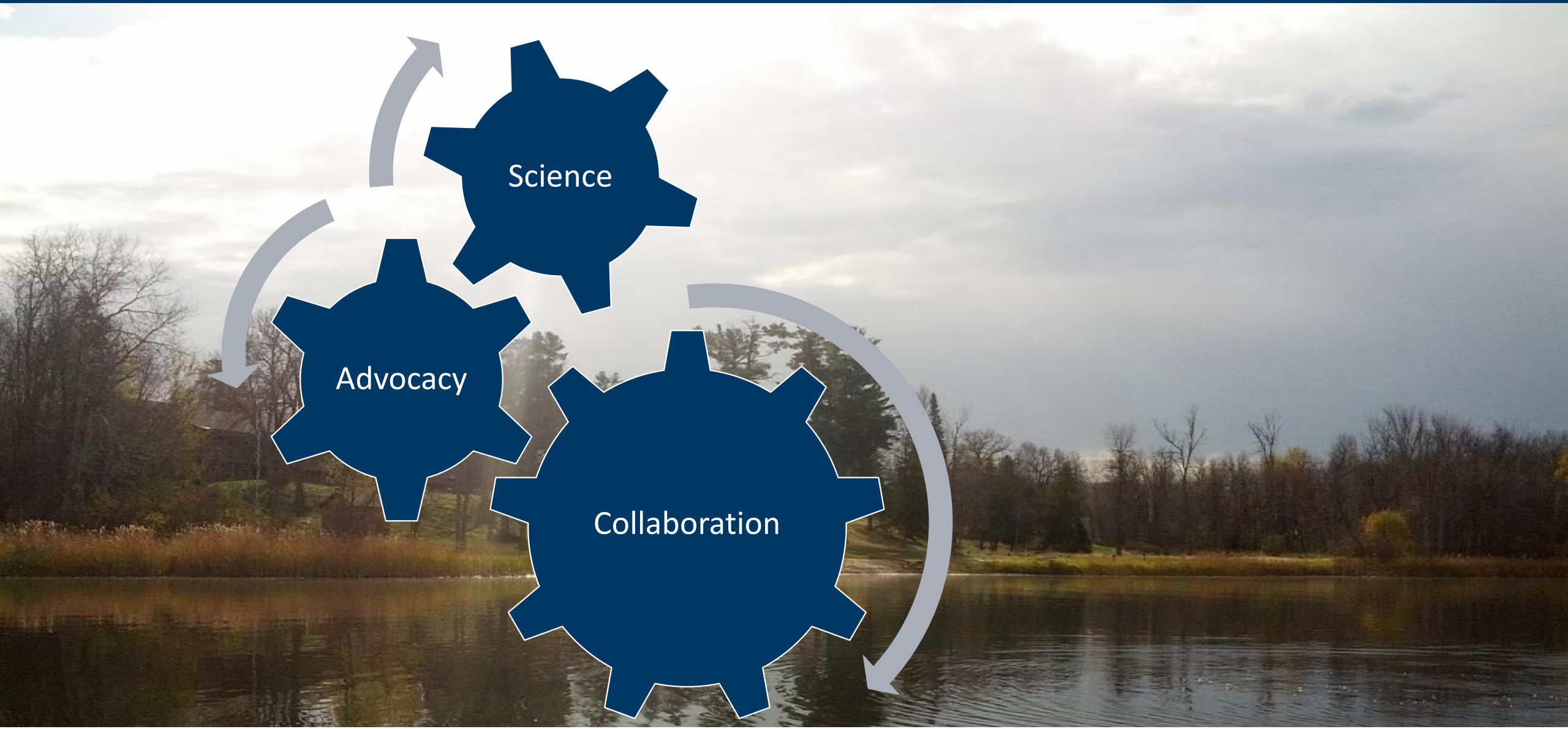
MINNESOTA

Department of Natural Resources

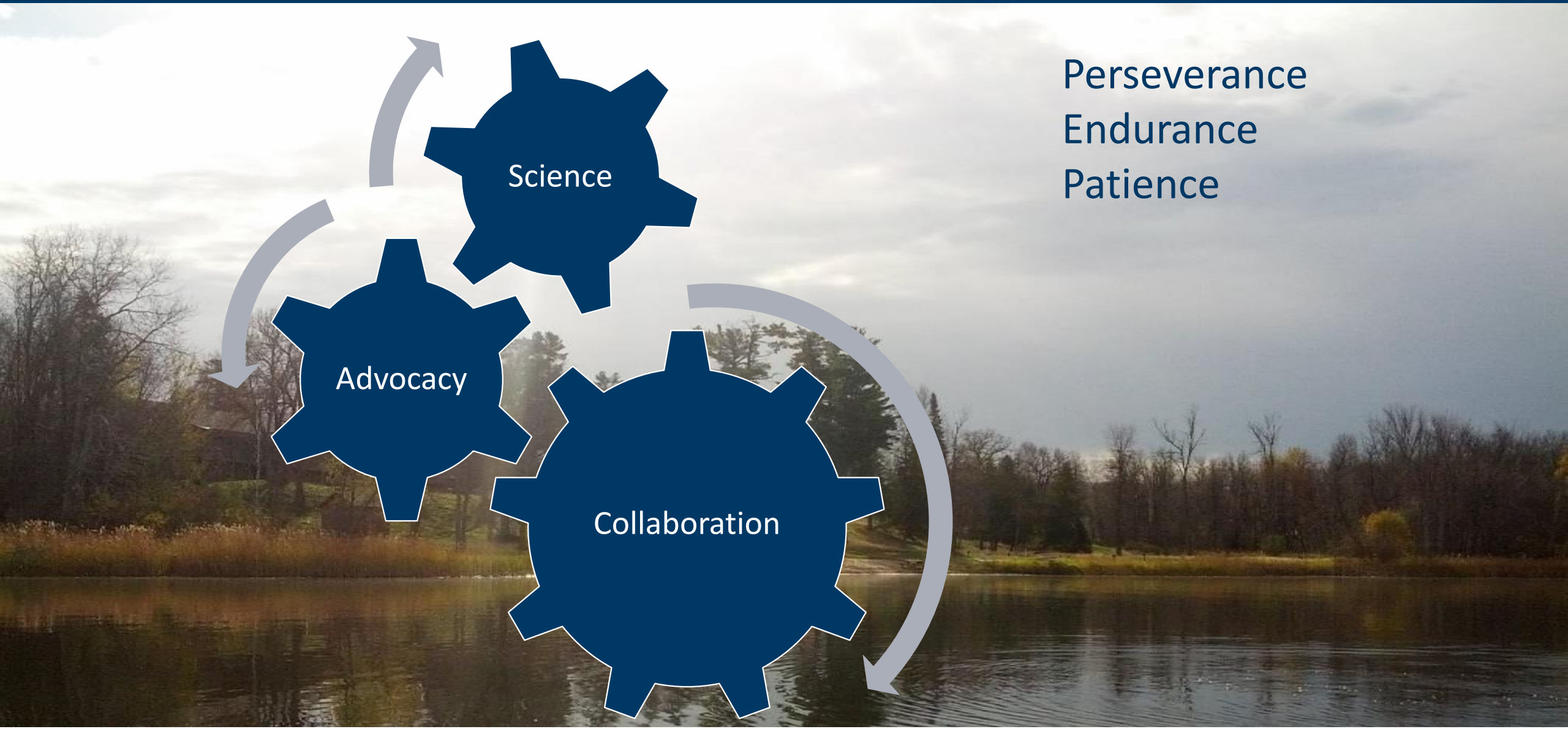
Institutional Tools

- **MN Shoreland Management Act of 1969**
  - **Shoreland Development Standards; P&Z**
- **Federal Clean Water Act of 1972**
- **Minnesota's Clean Water Legacy Act of 2008**
  - **Funds for clean water, habitat, parks, & arts**
  - **Outdoor Heritage Fund: $120M/year**
    - **Conservation easements and land acquisitions – *target***
  - **Clean Water Fund: $110M/year**
    - **Clean Water Accountability Act of 2013 – *prioritize***

Process



Process



Perseverance
Endurance
Patience

Ojibwe men harvesting wild rice, ca. 1925. Photo from Minnesota Historical Society

Wild Rice Lake Protection

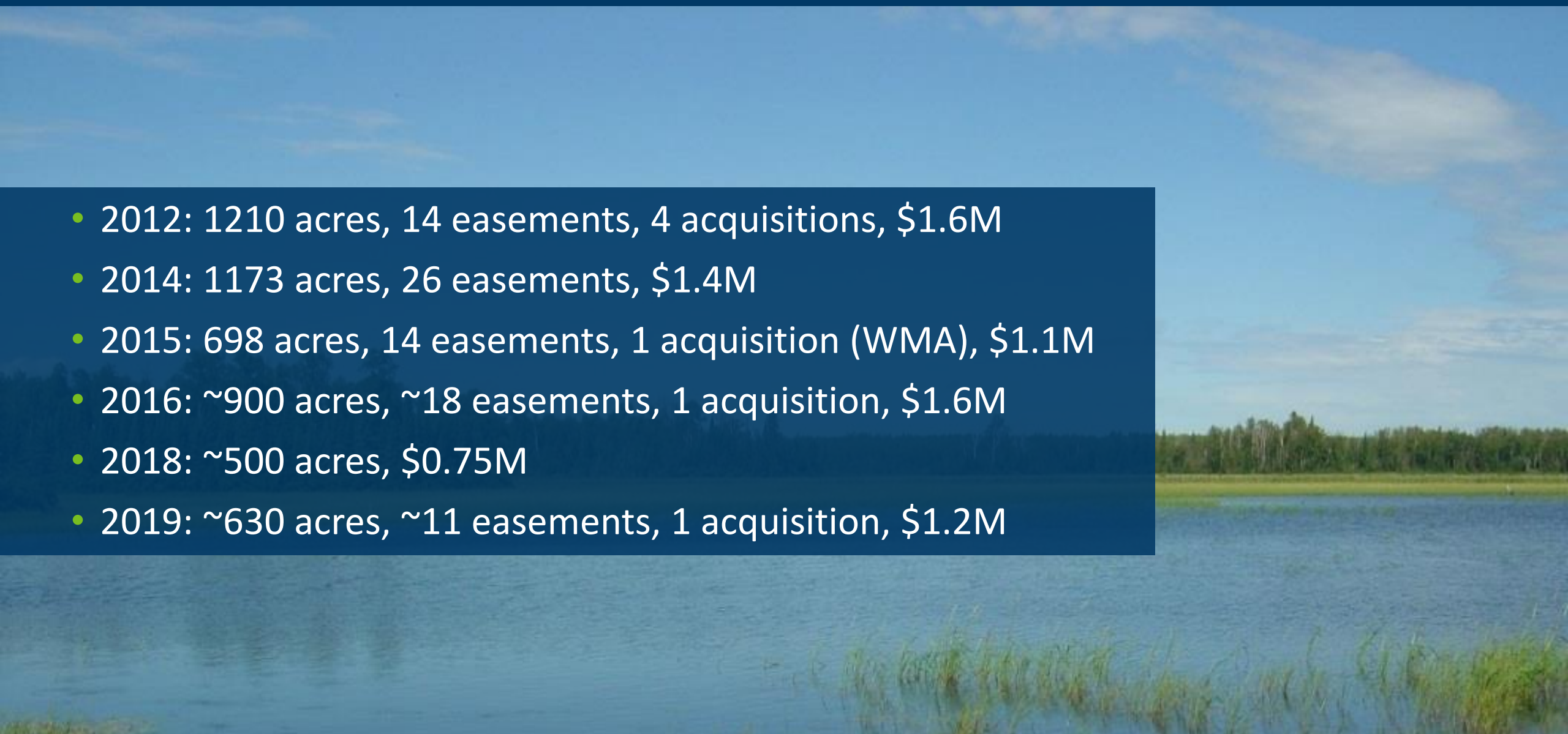
Nicole Hansel-Welch
MDNR, Shallow Lakes Program

Dan Steward
MN BWSR

Lakeshore property owners
8-14 County SWCDs, DU, DNR

Parcels ranked objectively using established criteria by project committee.

Wild Rice Lake Protection



- 2012: 1210 acres, 14 easements, 4 acquisitions, $1.6M
- 2014: 1173 acres, 26 easements, $1.4M
- 2015: 698 acres, 14 easements, 1 acquisition (WMA), $1.1M
- 2016: ~900 acres, ~18 easements, 1 acquisition, $1.6M
- 2018: ~500 acres, $0.75M
- 2019: ~630 acres, ~11 easements, 1 acquisition, $1.2M

Sensitive Lakeshore

Not all shorelines are created equal

Critical Lakeshore Protection

Science

DNR Sensitive Lakeshore Project

Advocacy

Collaboration

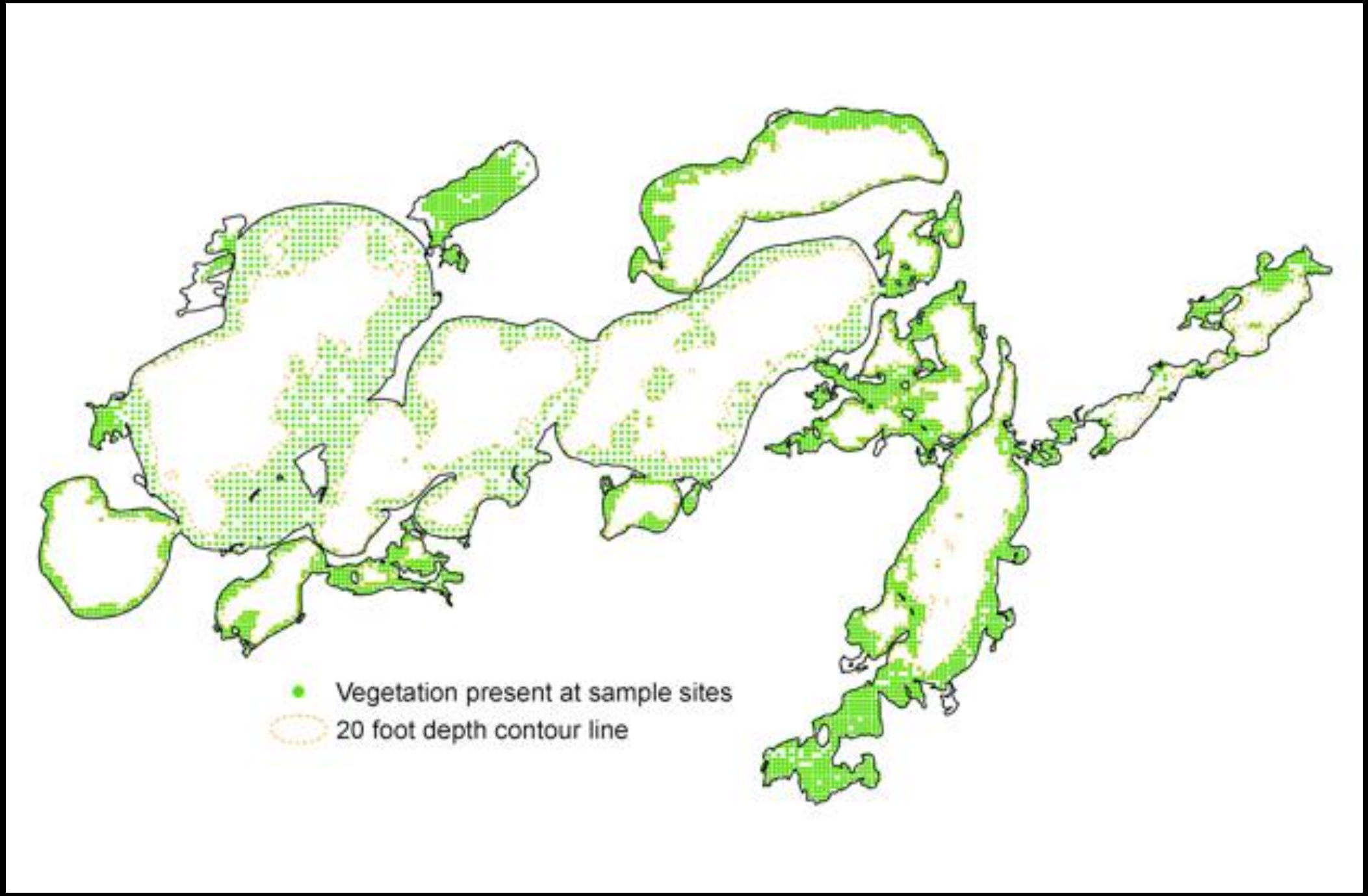
Lakeshore property owners

Initially Cass County and then all northcentral MN Counties

Lindsey Ketchel, Paula West
Leech Lake Area Watershed Foundation

Kris Larson
Minnesota Land Trust

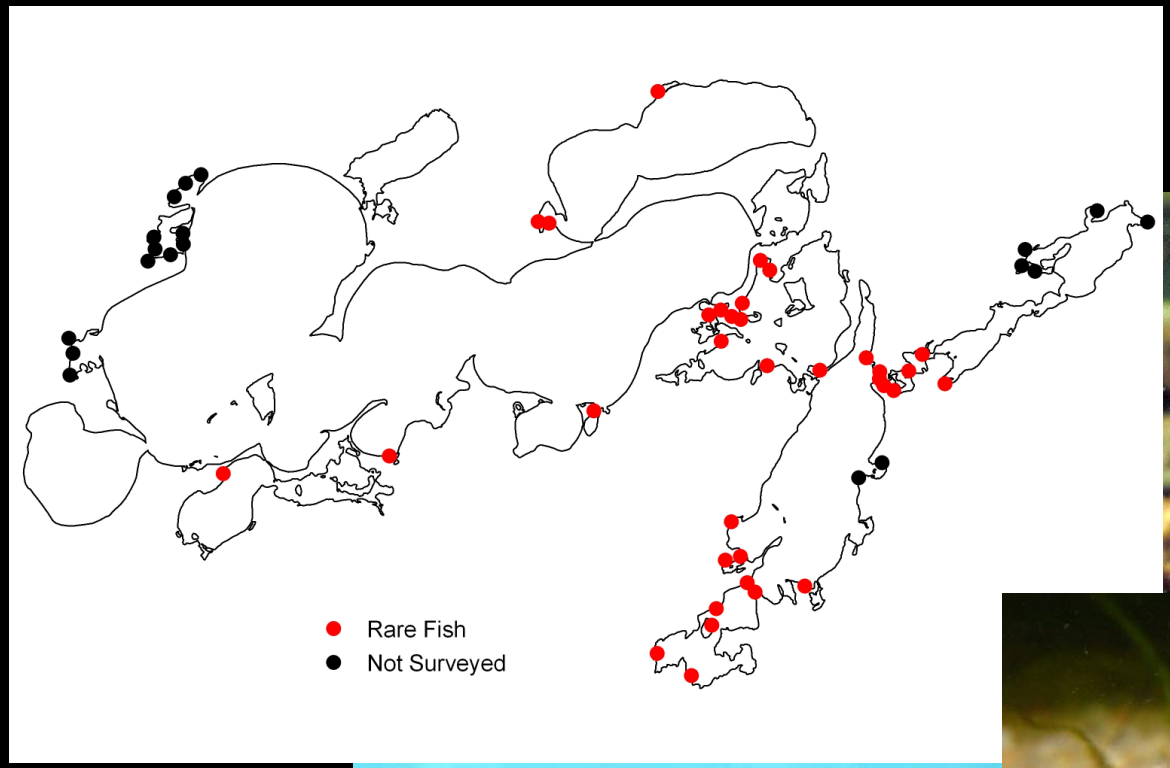
John Ringle
Cass County


Vegetation present at sample sites
20 foot depth contour line

Mixed bulrush beds
Mixed wild rice beds
Mixed waterlily beds
Other emergent species

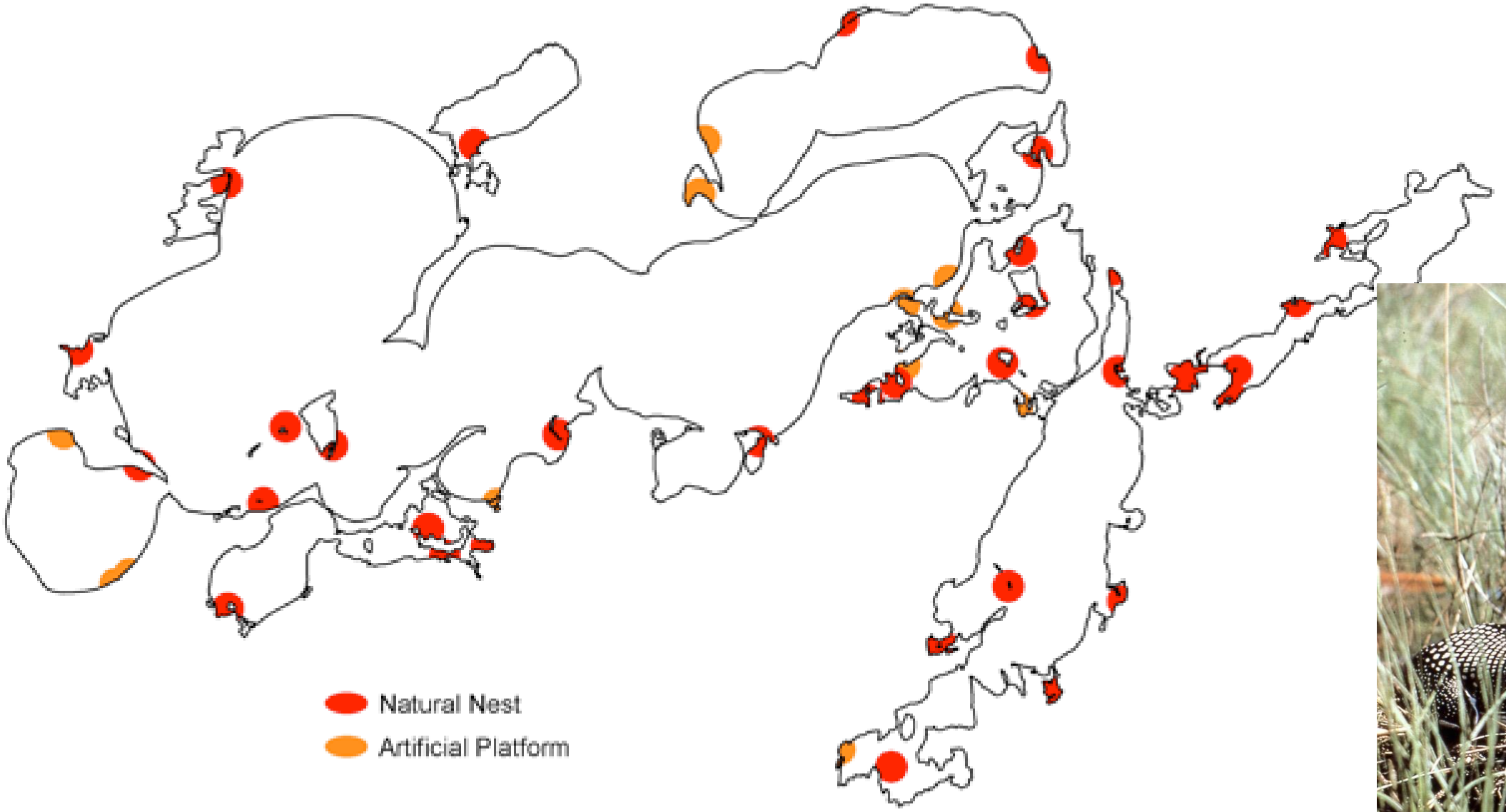
Point Count and Playback Surveys

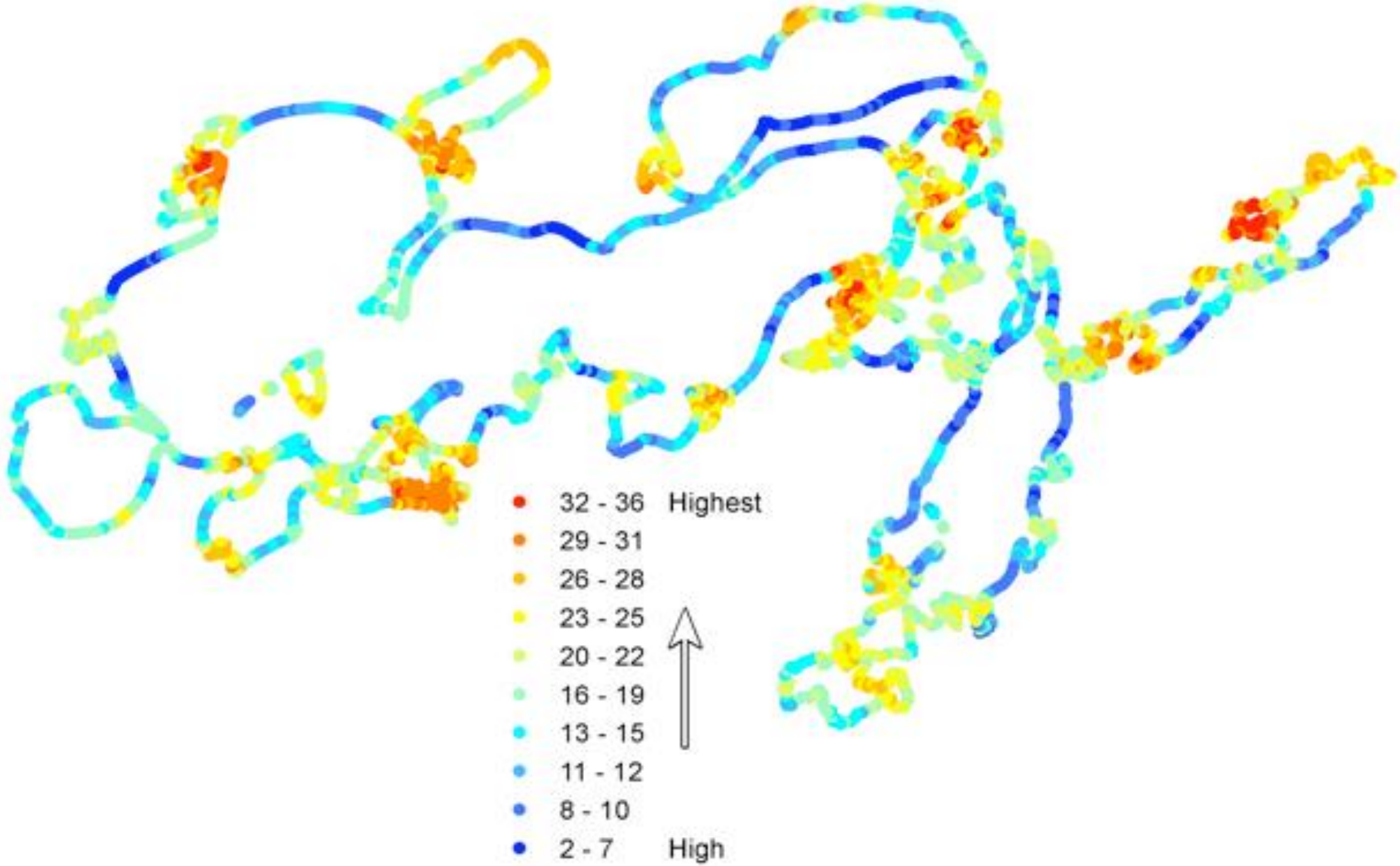
Fish SGCN Distribution

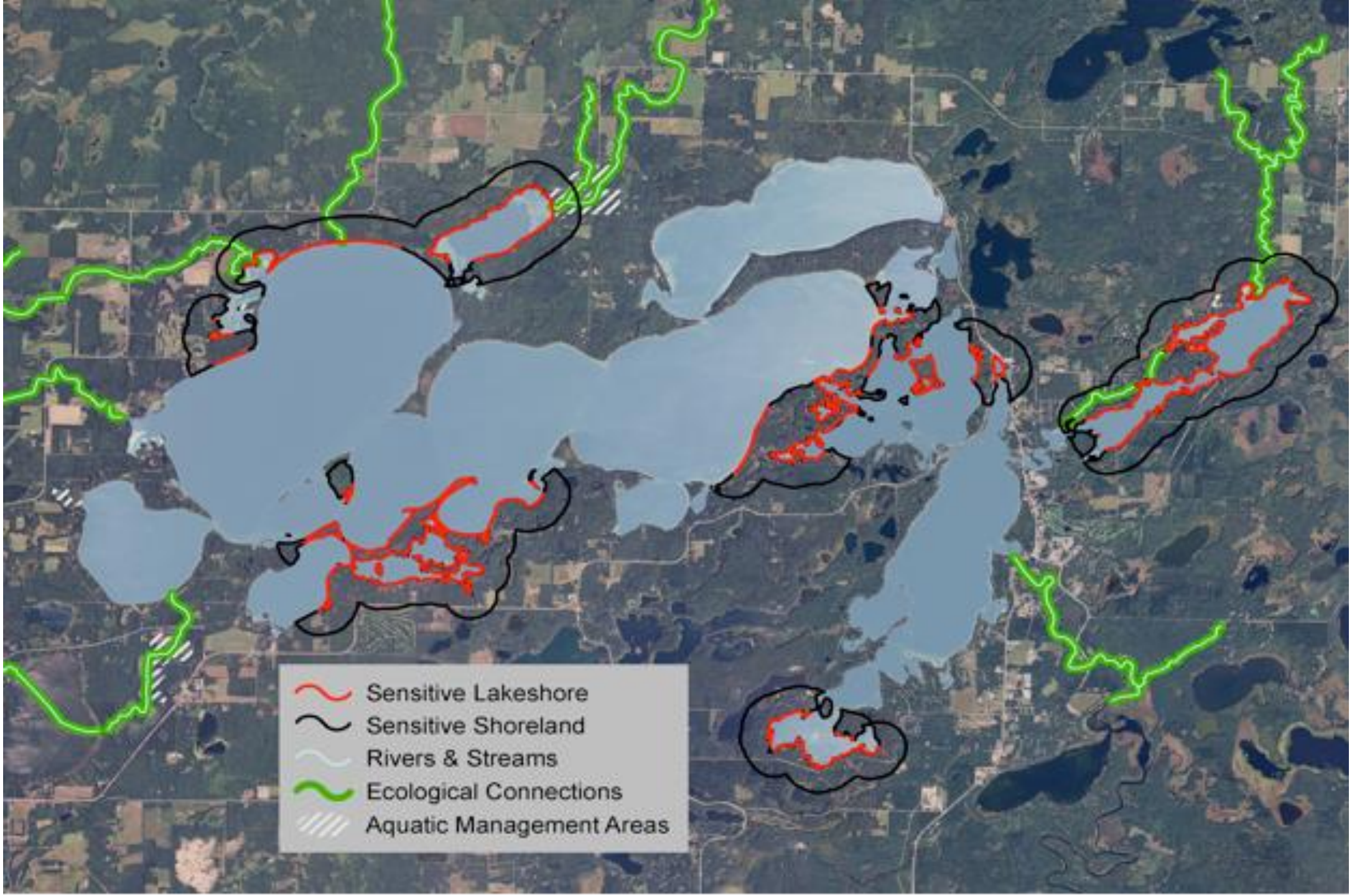


Green Frog

Mink Frog


Natural Nest
Artificial Platform


32 - 36 Highest
29 - 31
26 - 28
23 - 25
20 - 22
16 - 19
13 - 15
11 - 12
8 - 10
2 - 7 High


Sensitive Lakeshore
Sensitive Shoreland
Rivers & Streams
Ecological Connections
Aquatic Management Areas


Andrea Lee Lambrecht

Critical Lakeshore Protection

Science

Advocacy

Collaboration

DNR Sensitive Lakeshore Project

John Ringle
Cass County

Lakeshore property owners
Initially Cass County and then all northcentral MN Counties

Lindsey Ketchel, Paula West
Leech Lake Area Watershed Foundation

Kris Larson
Minnesota Land Trust

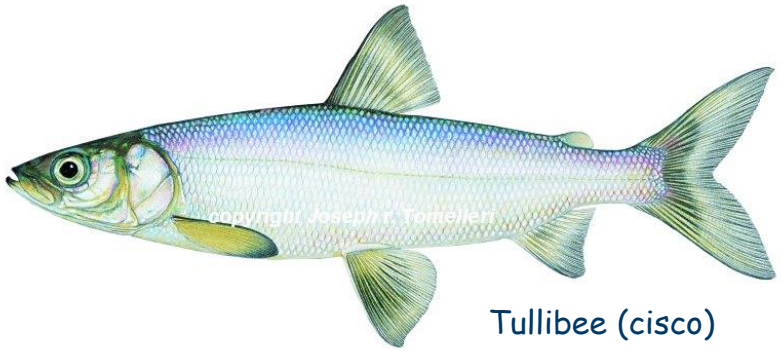
Wayne Ostlie
Minnesota Land Trust

Critical Lakeshore Protection

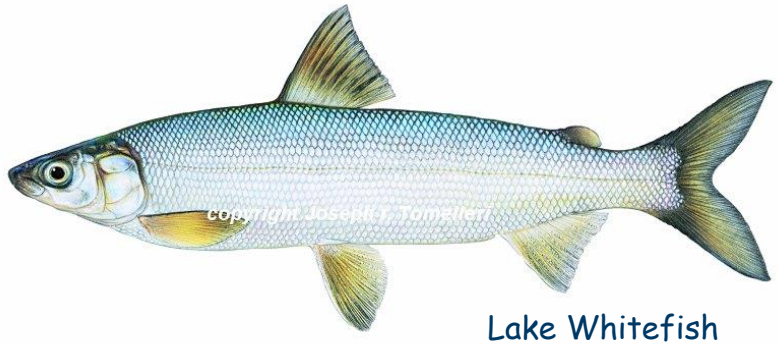
- 2011: 305 acres, 2.5 miles sensitive shoreline, 9 easements, $0.3M
- 2012: 260 acres, 3.6 miles sensitive shoreline, $0.3M
- 2014: 911 acres, 5.4 miles sensitive shoreline, 7 easements, $0.8M
- 2016: 641 acres, 7.5 miles critical shoreline, 7 easements, $1.6M
- 2018: ~330 acres, ~1 mile critical shoreline, $1.7M
- 2019: ~225 acres, 0.6 mile critical shoreline, $1M

Treasures of the Deep: protecting hypolimnetic oxygen in Minnesota lakes

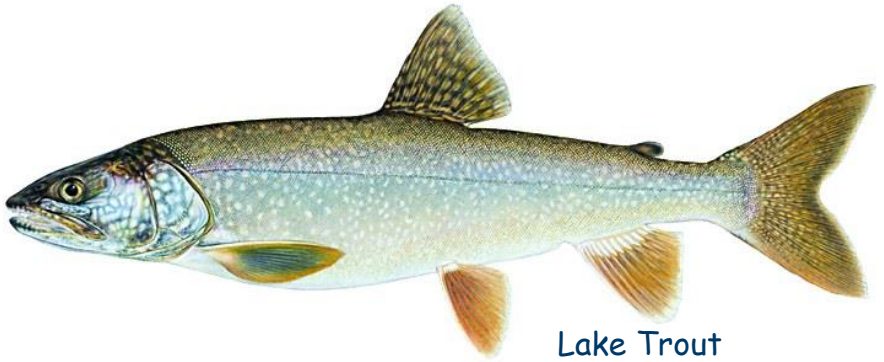
- Hypolimnetic oxygen will be an increasingly valuable ecological resource in a climate warmed Minnesota
- Deep lakes with good water quality need extra protection
- Statewide significance
- High priority for shoreland and watershed protection



Tullibee (cisco)



Lake Whitefish



Lake Trout

Artwork - Joseph Tomelleri

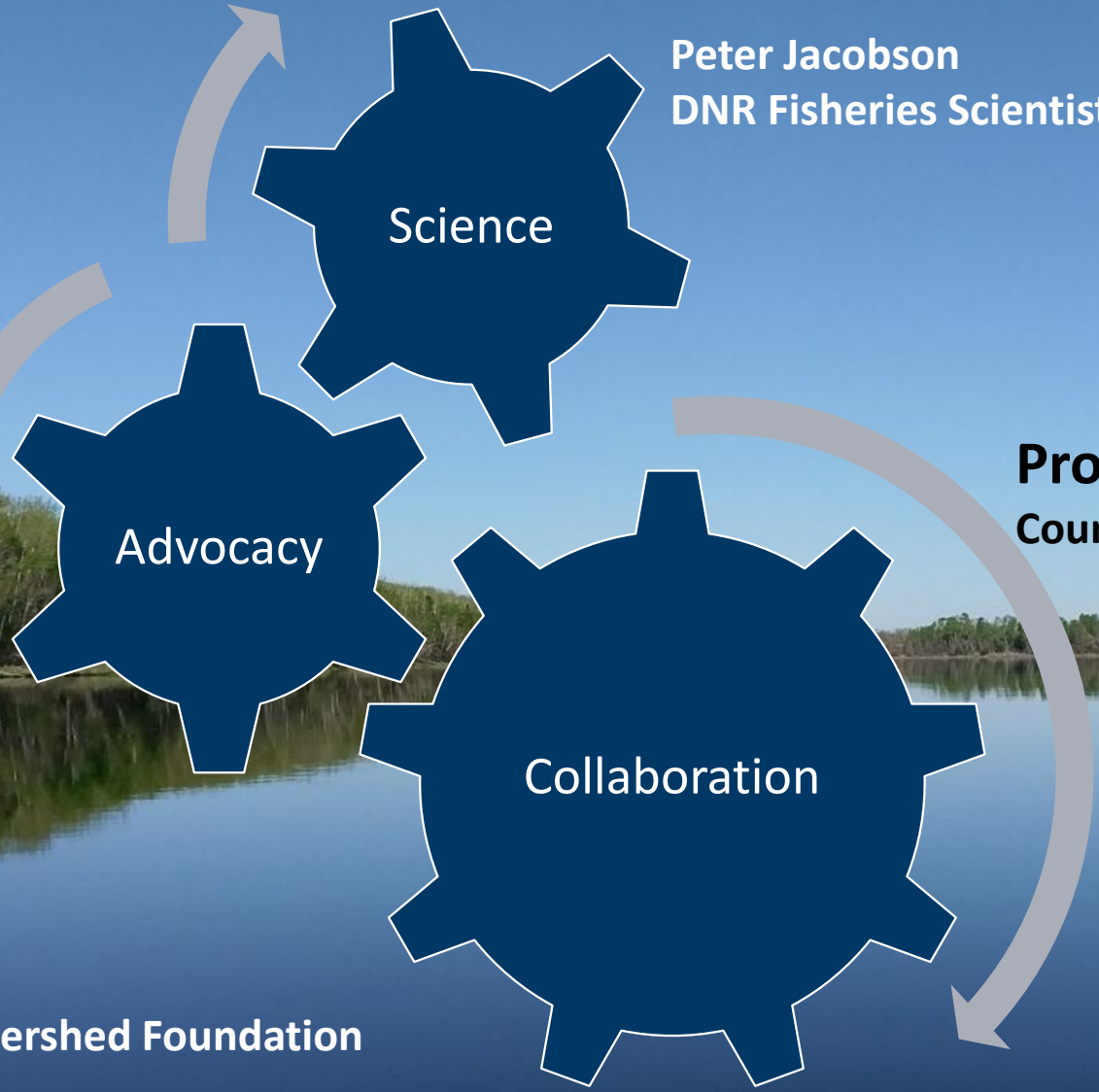
Cisco Lake Protection

Peter Jacobson
DNR Fisheries Scientist

Lindsey Ketchel
Leech Lake Area Watershed Foundation

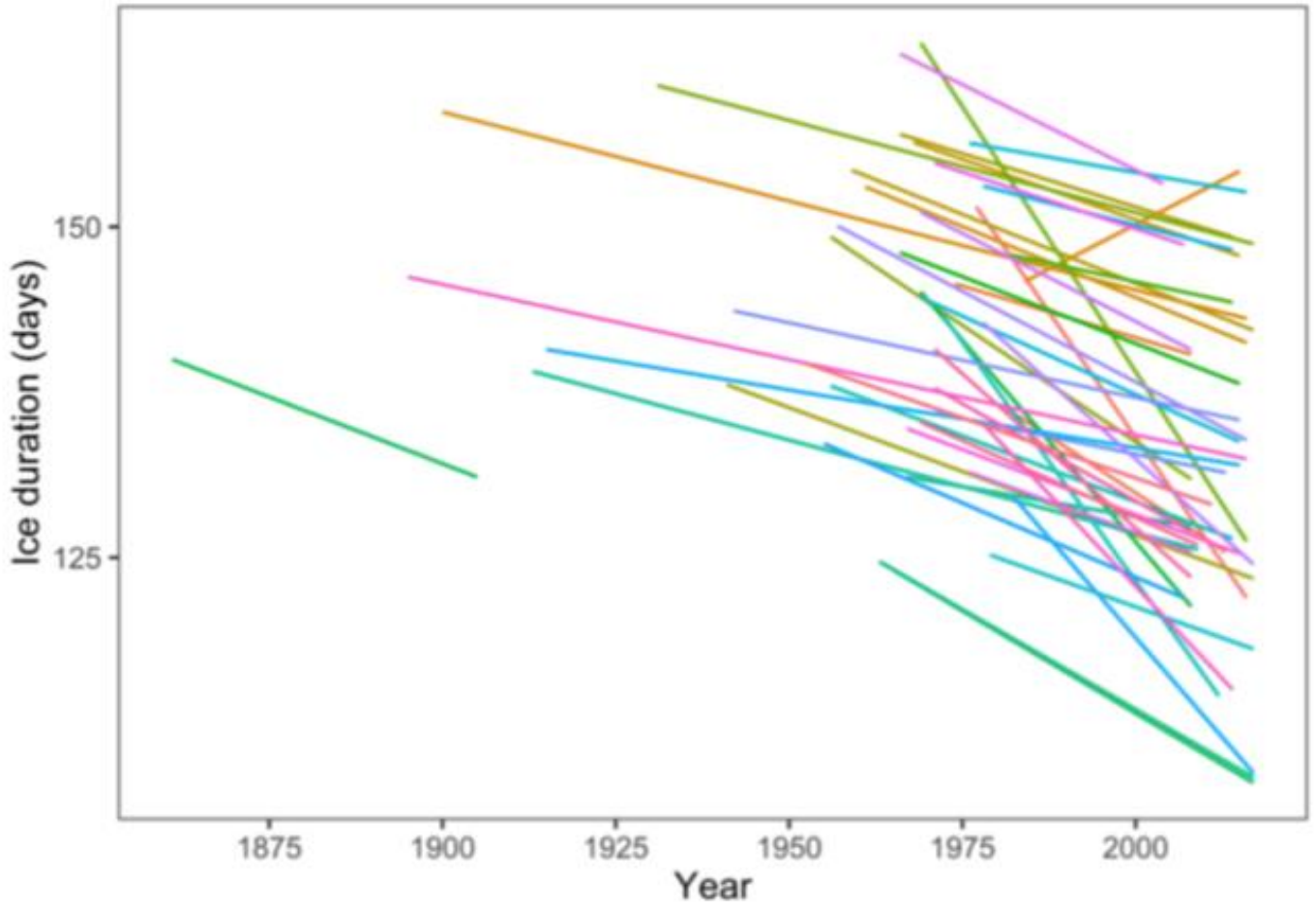
Property Owners on Cisco Lakes
County SWCDs

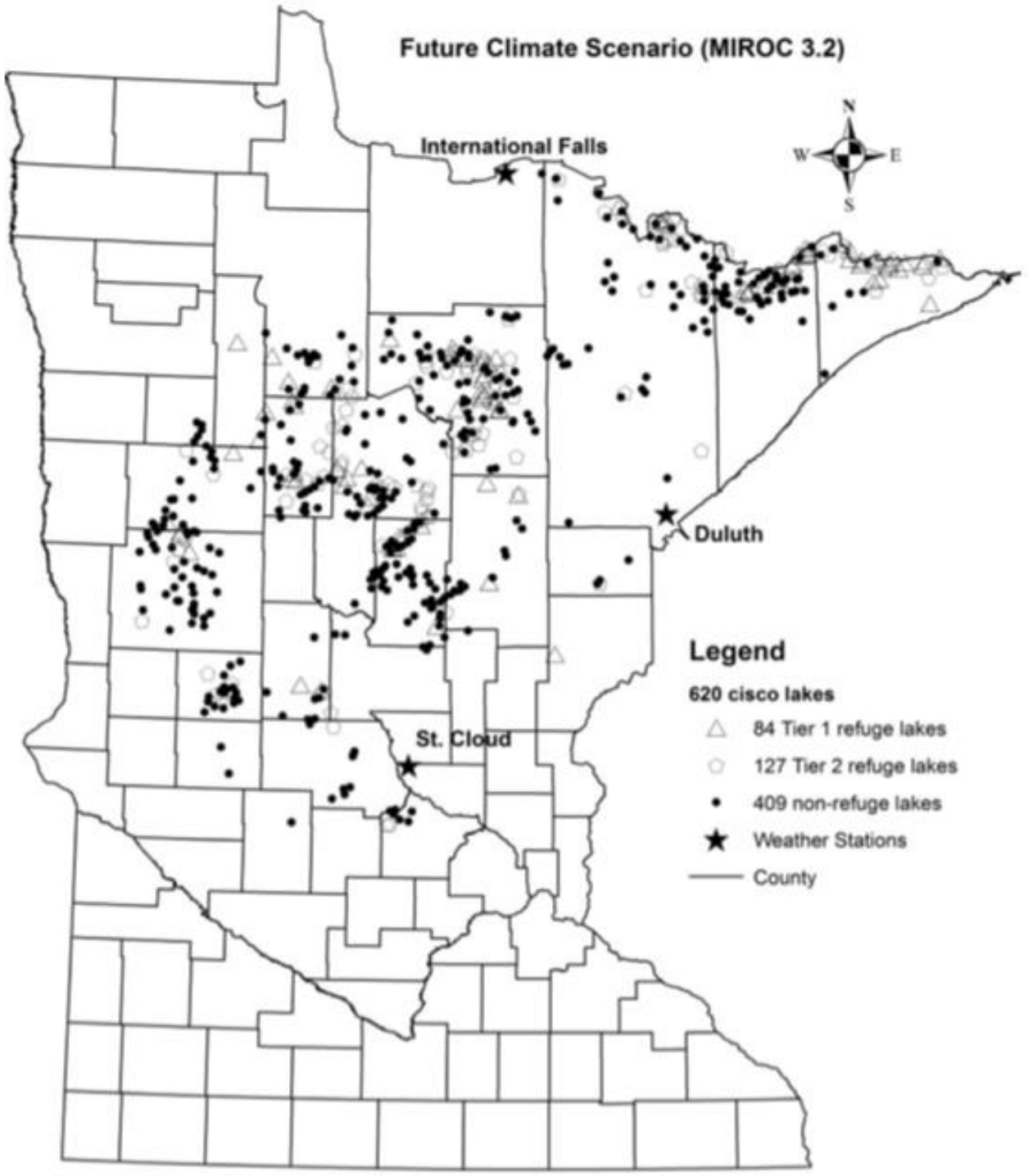
Kris Larson
Minnesota Land Trust



Lake Ice Season Decreasing

- MN long-term decline is 1.8 days/decade
- Decline from 1987-2017 is -4.2 days per



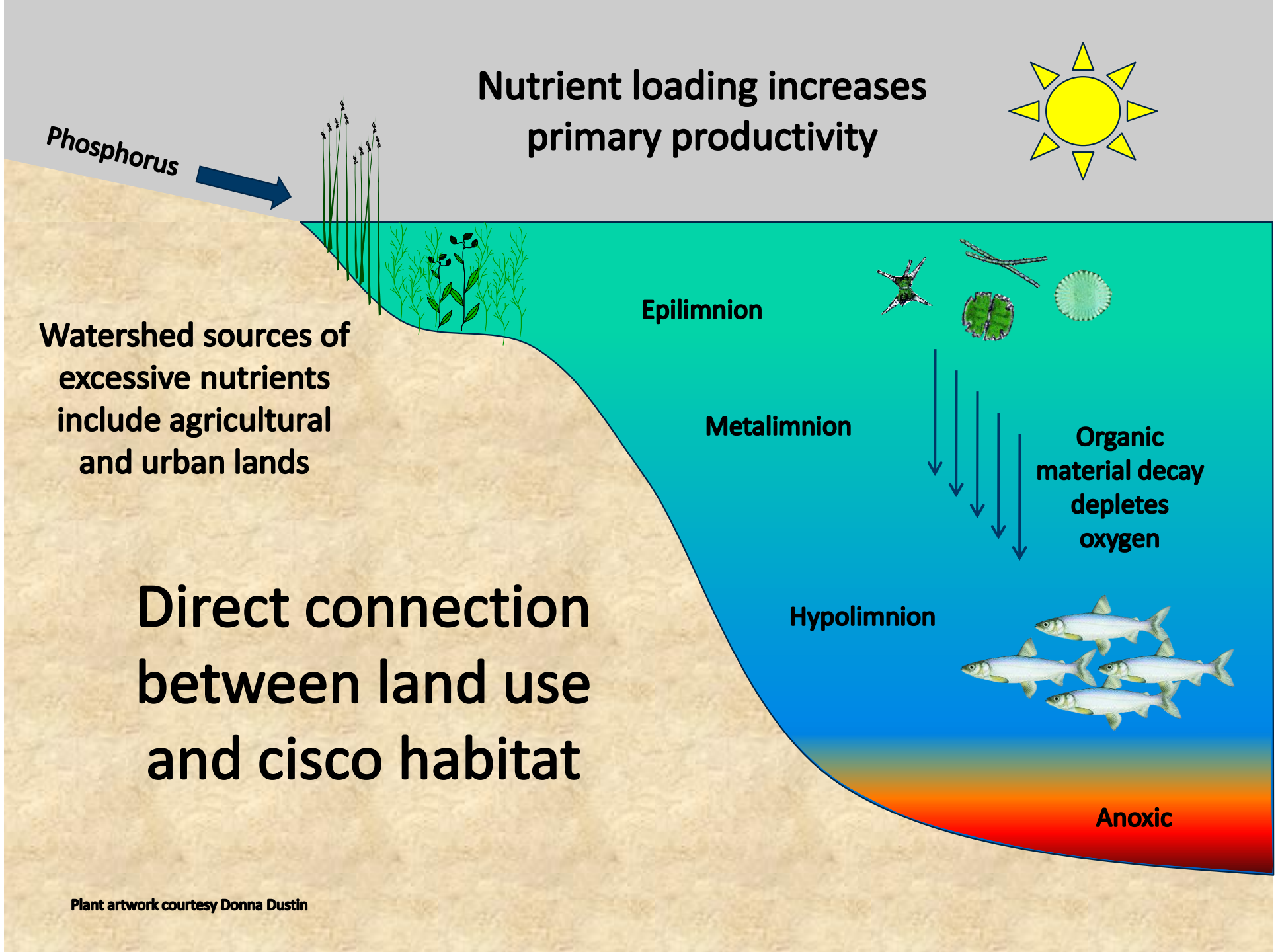


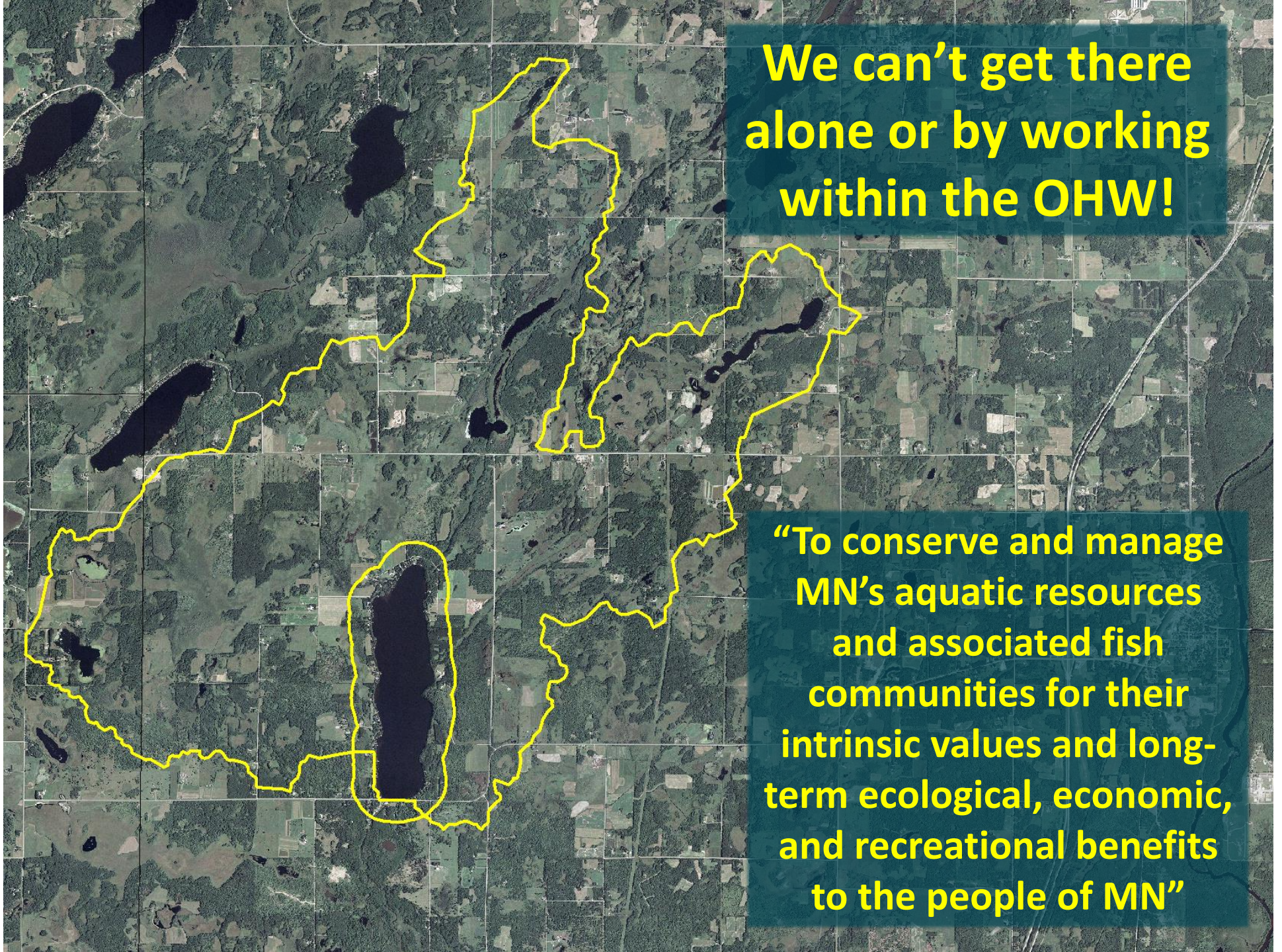
"about one-third of the 620 lakes that currently have cisco populations are projected to be able to maintain cisco habitat under future climate scenarios"

"results predict that 67% of current cisco lakes will become nonrefuge lakes, which is similar to the results of a recent study of about 170 cisco lakes in Wisconsin (Sharma et al. 2011)"

"Only if the water quality in these [refuge] lakes is maintained will they truly be able to function as refuges from climate warming for coldwater fish such as the cisco."

Fang et al. 2014. Identifying Cisco Refuge Lakes in Minnesota under Future Climate Scenarios.

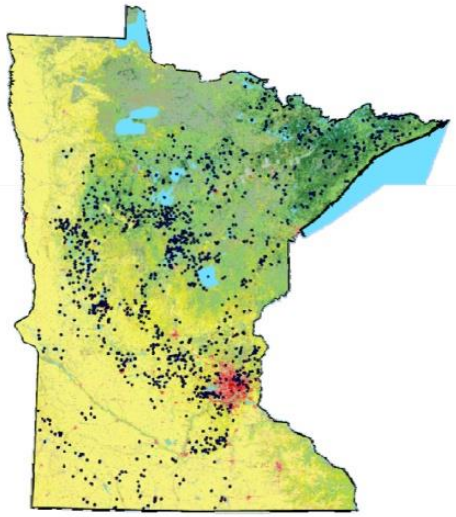

Nutrient loading increases primary productivity
Phosphorus
Watershed sources of excessive nutrients include agricultural and urban lands
Epilimnion
Metalimnion
Organic material decay depletes oxygen
Hypolimnion
Anoxic
Direct connection between land use and cisco habitat
Plant artwork courtesy Donna Dustin


We can’t get there alone or by working within the OHW!
“To conserve and manage MN’s aquatic resources and associated fish communities for their intrinsic values and long-term ecological, economic, and recreational benefits to the people of MN”

Land disturbance predicts WQ

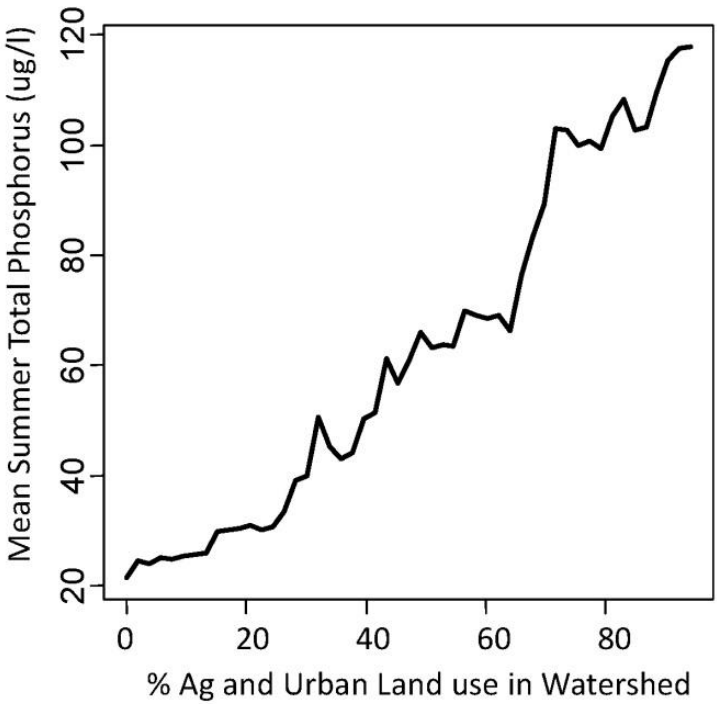
Phosphorus Model

Mean summer Total P in 1330 lakes as a function of depth, watershed ratio, and land use disturbance

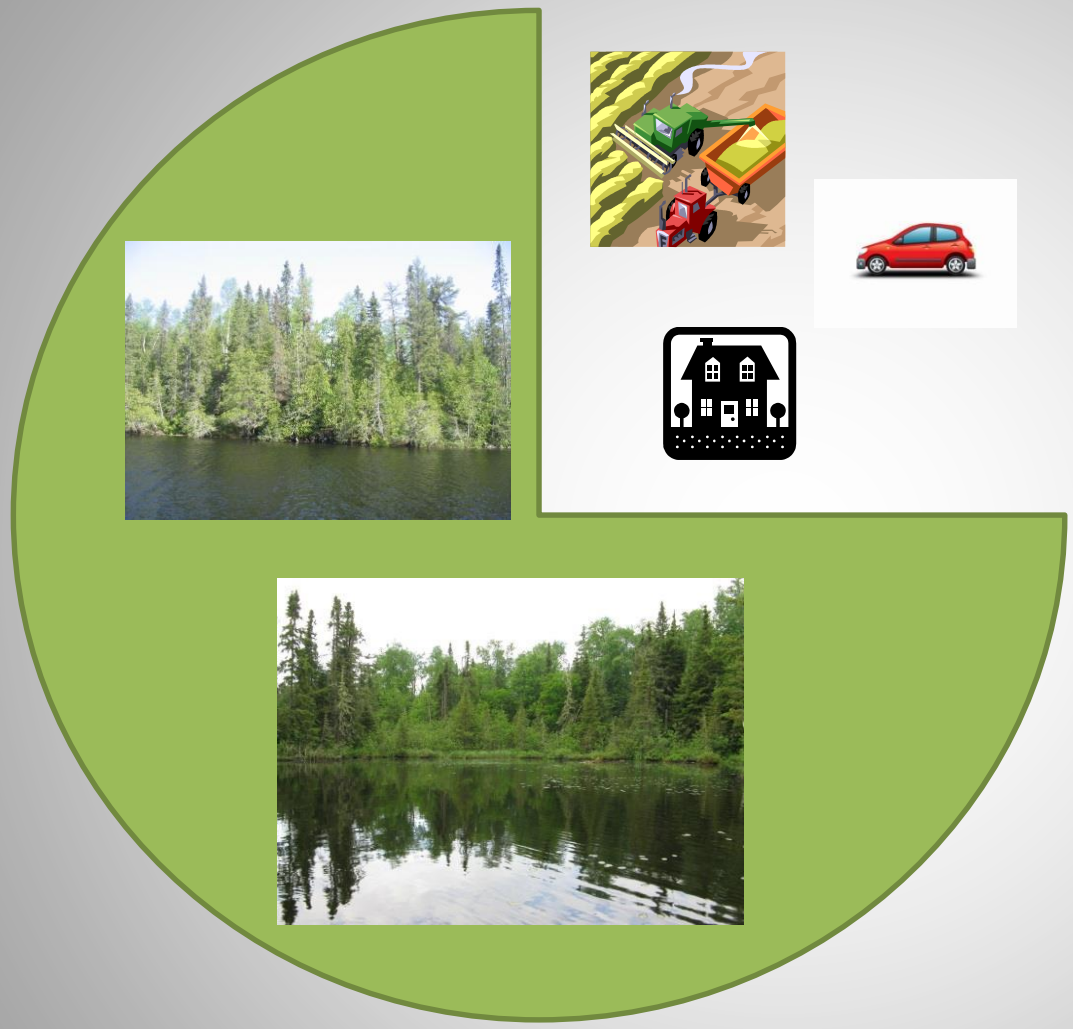


Partial Dependence on % Disturbance

Random Forest Model



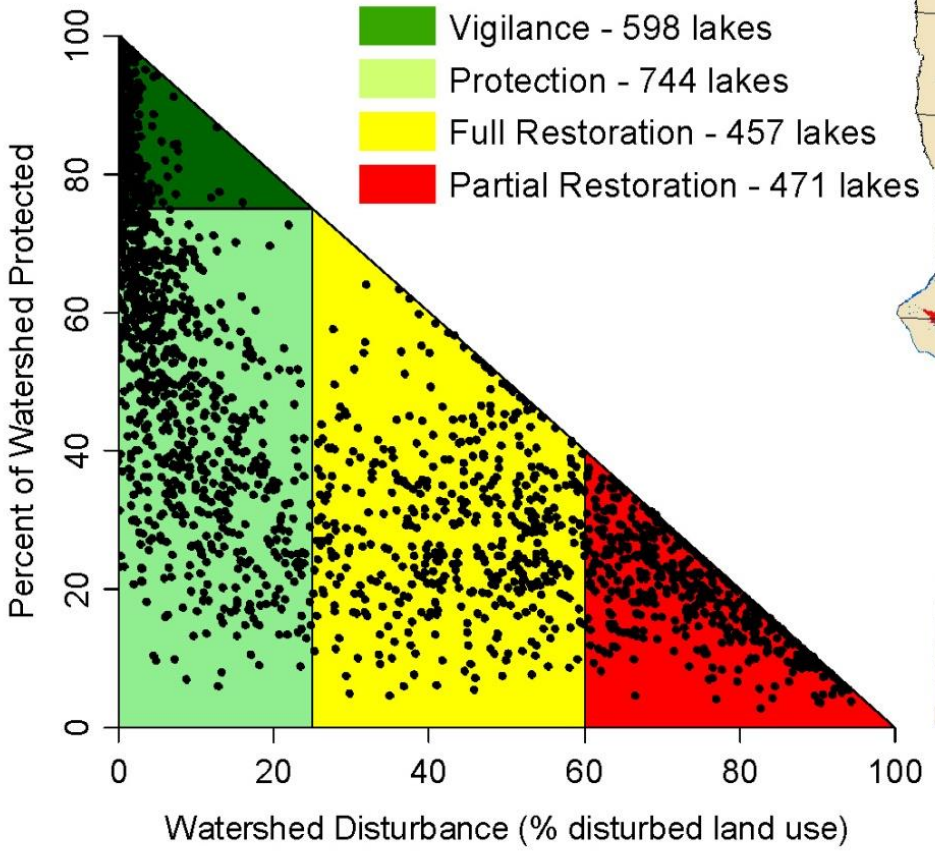
Tim Cross and Pete Jacobson

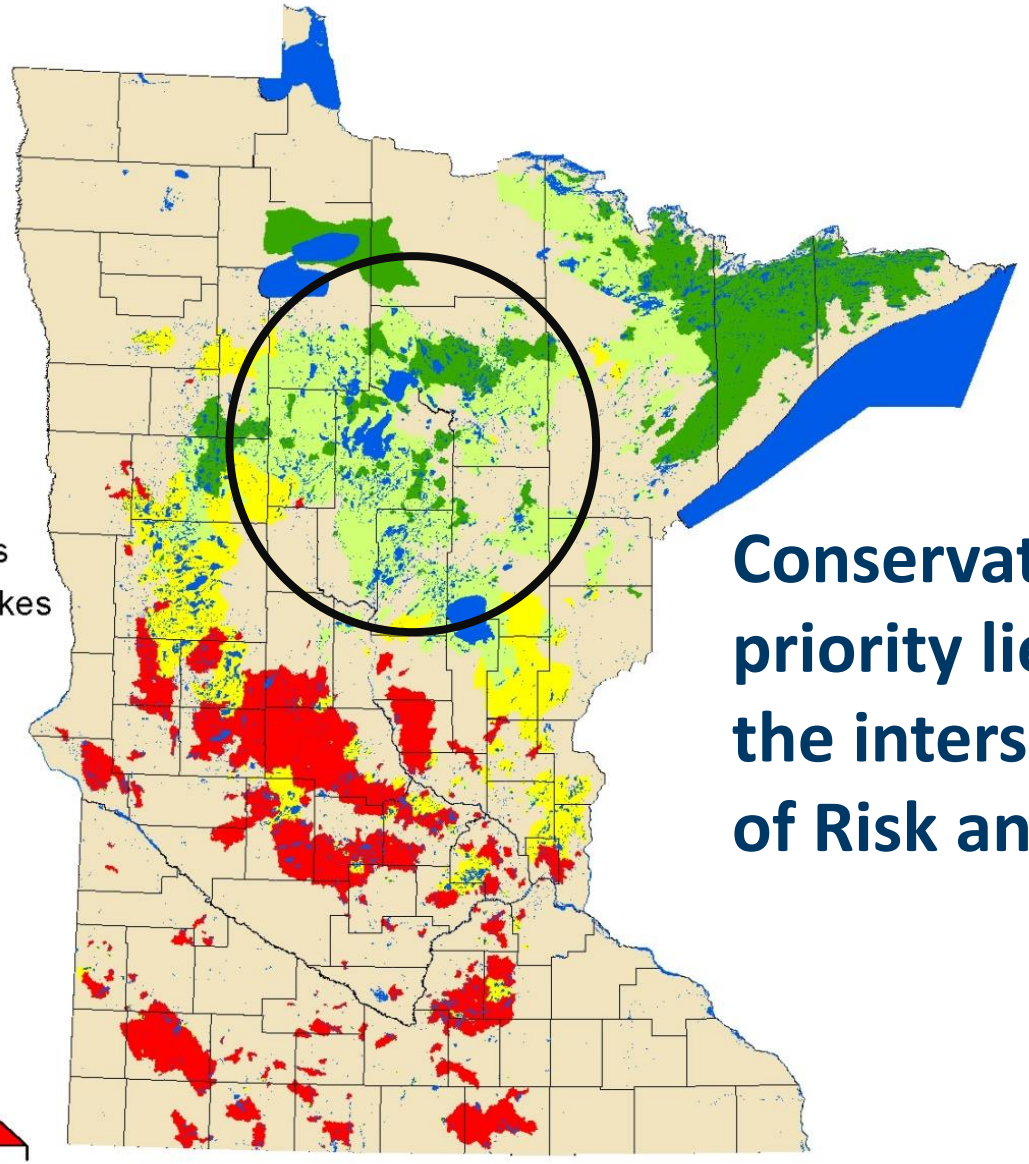


Protecting 75% of the watershed of a lake as forested keeps good water quality and good fish habitat

T. Cross and P. Jacobson (2013) : Landscape factors influencing lake phosphorus concentrations across Minnesota, Lake and Reservoir Management, 29:1, 1-12

Watershed Disturbance Class for lake catchments



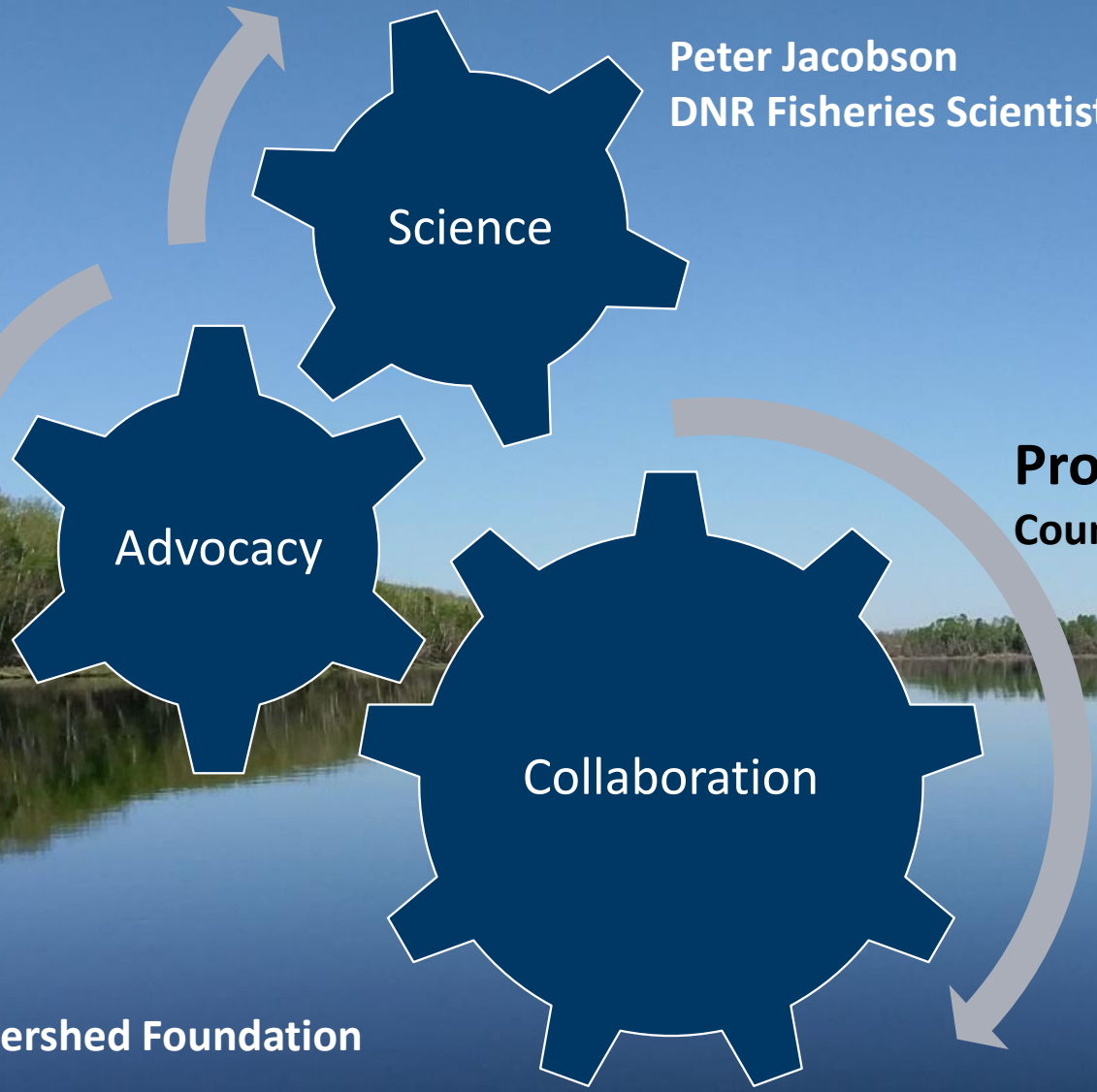


Conservation priority lies at the intersection of Risk and Value

Cisco Lake Protection

Peter Jacobson
DNR Fisheries Scientist

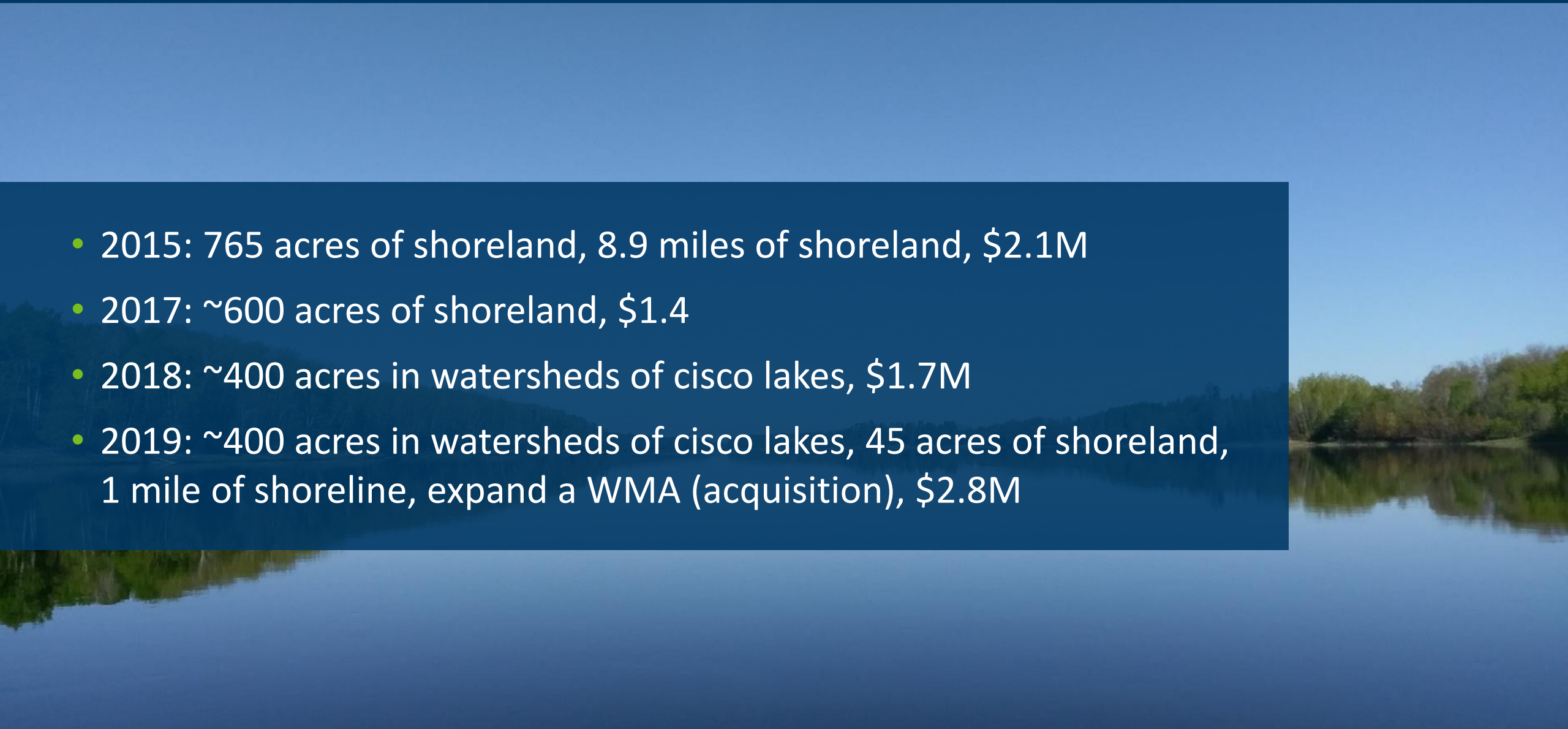
Lindsey Ketchel
Leech Lake Area Watershed Foundation



Property Owners on Cisco Lakes
County SWCDs

Kris Larson
Minnesota Land Trust

Critical Lakeshore Protection

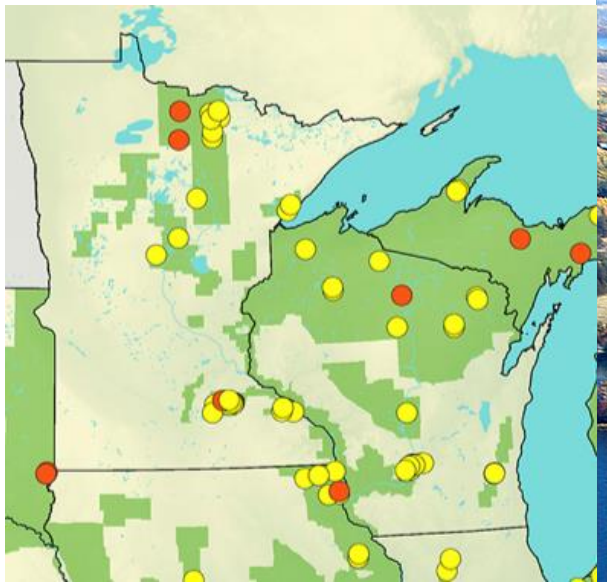


- 2015: 765 acres of shoreland, 8.9 miles of shoreland, $2.1M
- 2017: ~600 acres of shoreland, $1.4
- 2018: ~400 acres in watersheds of cisco lakes, $1.7M
- 2019: ~400 acres in watersheds of cisco lakes, 45 acres of shoreland, 1 mile of shoreline, expand a WMA (acquisition), $2.8M

Working Forests

Forest Legacy Program

- Administered by the USFS
- WI & MN are partner states in the program
- Funded by the Land and Water Conservation Fund
- WI: 30 tracts, 118,000 acres
- MN 34 tracts, 146,000 acres



Working Forests

MN Sustainable Forest Incentive Act (SFIA)

- Annual incentive payments to encourage private landowners to keep their wooded areas undeveloped.
- Payment amounts vary based on covenant length (8, 20, or 50 years) and acres enrolled ($9-$19/year)
- Forest management plan

Clean Water Fund

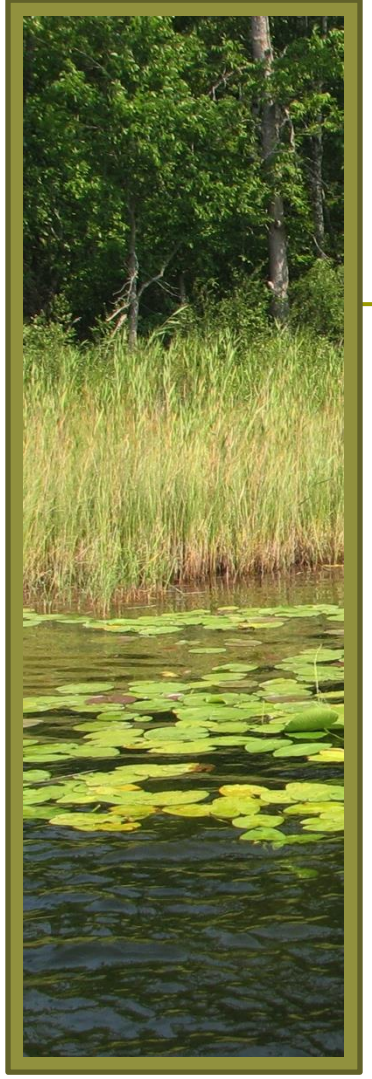
Why Prioritize?

- we have a lot of water and don’t have resources to work everywhere

What Lakes Should We Invest In?

MINNESOTA

Pollution Control Agency | Department of Natural Resources | Board of Soil and Water Resources



Common Prioritization Approaches

- First Come (Impaired?), First Served
- Squeaky Wheel
- Those with Resources get more Resources
- Science-based (ecological, economic, etc.)
- Various combinations

Avoid: Arbitrariness & Hidden value judgments

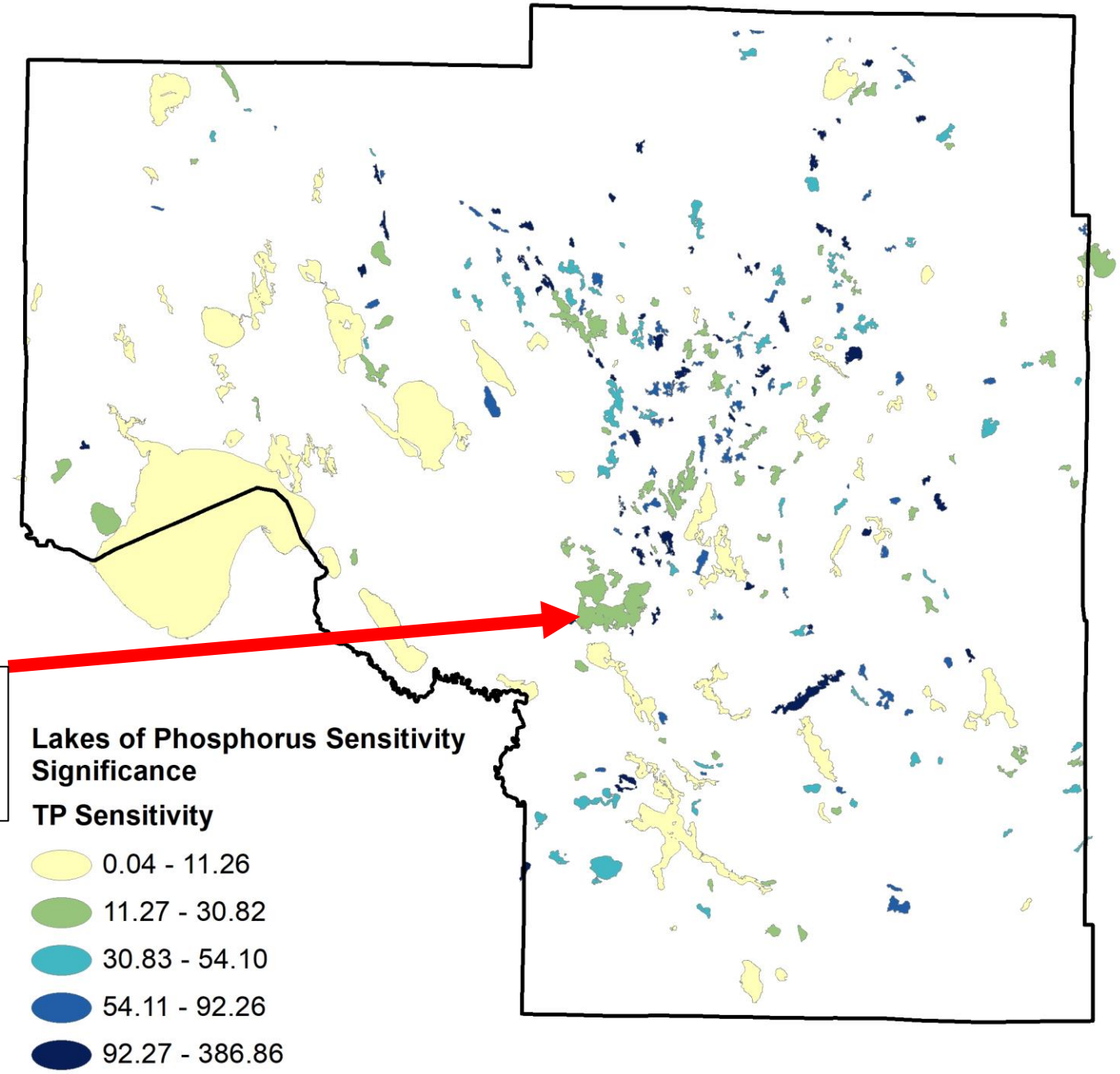
Lake Prioritization for Local Gov

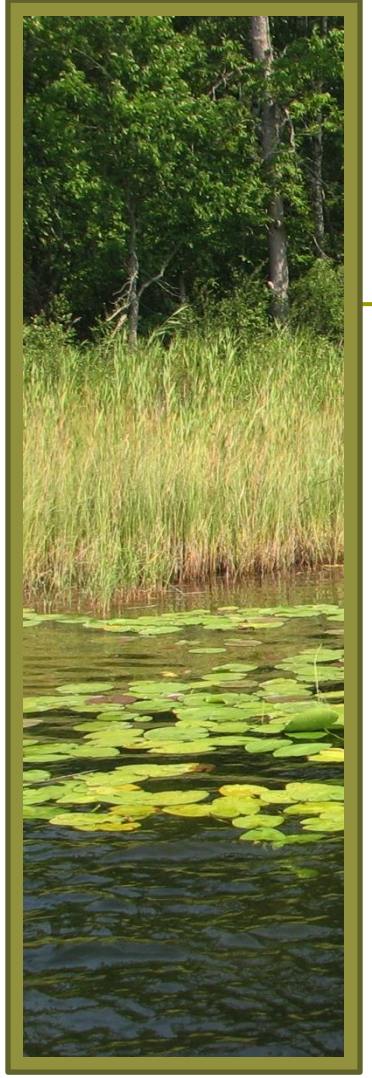
- Different objectives:
  - *Focus on impaired lakes*
    - **MPCA List**
  - *Focus on high-quality lakes at greatest risk of becoming degraded or further degraded*
    - **Lakes of Phosphorus Sensitivity Significance**
  - *Focus on lakes with high-quality biological communities*
    - **Lakes of Biological Significance**
  - *Focus on high-value lakes that provide the greatest return on investment*
    - ***Lake Benefit:Cost Assessment***

TP Sensitivity

Inches lost in water clarity with +100 lbs TP

Deer Lake
~2’ of water clarity lost with 100lbs of P
~25 lb/year phosphorus reduction goal





Lakes of Phosphorus Sensitivity Significance (LPSS)

Factors

- TP sensitivity (inches of water clarity lost with 100 pounds of phosphorus)
- Lake size
- Proximity to impairment threshold
- % watershed disturbance

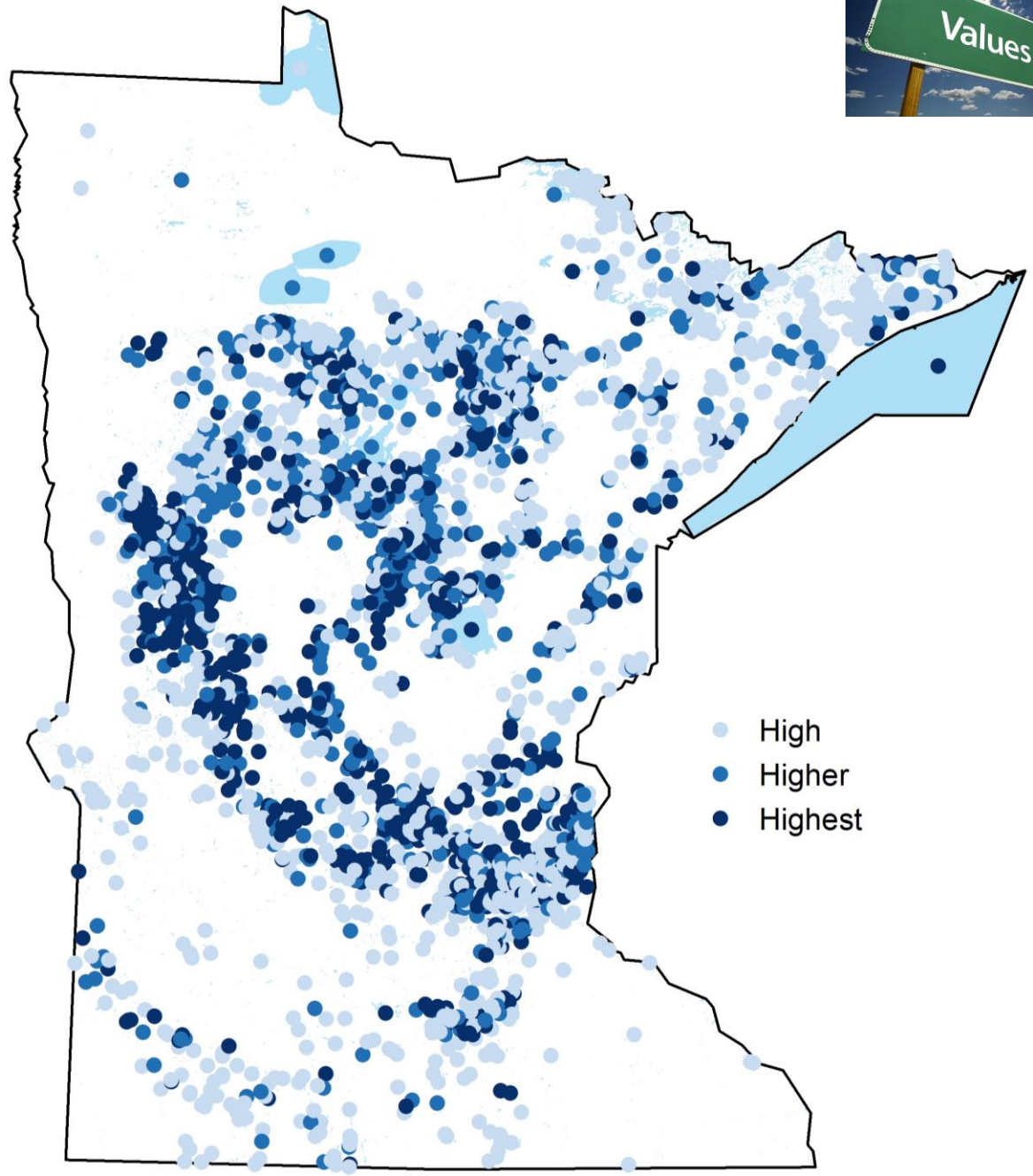
Output for each lake:

- Priority score - 0 to 100 (low to high)
- Priority ranking & class
- Load reduction goal (5% reduction; pounds/year)

LPSS Priority Score

Based on a lake's sensitivity significance and presence of declining water quality trend

Focus on high-quality lakes at greatest risk of becoming degraded or further degraded



Lake Prioritization for Local Gov

- Different objectives:
  - *Focus on impaired lakes*
    - **MPCA List**
  - *Focus on high-quality lakes at greatest risk of becoming degraded or further degraded*
    - **Lakes of Phosphorus Sensitivity Significance**
  - *Focus on lakes with high-quality biological communities*
    - **Lakes of Biological Significance**
  - *Focus on high-value lakes that provide the greatest return on investment*
    - ***Lake Benefit:Cost Assessment***

Focus on Impaired Lakes

- **80% spent on restoration projects for Impaired Waters**
- **> 600 Nutrient Impaired Lakes**

Lakes with low BCR

Impaired Lakes → Higher Costs

- IF restoration focused on the top 100 BCR impaired lakes, THEN Cost = $80 million & Benefit = $34 million
- For the same $80 million, selecting high BCR lakes without regard to impairment status:

  198 lakes (vs. 100)

  Benefit = $209 million (vs. $34 million)

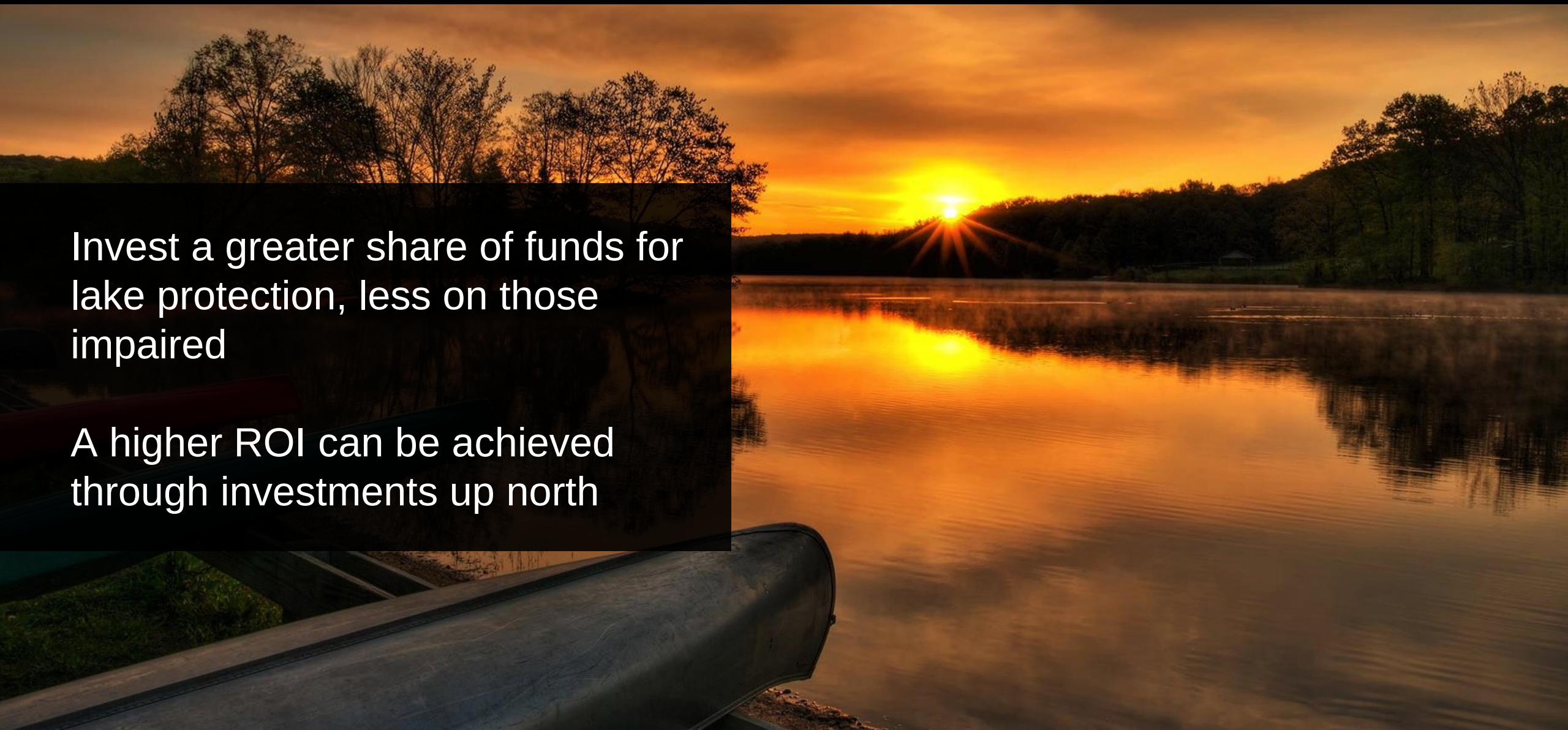
6X greater ROI if focused on high BCR lakes over focus on impaired lakes

Which Lakes Would You Prioritize?

Think about giving higher priority to lakes that are:

- Large
- Sensitive to Phosphorus loading
- Protected with cost-effective strategies (forested shoreland)
- In cities or highly developed
- High value biological communities

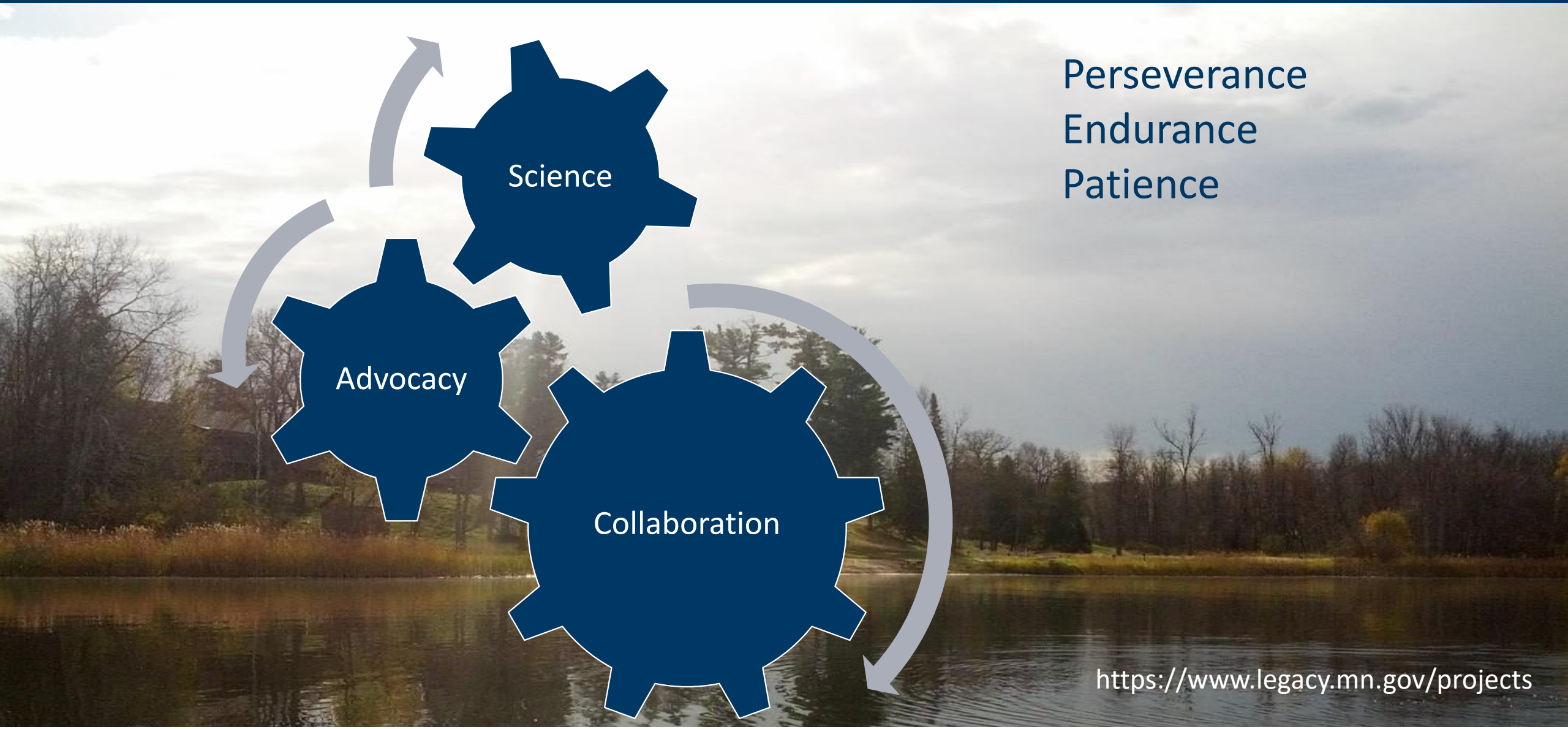
Benefit Cost Ratio Analysis



Invest a greater share of funds for lake protection, less on those impaired

A higher ROI can be achieved through investments up north

Process



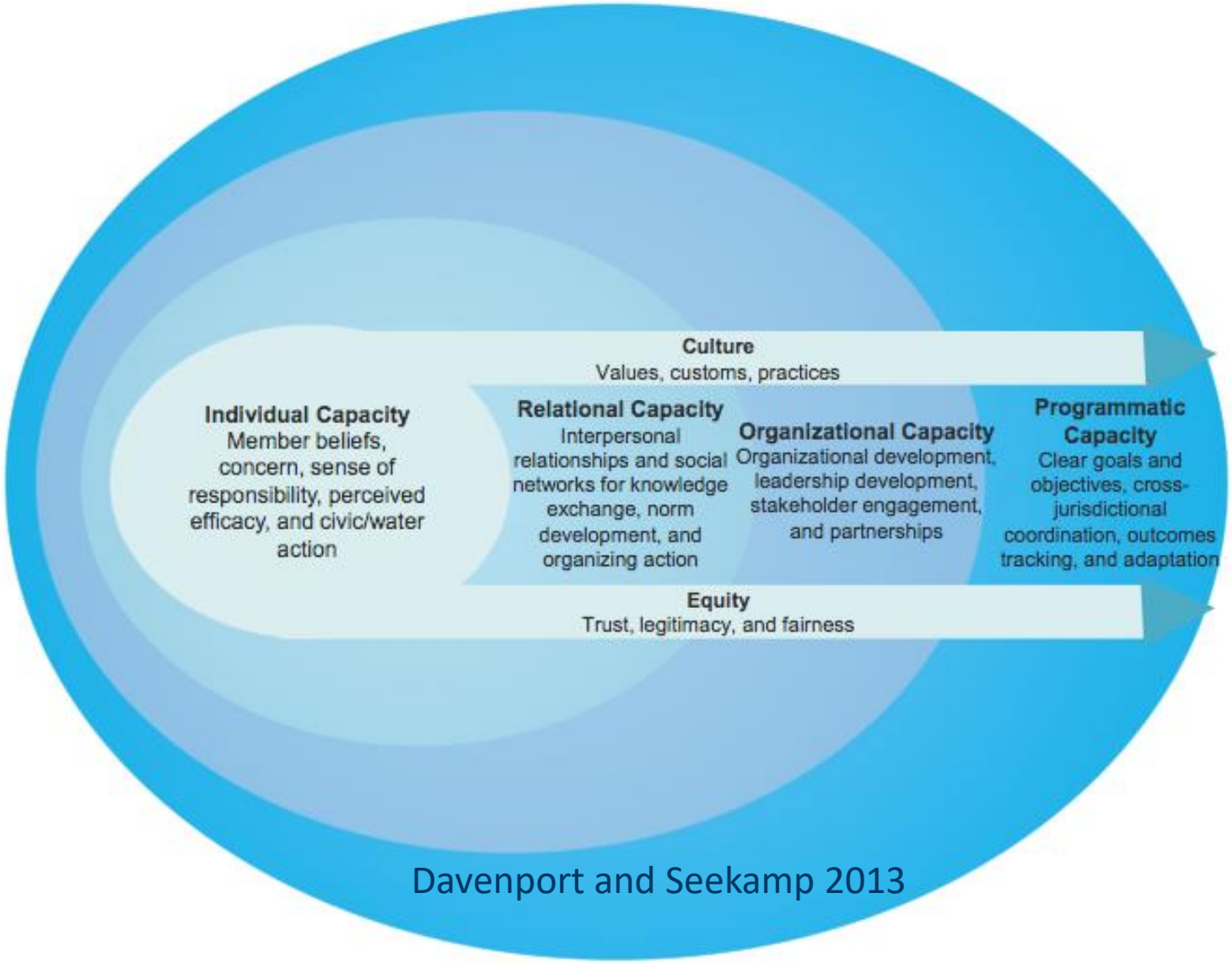
Perseverance
Endurance
Patience

https://www.legacy.mn.gov/projects

Lake Protection and Prioritization

Environmental problems are **social** problems

Dr. Amit Pradhananga
University of MN



Davenport and Seekamp 2013

Lake Protection and Prioritization

- Systematic, thoughtful, deliberate
- Relationships are critical
- You get big things done if you address capacity and find ways to collaborate

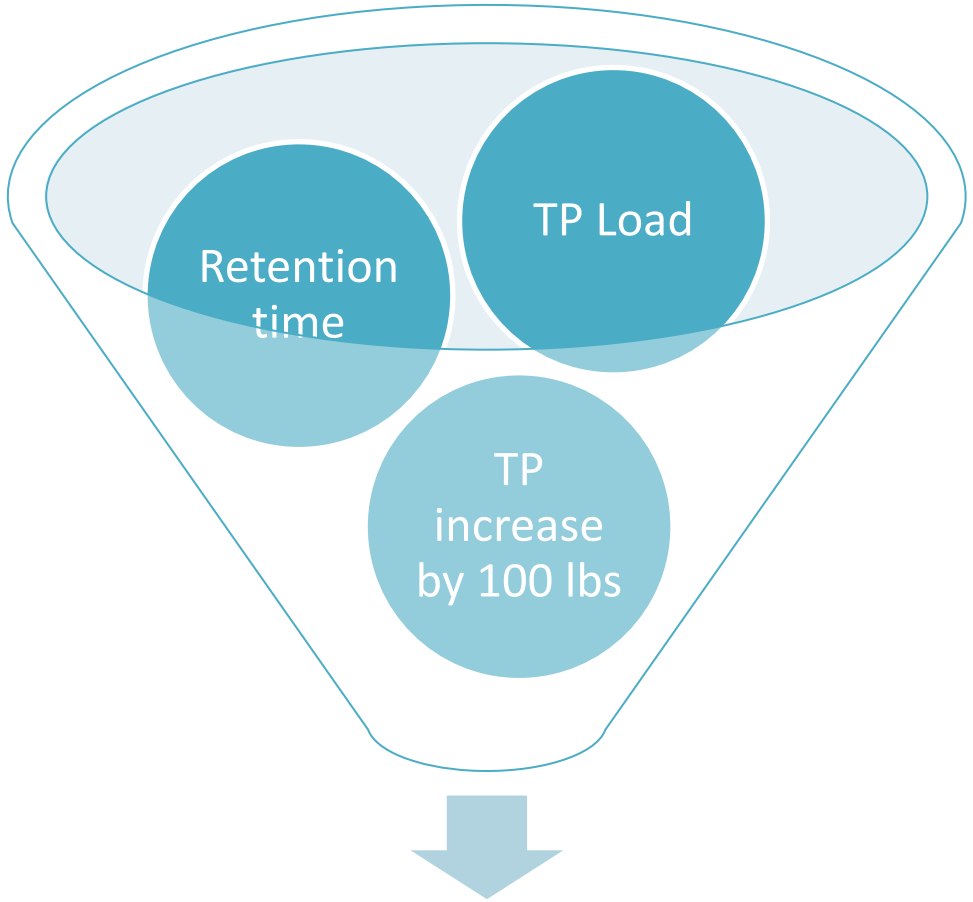
Thank you. Questions?

Paul Radomski | Lake Ecologist

September 2019

MINNESOTA
Department of Natural Resources

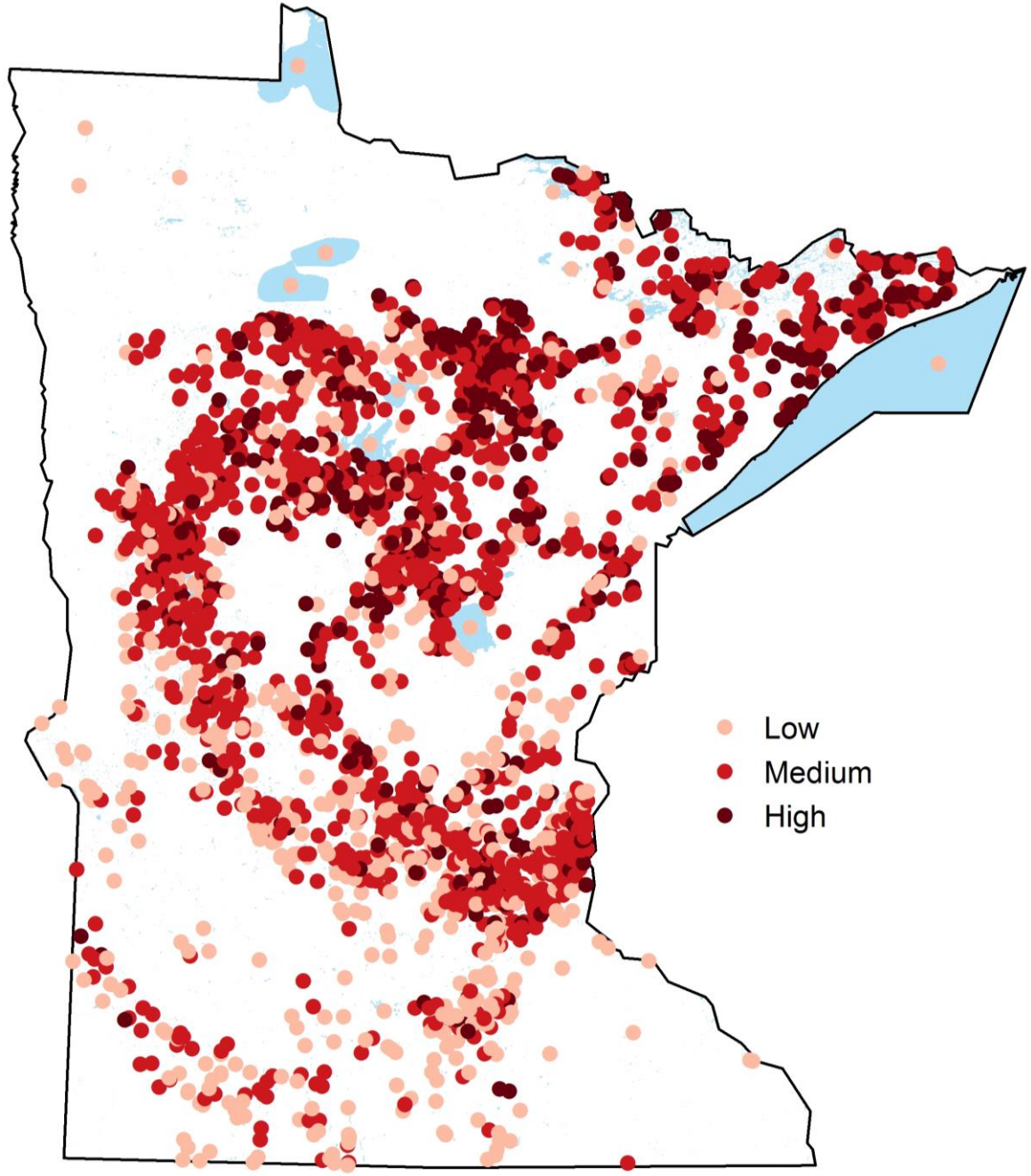
Lake's TP Sensitivity



Sensitivity = Loss in Secchi transparency (inches)

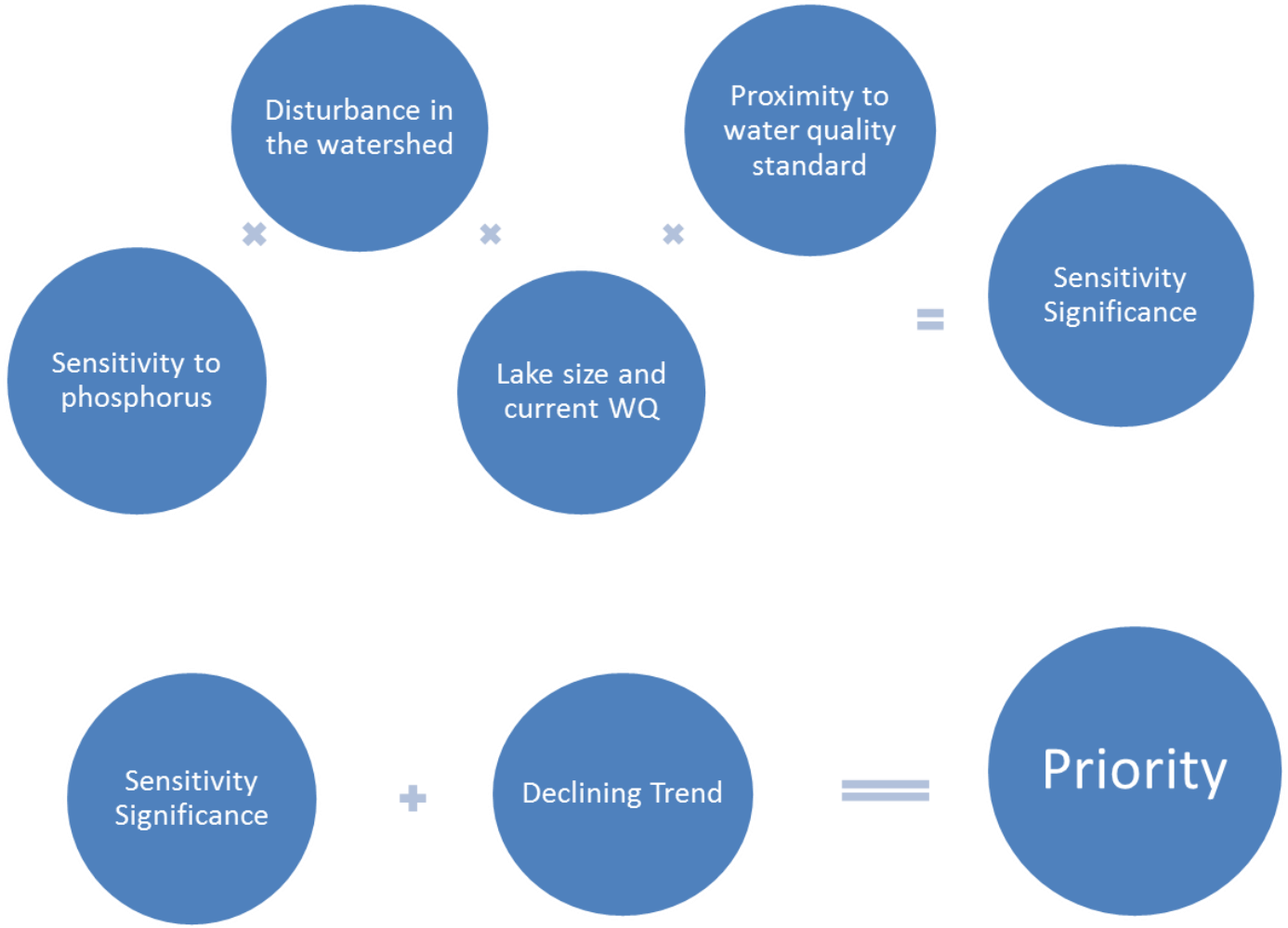
TP Sensitivity

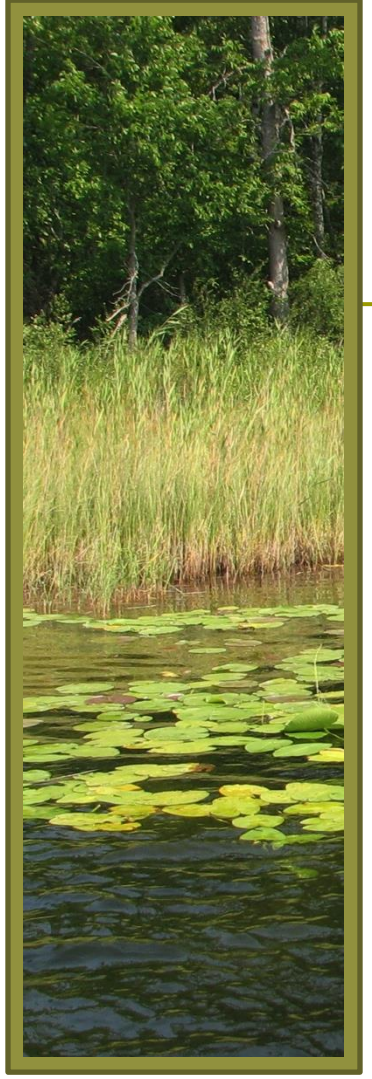
Inches lost in water clarity with an increase in 100 lbs of phosphorus loading



Lake Protection and Prioritization

- Framework to identify lakes at high risk for loss in quality (clarity) due to phosphorus increase
- Completed statewide on lakes with water quality data.





Lakes of Phosphorus Sensitivity Significance (LPSS)

Model inputs

- Lake volume, water retention time, mean Total Phosphorus (TP)
- TP sensitivity (inches of water clarity lost with 100 pounds of phosphorus)
- Proximity to impairment threshold
- % watershed disturbance

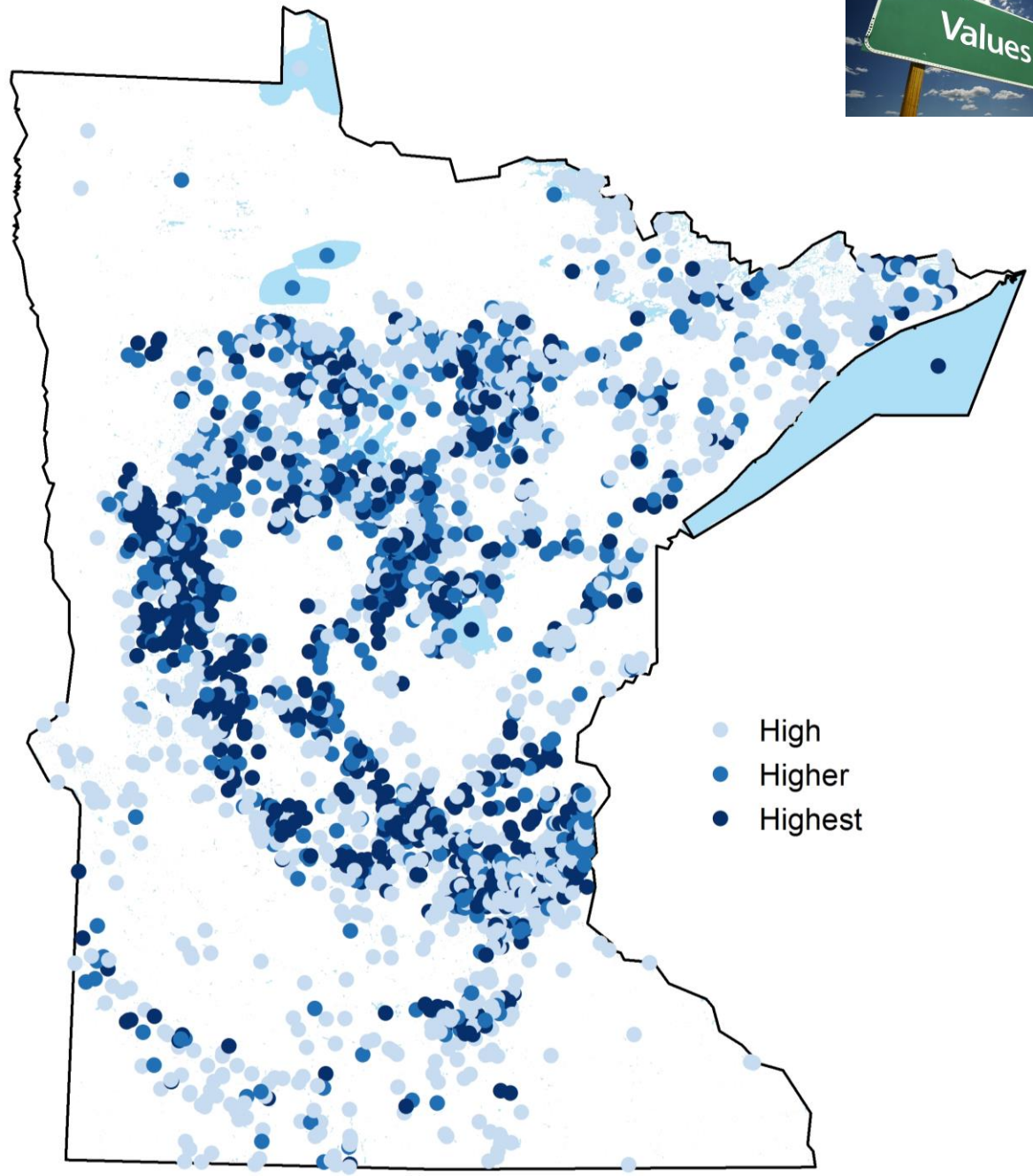
Output for each lake:

- Priority score - 0 to 100 (low to high)
- Priority ranking & class
- Load reduction goal (5% reduction; pounds/year)

LPSS Priority Score

Based on a lake's sensitivity significance and presence of declining water quality trend

Focus on high-quality lakes at greatest risk of becoming degraded or further degraded



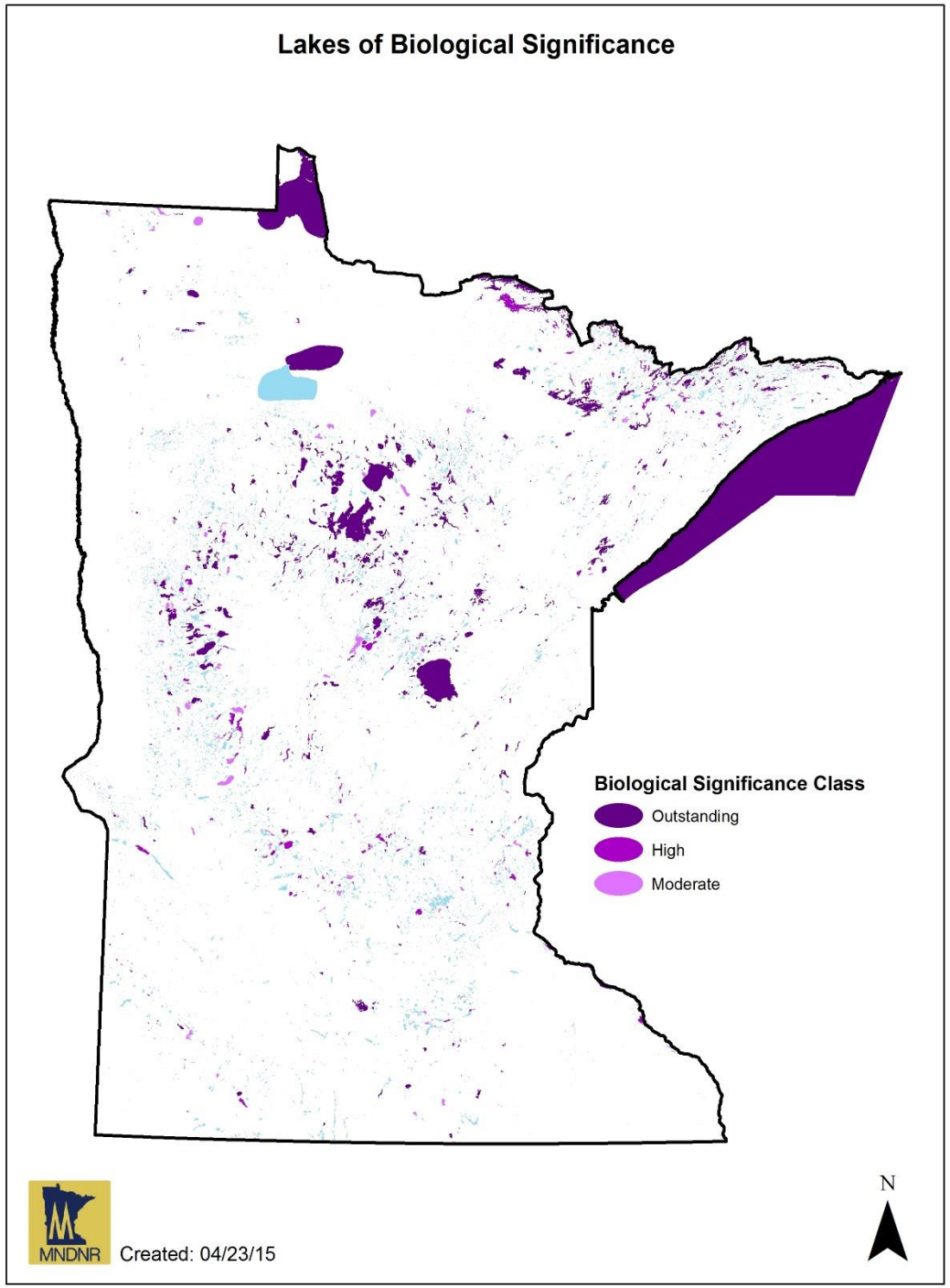
Lakes of Biological Significance (LOBS)

A list of high quality lakes based on dedicated biological sampling.

Lakes were rated and grouped for fish, aquatic plants, birds, and amphibians

Highest quality features within any of the 4 assessed biological communities set classification

Focus on lakes with high-quality biological communities



BCR (Economic Model)

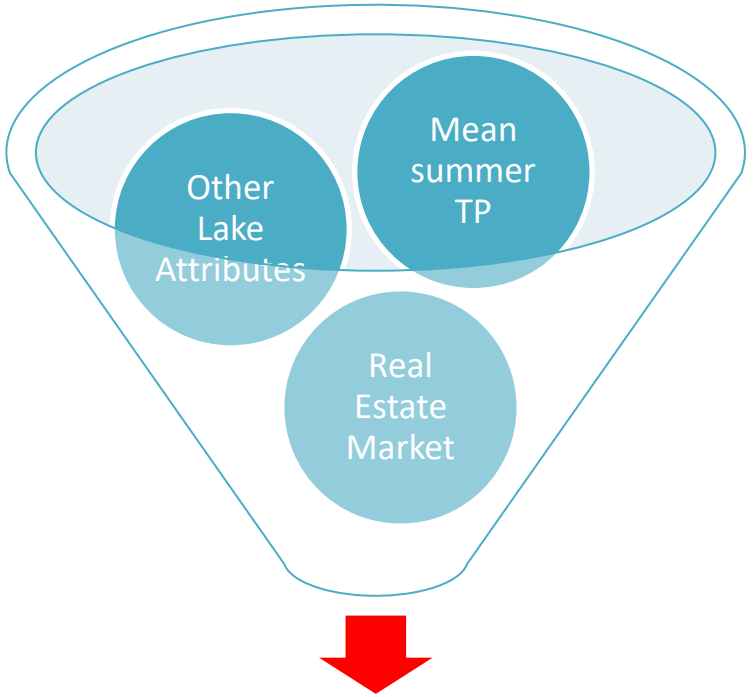
Benefits (B) – $ VALUE

- **Market Valuation**
  - Price for clearer lake
- **Indirect Valuation**
  - Difference in prices
  - Travel cost

BCR

Predicted land values based on lake's mean TP ($/shoreline ft)

- Land value was higher with lower TP
- Land value was higher with bigger and deeper lakes
- Real Estate Market

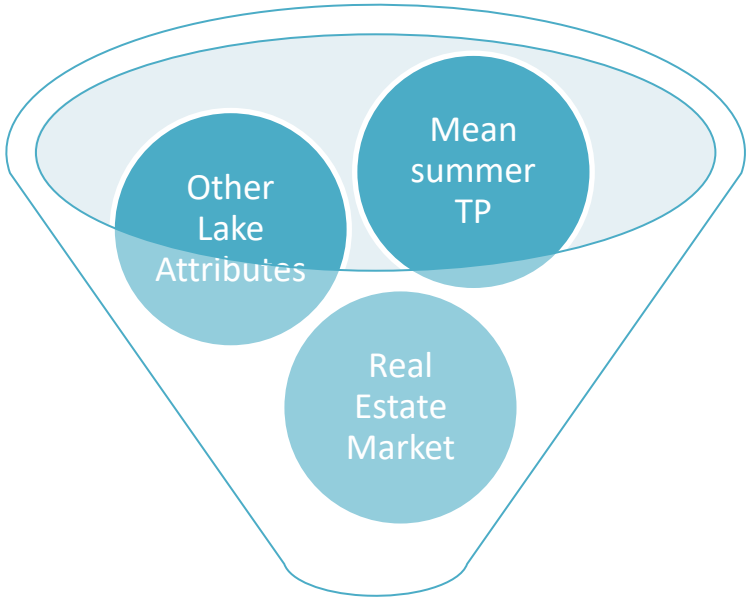


One Can Predict Benefits!

BCR

Predicted land values based on lake's mean TP ($/shoreline ft)

- Land value was higher with lower TP
- Land value was higher with bigger and deeper lakes
- Real Estate Market



Land Value ($/shoreline ft)

BCR

Benefits (B)

- Total land value increase for a lake with 5% P reduction

Cost (C)

- Ag – $18/pound P
- Residential/Urban – $21,000/pound P
- Forest – conservation easement 60% of land $

BCR

- Multipliers – probability of feasibility (T) & willingness (W)
- BCR = B/C x T x W
- Higher the BCR → better the return on investment (ROI)

Shoreline Value

Mean lake shoreline value

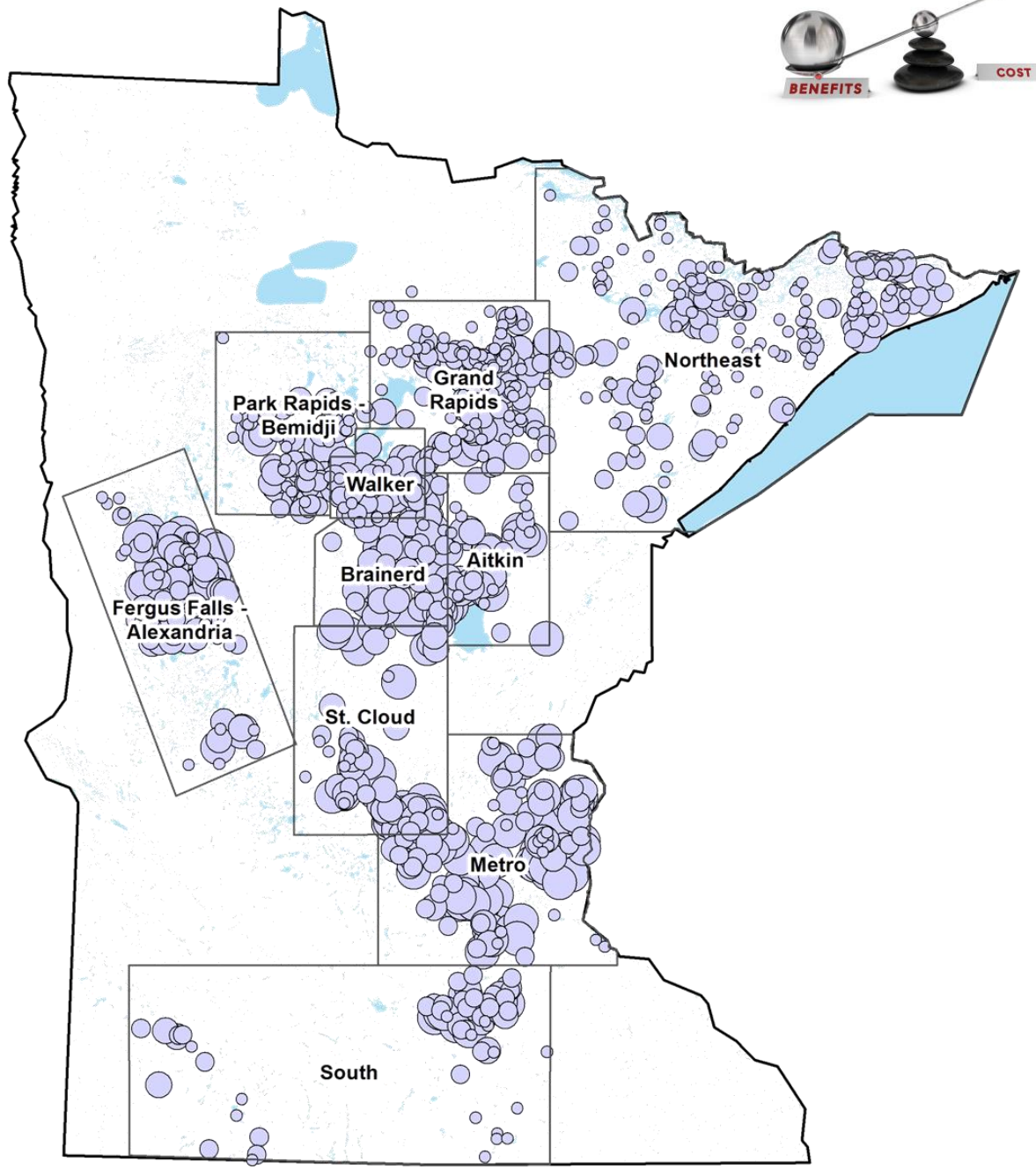
Land value ($/ft)

Brainerd

Median: $800/ft (max $3800/ft)

Walker

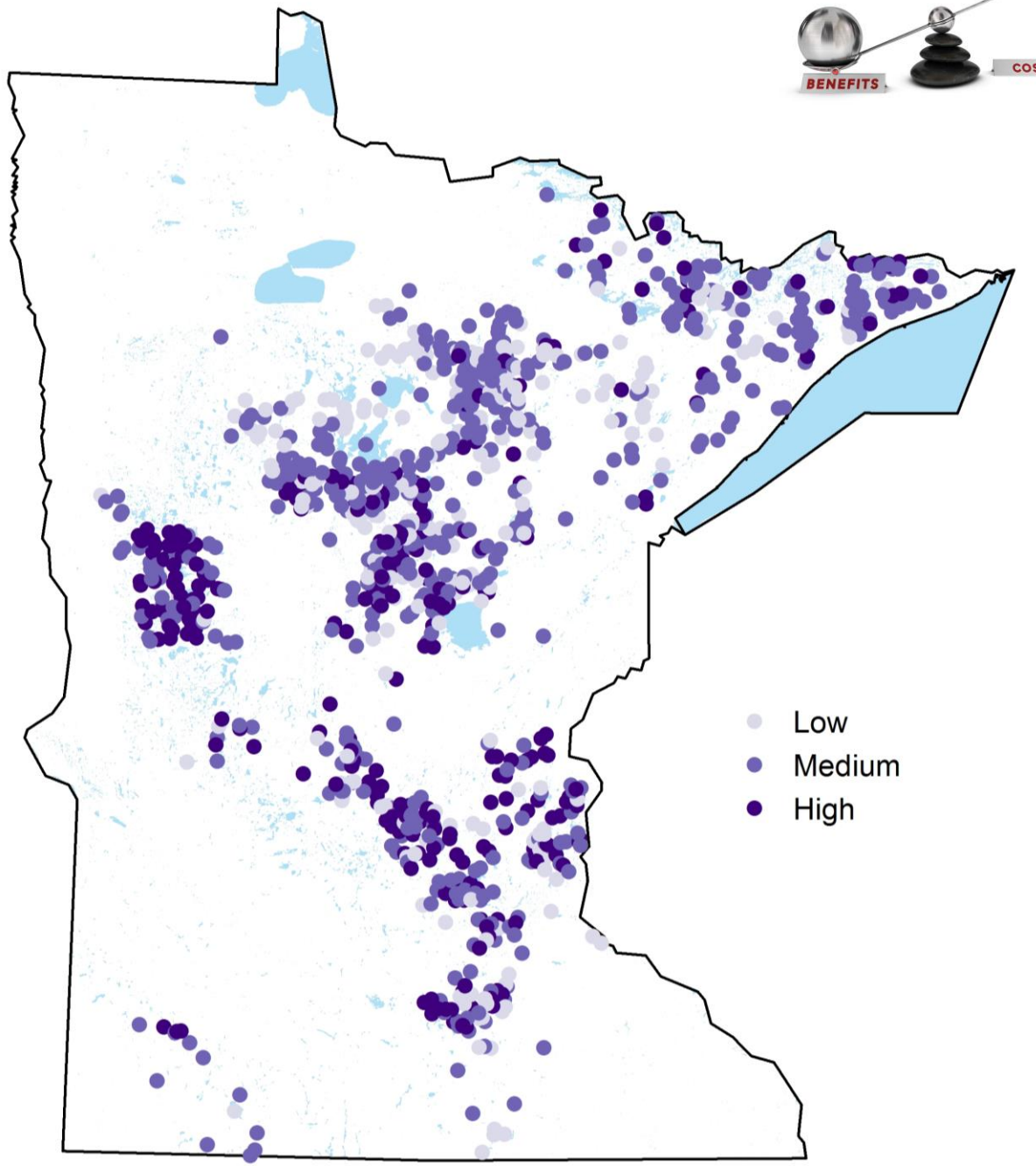
Median: $500/ft (max $1600/ft)



BCR

Benefit:cost ratio

- Benefits - Large lakes & urban lake benefits likely exceed $1 million
- Costs - by land use:
  - Forest (cons. easement) = $3/ft
  - Ag dominated watersheds = $9/ft
  - Residential/Urban watersheds = $17/ft



Lakes with high BCR

- Large lakes (>1000 acres)
- High land value lakes
- Lakes of Biological Significance
- Lakes highly vulnerable to additional phosphorus loading (TP Sensitivity)

Lakes with low BCR

Impaired Lakes → Higher Costs

- IF restoration focused on the top 100 BCR impaired lakes, THEN Cost = $80 million & Benefit = $34 million
- For the same $80 million, selecting high BCR lakes without regard to impairment status:

  198 lakes (vs. 100)

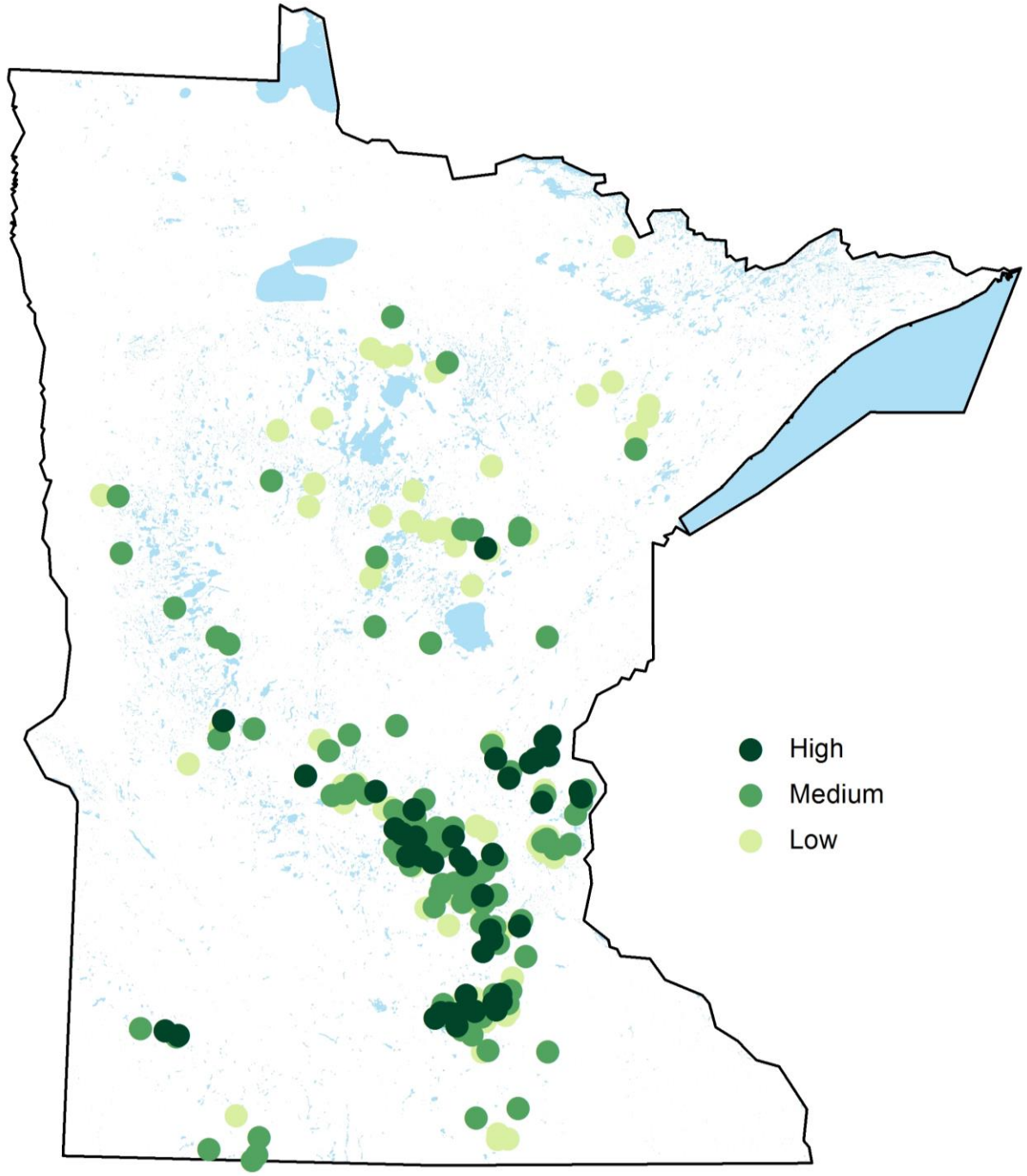
  Benefit = $209 million (vs. $34 million)

6X greater ROI if focused on high BCR lakes over focus on impaired lakes

Impaired Lakes

Top 100 BCR impaired lakes

There are nutrient impaired lakes with high BCR!



Which Lakes Would You Prioritize?

Think about giving higher priority to lakes that are:

- Large
- Sensitive to Phosphorus loading
- Protected with cost-effective strategies (forested shoreland)
- In cities or highly developed
- High value biological communities

Summary

Invest a greater share of funds for lake protection, less on those impaired

A higher ROI can be achieved through investments up north

Asset preservation
Asset creation
Connecting people & things

LAKESHORE LIVING